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FIREBASE

ABSTRACT

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Firebase is a development platform launched in April 2012 and acquired by Google in 2014 as an solution for back-end developer.

The feature combination in Firebase accelerates the cloud database integration automatically in both web and mobile app, and directs to settle the required massive tasks which should be accomplished by developers. Firebase is divided into 3 units: develop, earn and grow. Depending on the properties of the app, the client could deploy one of these 3 pillars or integrate all functionalities of Firebase to synchronize the essential data, resulting in the trouble-free experience for end users from the real-time database, analytics, messaging to dynamics link. By charging no cost under limited usage, Firebase is available to be commenced and clients are able to upgrade when the app tasks are requested to be equipped with more advanced features. Developers could uplift the infrastructure on the Google-based app, focus on the app content and user's satisfaction in a secure system.

The thesis focuses on Firebase features that simplify the coding process and systemize upon development for both web and mobile applications. The simplicity and systemization are analyzed through the case of Medirex, which is a pure Firebase web application.

Key words
Firebase, function, developed technology, authentication, real-time database

CONCEPT DEFINITIONS

Hyper Text Markup Language (HTML): an independent hypertext document is equipped with HTML that obtains a wide range of domain to public information into the Internet. HTML is purely Standard Generalized Markup Language with generic semantics which is feasible to present news, emails, hypermedia, document, simple structured documents with in-lined graphics; hypertext views of existing bodies of information menus of options and database query results.
(Connolly 1995.)

APS.NET: .NET is libraries, programming languages and tools to construct a platform for several types of application. Especially, APS.NET is the enhancement, in which it is a part of Microsoft platform to generate a dynamic web page, web service and web application as an open source server-side web application. (Microsoft 2019.)

PHP: an acronym for Hypertext Preprocessor. The PHP code is executed on the web server. It is a scripting language which is interpreted in place of assembling like Java and C++. (McCown 2012.)

Perl: used to be one of the most common general-purpose programming languages in the 1980s. It is widely applied in computer-center system admin and Web development. Perl holds the ability to shorten text files so that it can be achieved within a few lines of coding that might consume half a page when deploying C or Java. (Sampson 2010.)

Ruby on Rails: (or Rails) defined as a dynamic programming language that effectively conveys meaning and complex grammar. There exists a library on Rails which contains powerful API for procedural and functional programming styles though it is a pure object-oriented language. It comprises powerful metaprogramming competences and can be deployed to create domain-specific languages. (Matsumoto, Flanagan and Yukihiro 2008.) Rails is a software library which enhances the Ruby programming language. Rails is basically a framework for building websites that are installed over the operating system command-line interface. It is executed on a web server by using Ruby with many other languages to build web applications such as software libraries that simplify the task of building complex websites. (Kehoe 2013.)

Python: a classically powerful programming language that counts on indentation as a control structure and permits developer to deploy variables without declaring them such as it determines types implicitly. Python can be executed on Windows and Unix-like systems such as Linux, BSD, and Mac OS X. In Python, the developers are free to copy and study source code as well as build change into it. (Doty 2008.)

Java: a full-featured and versatile programming language which is able to progress robust mission-critical applications. Not only being utilized for web programming, Java is also employed among diverse platforms on a desktop computer, mobile service and servers. Today, Java is commonly used to develop applications and Android that is able to process data, perform computations, and generate dynamic Web pages. (Liang 2015.)

C++: a programming language providing object-oriented programming features. Later, it has added generic capabilities as a hybrid programming language that contains the C functionality, which means it is feasible to implement all features in C language. (Halterman 2019.)

JavaScript: in HTML pages, JavaScript is applied to perform as a programming language. It operates as an interpreter built into the web browser of the user. JavaScript is a compiled object-oriented language, unlike Java. The code is utilized for client-side applications sent to a user via computer when a Web page is loaded. (Brooks 2007.)

CSS: Cascading Style Sheets. It is a set of requirements to monitor how the web browser is viewed on the web pages. (AndarSoftware 2018.)

NoSQL: an acronym for not only SQL, the storage where the database is saved in. NoSQL databases are distributed, open-source and are horizontally scalable, and non-relational database management system which can deliver retrieval database fast. (Sharma and Dave 2012.)

JSON: stands for JavaScript Object Notation. In order to interchange data into easily readable one for the individual, JSON is an independently trivial text-based open standard which is extended from the JavaScript scripting language. It is executed while deploying JavaScript based applications that comprise browser extensions and transmit data between a server and web applications publicly. (Tutorials Point 2017.)

HTTPS: Hyper Text Transfer Protocol Secure emerges in the URL if the website is already secured by Secure Sockets Layer certificate. When clicking on the lock symbol on the browser bar, the detail of the certificate is viewed together with the issuing authority and the corporate name of the website owner. (Symantec 2019.)

SSL: an acronym for Secure Sockets Layer. To secure the internet connection and sensitive data between many systems, SSL is illustrated as a standard technology which prevents criminals from reading data and modifies any information transferred. The system could be server and server or server and client. To prohibit a hacker from reading and destroying the connection, SSL executes encryption algorithms to muddle data in transit. It thus protects the information of users that could consist of name, address and financial data. (Symantec 2019.)

SSDs: stands for Solid State Storage Drives which are based on flash memory. SSDs is the similar type as SD card yet it holds much greater reliability than SD card which is ideal for storing data on a long-term basis. Depending on the access types, SSDs has greater performance than traditional HDDs and it does not require to rotate nor look for local data. (Solutions 2017.)

CDN Edges: an acronym for Content Delivery Networks. It exists as the "edge" of a network that its server works for the separated network that desire to connect. CDN is in regard to a geographically distributed group of servers that operates to provide data fast along with Internet content. It aims to store content at a nearby machine, in case the client requests data, thenceforth decrease the latency and boost the load times A CDN permits quick loading time from beneficial transferring content in several types of document. Today, many websites' traffic is relying on CND services to transfer files. (Cloudflare 2019.)

SDK: stands for "Software Development Kit". Due to a specific platform, SDKs combines software used to develop an application. It includes certain tools such as related documents, libraries, code samples, processes and tutorials, which is equipped for the developer to create software applications on a specific platform. (Sandoval 2018.)

Unity Platform: a cross-platform for Unity3D Game Engine. Unity3D is the integration tool to advance interactive contents like architectural visualization, video games, and real-time 3D animations. Though it is edited on both Windows and Mac OS X platforms, it is still available to run on more than fifteen platforms such as iOS, Wii, Linux, Android, and Web Player. Based on JavaScript and/or C#, Unity3D can develop many types of games that are available on websites, desktops, handheld devices and consoles. (Patil and Alvares 2015.)

XMPP: an acronym for The Extensible Messaging and Presence Protocol (XMPP). It uses as the format of Extensible Markup Language (XML) for real-time communication such as exchange information between entities by sending small pieces of XML. It can be considered as both a service and an application depending on a specific purpose. XMPP is a secure, decentralized, extensible and scalable community that provides open technology full real-time interactions and interfaces. (Saint-Andre, Smith and Tronçon 2019.)

Progressive Web App (PWA): a type of application designed to overcome the restriction of mobile browsing and native applications. Google has developed PWA as hybrid technology. In general, PWA is a website constructed employing web technologies that undertake as an app and is not essential to be installed like a native app. It is a web application towards user experience on a mobile device via offline support and pushes notifications that are suitable in any devices. (Tandel and Jamadar 2018.)

Continuous Integration (CI): supports developers to save time by integrating development practice process. CI ensures the multiple layers of each component work seamlessly. It enables software companies to improve competencies by practicing automated software building and testing in the project over optimally multiple times a day. Hence, CI in result leads significantly fewer integration headaches and immediate feedback about the health status of the project. (Tutorials Point 2016.)

Gradle: known as a build automation tool for Java and Groovy. It is also an advanced general purpose build management system and open source via ANT, Maven, and Ivy repositories construction. Gradle carries Groovy language based Domain Specific Language and yields indicative language elements relying on general purpose tasks. (Tutorials Point 2016.)

CocoaPods: defined as a dependency manager for Swift and Objective-C Cocoa projects. It is built along with default Ruby which is installable on macOS to support an elegant movement in a project and to provide more than 60 thousand libraries for over 3 million apps. (CocoaPods 2019.)

REST API: an acronym for Representational State Transfer. It is an architectural style for hypermedia systems which holds 6 guideline constraints that should be qualified when an interface is referred to as RESTful. It applies a resource identifier to associate a certain resource including interaction among factors. (Fielding 2008.)

BigQuery: handled by Google, known as cloud-based interactive query service for heavy datasets and fully-monitor an implement extension of Dremel core technology. BigQuery contributes certain features of Dremel to third-party developers and gets accurate results in merely few seconds of big data sets. (Sato 2012.)

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1   INTRODUCTION

Technology is a major concern in the society and human's behaviors in the last decades. Towards its benefits, modern technology influences people's life by shortening the distances, contributing new relationship, and widening knowledge of humanity. Although there are many minus impacts to the community, technologies by far take an extremely important character in every angle. (Younes and Al-Zoubi 2015.) Among the technologies, smartphone solves all complicated problems. Smartphone accommodates several functionalities serving the demands of the users. It could be a camera, recorder, calculator, and computer to entry various applications both online and offline. In general, the smartphone carries installed programmed applications, which are developed by programming languages. The app is defined as a version of a company website, or an official product obtained certain expertise. So far, as the active manipulation worldwide by smartphone is employed within every minute, even second, developers thus consume numerous hours to deploy code from A-Z. As a result, Android, IOS and web are the three significant platforms presented. It is complex to program for these platforms. They demand to process the most essential contents, and the other tasks can be supported by a third-party to decrease the time consumption and increase the total revenue earning. The third-party can distribute and exploit the original platform from the developer, and post these desirable functions for the app's users.

To simplify the performing tasks for programmers, Firebase is considered as one of the most preferable options. It provides many tools to diminish the effort of the. Since it is a currently weighty task for programmers to enhance user experiences in the app, Firebase lets developer set the app on App Store or Play Store. (Moroney 2017.) The feature combination in Firebase accelerates the cloud database integration automatically in both web and mobile app, and directs to settle the required massive tasks which should be accomplished by developers. Developers could uplift the infrastructure on the Google-based app, focus on the app content and user's satisfaction in a secure system. Overall, Firebase today is an engaging field for a developer to harness and it will be focused in this thesis as a multi-tasking tool.

2   THEORETICAL BACKGROUND

In the 1950s, the internet was used to communicate between computers with the very first programming language – ARPANET, which was sponsored by the government to share information from different locations. Until now, the creation of the internet and web has elevated the society to a modern generation in all the aspects. In more than 50 years, the internet today presents a very crucial background to connect, share, help, and work. Every traditional activity is converted into technology and simplifies people's life. To clarify this standpoint, all will be analyzed and deeply discussed below. (Banks 2012.)

2.1   Internet Definition

In the early internet, people used to directly communicate with each other by computer through cable and controlled by thousand agencies such as government, institute, business or even individuals. Internet is the foundation of connection, data, hardware, and software. A billion computers linked information throughout the world at higher speed, resulting in advanced technology line in a new generation. (McBride 2006.)

2.1.1   Internet Service Provider System

The web browser displays all the images, text, video or audio to the end user by using the web server. Eventually, a web server is a depot storing information on the internet. Therefore, it arranges the data structurally and shares the data to the individual. The web server can run the software on a web page. The web page presents data in text, image, video or audio depending on the creator's purpose. Hence, to display the web page, the use of Hypertext Markup Language (HTML) is needed. Similar to a book, the collection of web pages is called a web site. The web sites are usually named to approach the user. It might be educational institutions, company department, or services. The web site can be also maintained to advertise and promote a product. (Bangia 2005.)

2.1.2   Domain Name System

To approach a web page, a specific address is given. For the internet, the address is called an IP address. People would like to use alphanumeric names since it is quite difficult to remember numerical value. If there are tons of addresses worldwide, the loading time is slower by the heavy and non-structured information stored in the system. Hence, it is encouraged to store information on many computers which is known as a DNS server. The DNS is utilized to specify a web browser or website. It is separated into 3 parts in one link: (Molia 2014.) Identification label (It is named by the name of company, organization, institute), Generic Domain (Relates to the organization abbreviation. It is named by the service's type or provided content) and Country Domain **(**Mostly, every country uses two characters to demonstrate the country abbreviation. It can be de (Germany), fi (Finland), uk (United Kingdom), in (India)). These generic domains are common labels nowadays. (Molia 2014.)

Generic Domain Label	Description
gov	Government organization
com	Commercial organization
edu	Educational institute
org	Non-profit organization

TABLE 1. Generic domain labels (adopted from Molia 2014)

2.2   Web Definition

In the past, the internet is linked with a cable modem to connect computers. But in the modern era, the internet becomes the most popular technology and wirelessly. It is the resource for services, goods, and information via computer network (Shelly and Vermaat 2010.). World Wide Web is the most primary thing on the internet since it is the only way to approach a website. Furthermore, the internet contains a great deal of information converted in pages and stored in the linked computer through world wide web. (Singh 2001.)

2.2.1 Static Site

A static site is presented for fixed-web, which means it is unable to check who visited for the website and the data on that platform does not change itself. (Toolkit 2013.). Nevertheless, from another standpoint, there are some limited functions for a static site. The static site was no longer in use for dynamics data, personal content, or information structure's arrangement. So, it is suitable for showcasing things such as blog, restaurant, profiles or portfolio. (Camden and Rinaldi 2017.)

2.2.2 Dynamic Site

A dynamic site is a concept to interact with data, also personalize and build a relationship between updated information and visitors. (Toolkit 2013.) The dynamic site is un-fixed and presented due to the user's request. It utilizes programming language such as ASP.NET and PHP. According to client input information, the content on that page is yielded. It can be a shopping website or online result system. The dynamic website is therefore based on client specific request to deliver the page data. (Molia 2014.)

2.3 Applications of Internet and Web

So far, the human depends more on the Internet and the web. Back in the 1990s, the web started with HTML language and quickly became one of the most important platforms on the Internet. Over time, web applications received many pluses from individuals and society through advantages of communication, E-commerce, Collaboration and Training as in figure 1. (Alor-Hernández 2015.)
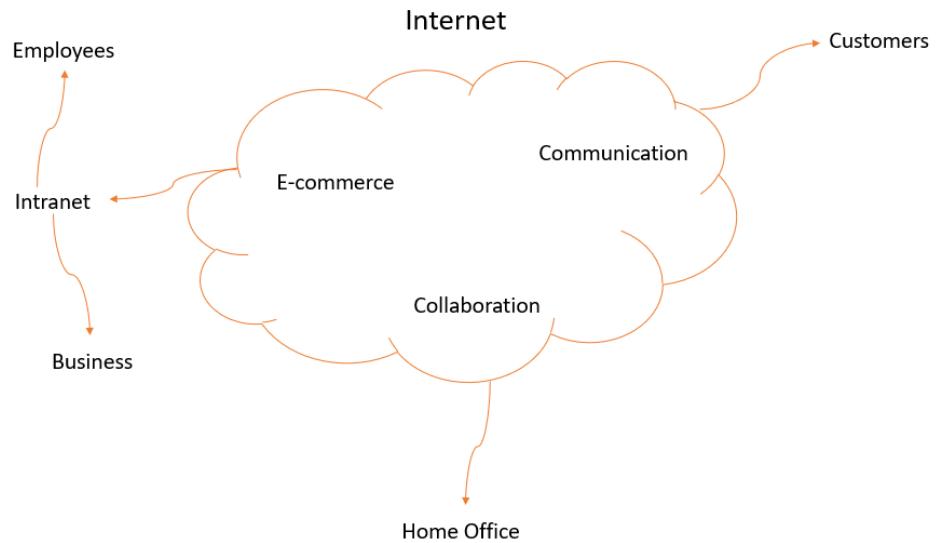
FIGURE 1. The common uses of Internet (adapted from Reid and Lorenz 2008)

2.3.1   E-commerce

E-commerce is the business set up on the web. People nowadays do not require to work traditionally; every issue is feasible to be solved on the internet via a web browser. Those activities include brochures, catalogues, advertisement and distribution services. (Reid and Lorenz 2008.) For instance, finding a hotel to stay when travelling is not a concern anymore thanks to the booking service. It allows customers to book and select the apartment via the internet on a computer or a smart device. Looking for information also becomes uncomplicated nowadays because people can approach a lot of results just by typing knowledge they want to search. Day by day, e-business becomes viral and successful along with the internet thanks to the low cost and time efficiency. (Fletcher, et al. 2004.)

2.3.2   Communication

There are many communication platforms on the internet. They can be message, audio, video, email, which reduces the cost when compared to traditional communication ways. Those are accomplished on the web browser in which all data are stored and shared wisely and quickly. (Reid and Lorenz 2008.)

2.3.3 Training and Collaboration

Through the internet, people can upload and find a document, e-book, or spreadsheet from all over the world. The internet forms a new training method, which supports individuals to learn and work comfortably in a remote location with a flexible schedule. Online studying, virtual meeting or online conference can also be done at ease through the internet. (Reid and Lorenz 2008.)

2.4 Web Development Today

As the early internet, only cable modem was used to transfer the request to the server. However, the internet has developed greatly with a significant innovation worldwide – Wi-Fi hotspot which does not demand the cable modem. When Wi-Fi hotspots were commercially established, the wireless option expanded to smartphones and other electric devices. Thus, to response those demands, the web developer should be updated every day to solve difficulties and enhance new functions for the end users. (Shelly and Vermaat 2010.)

With the technology developed, there are numerous modern electric devices coming online together with several applications. Therefore, the internet standard is essential to exist to set rules and guidelines for those networks. Also, those rules are complied in any device that can access the Internet. When private information of someone is shared and accommodated in a database, it should alert security laws for their data. If an email is sent through the personal computer and received by smartphone device, then they are necessary to possess the same standard rules. (Reid and Lorenz 2008.)

Within internet standard and many services providers, the information technology today is an outstanding development in the world. Websites are in surplus more database-driven and aim to be impressive with designing and fast updating data. Due to those factors, building and maintaining the application in a web browser on technological devices that are connected to the internet are crucial in web development. (Taylor and Smith 2015.).

2.5   Programming Language

A programming language is used to communicate with the computer in a way that the computer can read the user' purposes and send back the results. Learning a programming language is defined as a normal language that includes vocabulary, grammar. Thus, the computer then can recognize the request. Overall, programming languages are divided into two main development languages, front end and back end as in figure 2. Both are very important to build a complete website. (Cook 2013.)
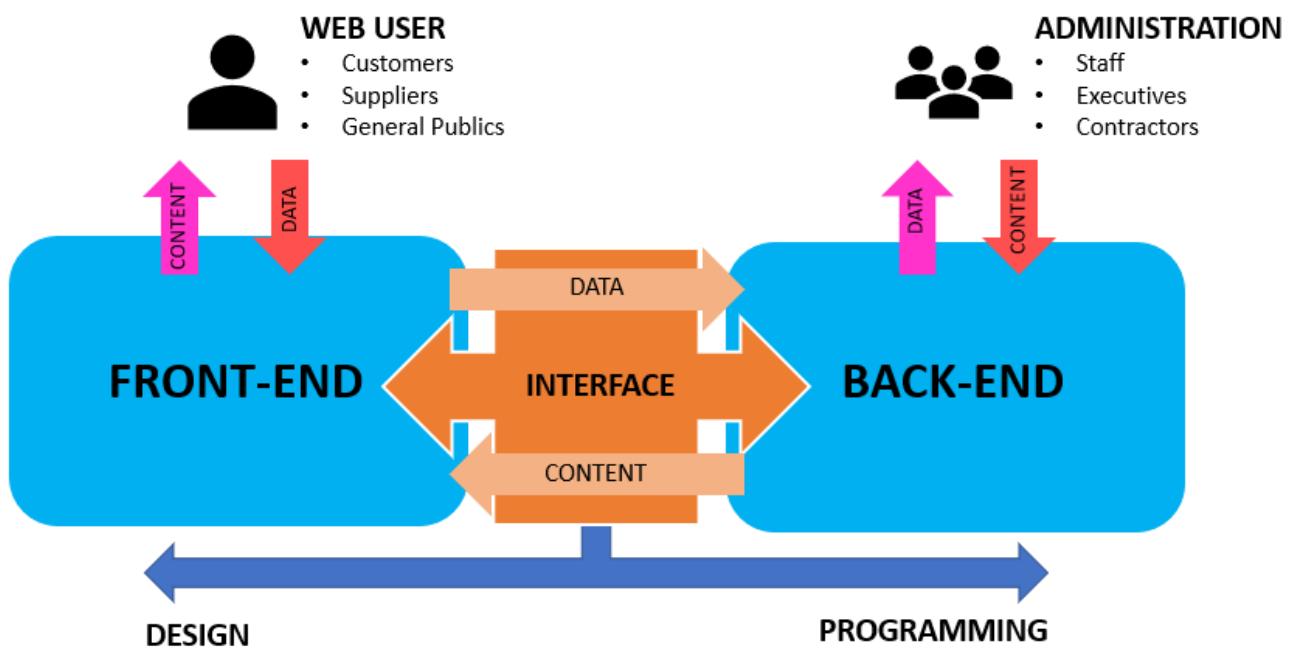
FIGURE 2. The relation between front-end and back-end (adapted from Technology 2019)

2.5.1   Front End

In the modern internet, many vendors desires to impress the clients with the web browser. Hence, there are competitions between various vendors, and it leads web developers to produce functions to display input and output information for end users. (Smith 2012.). The front end illustrates data over HTML, JavaScript and CSS languages for web applications. (Camden and Rinaldi 2017.) A front-end developer runs the web platform or compilation insert. A website designer is the career for this field. They establish and design the web layout. If the user requests something, the web server is loaded with data in the browser. However, if the request requires further information not only from the fixed data, for instance,

the converted currency worldwide should be updated every day, the back-end server is demanded, as in figure 3. In contrast, if the website purpose is merely for uploading information and sharing such as online newspapers or traditional blog, a static site is advocated. (Wodehouse 2019.)
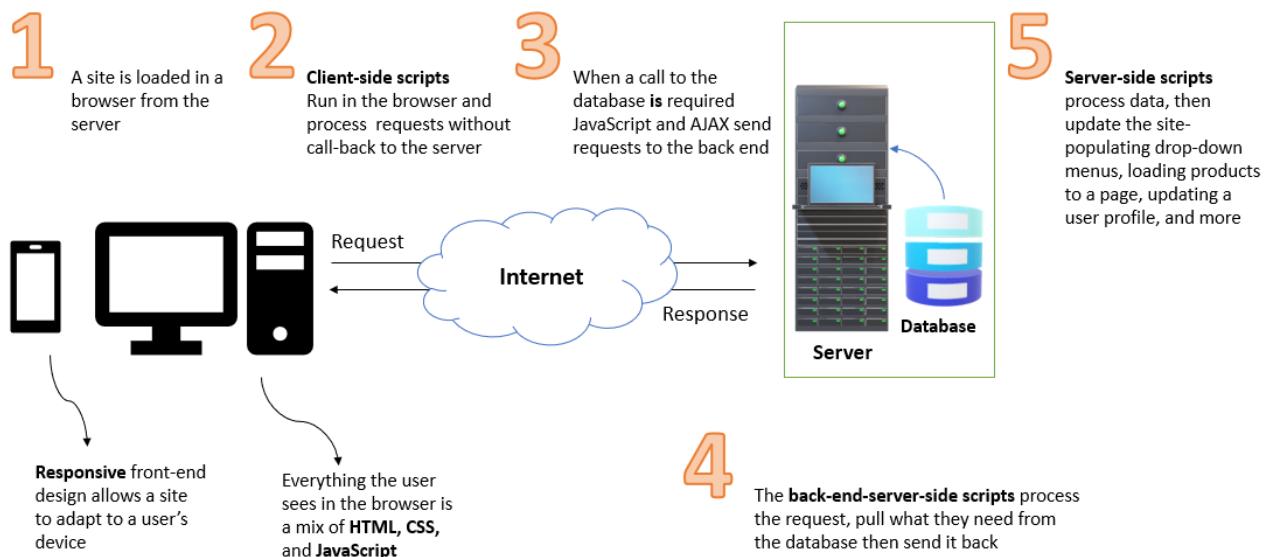
FIGURE 3.The front end and back end relation (adapted from Wodehouse 2019)

2.5.2 Back End

The back end is the type to sync or update information, can be written by many language programs and it is concerned with functions. In Amazon.com, back end assists users to add goods in the cart and purchase a shopping list with a private account. If the user inputs wrong password or credit card number, back end function creates feedback and requests a new secure method for clients to pay. (Washington 2019.). Different back end languages serve for specific purposes, and they can be Java, C++, Perl, Python, Ruby on Rail, PHP. (Tafazoli 2018.) Also, in Facebook.com, when users click add friend, the back end then sends a notification to that friend by interacting with the database on Facebook's storage, and a pop-up box will send the information back to the user as "friend request sent". The back end does not interact directly by users; it interacts with the front end presentation. In fact, the back end runs all the process behind the screens, and all information received by the user is presented by the front end. (Trivedi 2014.)

2.6   Different Technology

API (Application Programming Interface) stands for the third-party developer that accesses data and service for constructing an application such as an Android and IOS application on the mobile phone. API facilitates collaboration among several teams or organizations. Technically, API connects two applications through a programming language that both can understand and sync for that account. The simplest illustration is Google account. If there is a new application commanded the email and password, when the user wishes to log in upon Google account to sync all data from the Google database, and the information from the application sends the notification via Google email, it should have the third service – API to work for it. Firebase is a type of API, which is applied virtually and sponsored by Google. (Jacobson, Brail and Woods 2012.) API is an online software product. It will change constantly due to the new information of a business, so it works 24/7 and every day in a year. There are two types of API: private and public. (Jacobson, Brail and Woods 2012.)

Private API is more usual for a company that wants to transform complicated missions into uncomplicated ones to plug into the back end system. This software syncs and streamlines collaboration between the client's information. More than two thirds of customers access their services via API. API also reduces the cost of operating the back end application or web service. Thus, the business prefers to use API to interact with partners or clients. (Jacobson, Brail and Woods 2012.)

Popular companies such as eBay, Amazon and Airbnb use public API. Those businesses contact with the client by API. The activities such as 'select items put into the cart', 'list the arrival time', or 'count your total cost' are accomplished on API. It helps the customers interact with the company to comprehend all particulars over API. In public API, information is shared to everyone so it is expectant to develop the brand of a company. It also creates a flow of public data to several devices which can connect to the internet. (Jacobson, Brail and Woods 2012.)

3 FIREBASE

Firebase was launched in April 2012 and acquired by Google in 2014 to provide the solution for back-end developers. The feature combination in Firebase accelerates the cloud database integration in both web and mobile app. Firebase is a BaaS (Backend as a Service), which reduces configuration and setting up logically without time consumption. (Yahiaoui 2017.)

In summer of 2016, Google released Firebase officially for the goals of earning income for developers, building a successful application and promoting the growth of the business. Firebase can be called an enhancement or upgrade for APIs, which allows extended functions such as messaging, and service authentication. Consequently, this minimizes the cost and consumed time to build these services. Firebase provides new technology for business to advance via linking or referrals. Then, the system is connected by analysing the platform and is easy to integrate into the application. (Moroney 2017.)

3.1 An overview

It is not complex to create a Firebase application from scratch. As in figure 4, there are three features can be applied to the application: develop, grow, and earn. (Moroney 2017.). Developers are not required to use all three pillars; they are chosen depending on different purposes. Some technologies are at no cost such as Cloud Messaging, Crash Reporting, Remote config or Dynamic Links. (Moroney 2017.)

Build better apps   Improve app quality   Grow your business
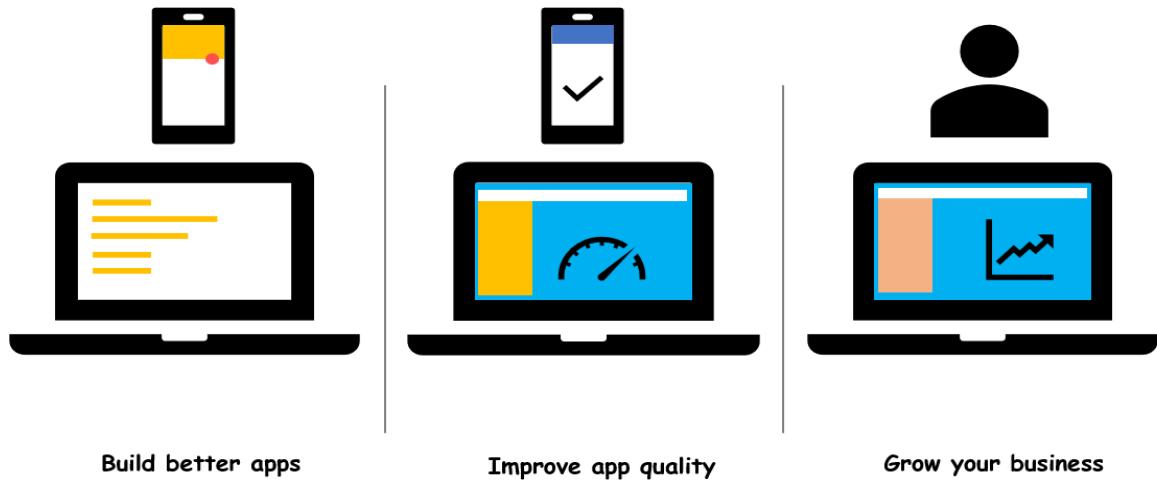
FIGURE 4. An overview of Firebase (adapted from Google 2019)

3.2   Firebase Authentication

At present, many web services use authentication to identify users and secure the data by controling access to their content. For instance, Google asks for account and password to log in some applications. The authentication is more complicated due to a third-party authentication - APIs. (Smyth 2017.) Hence, it is a goal of the Firebase team to complete the authentication to support developers by supplying with the convenient API which lets users log in or sign in from federated providers. It cooperates also with the real-time database to control the access, as in figure 5. (Moroney 2017.)

The common federated providers are Google, GitHub, Facebook and Twitter. If developers manipulate Firebase, it is not necessary to repeat the sign-in process, because it is already integrated with the authentication system of these providers. If the user has an existing account, it will instantly connect to the authentication system. (Moroney 2017.)

Firebase supports standard functions such as forgotten password, and users' verification via Firebase console. Users can anonymously sign in with temporary account and then the federated provider-base account is linked to that user. (Smyth 2017.) It also assists Smart Lock, which can automatically remember and sign-in by using the credentials. The email address is an essential credential to sign in, which then is passed to Firebase authentication SDK. Firebase back end server will verify these authentications,

then reply to the client. User's information can be determined when the user has the access to Firebase product or to control or verify their identity. (Google 2019.)

FIGURE 5. Firebase Authentication (adapted from Google 2019)

Firebase Auth is the least time-consuming option to integrate into programming. The actual project that supports Firebase authentication consumes longer time to write code than FirebaseUI Auth. It is an online library which allows clients to customize the common Firebase scenarios to provide the implementation for user authentication, which consists of user interface screens. (Smyth 2017.). FirebaseUI Auth covers many practices to authenticate on web, and mobile phone and is easy to handle. There are three main steps to integrate user authentication into apps on FirebaseUI Auth: Set up Sign-in methods, customize the sign-in UI, and use FirebaseUI to perform the sign-in flow. (Moroney 2017.)

Firebase Authentication SDK takes more time than the previous one. Also, it provides the verification for authentication process over full controlling the outlook. Eventually, this option maintains a complete version of authentication including many steps to identify the user's account. It is used to provide several tasks from signing in and out, logging in automatically to update the new user's data to the app. Firebase Authentication SDK moreover federates identity provider integration and anonymous authentication. To approach Firebase Auth, Firebase Authentication SDK is applied primarily. There are some steps that should be considered: Set up Sign-in method, implement UI flows for your sign-in methods and pass the user's credentials to the Firebase Authentication SDK. (Kumar 2018.)

3.3   The Real-time Database

The classic real-time database demonstrates the database system that overcomes the real-time restriction to consolidate a reliable database system. This is the key product of Firebase since it is a simple feature utilizing API. It syncs new information as JSON across all devices, in which real-time database collaborates the web and mobile version in the same device and shares with another device in milliseconds. Additionally, this product optimizes the offline service to save and store user information in the local cache and uses database SDKs so when the user is online, the data is synced automatically. The Real-time Firebase defines data structure and it is secured upon the Firebase Database Security Rules specifying people who can access particular information. (Google 2019.)

With a few codes by clients, it describes who can see specific information. It is not necessary to exist operation or maintenance server because the cloud service hosts a real-time database (NoSQL – based database). Like other products, the Real-time database is available for Android, IOS, Web, C++, Unity Platform and JavaScript. (Google 2019.). Real-time Database can scale up to 100 000 concurrent connections and 1 000/second for each database.
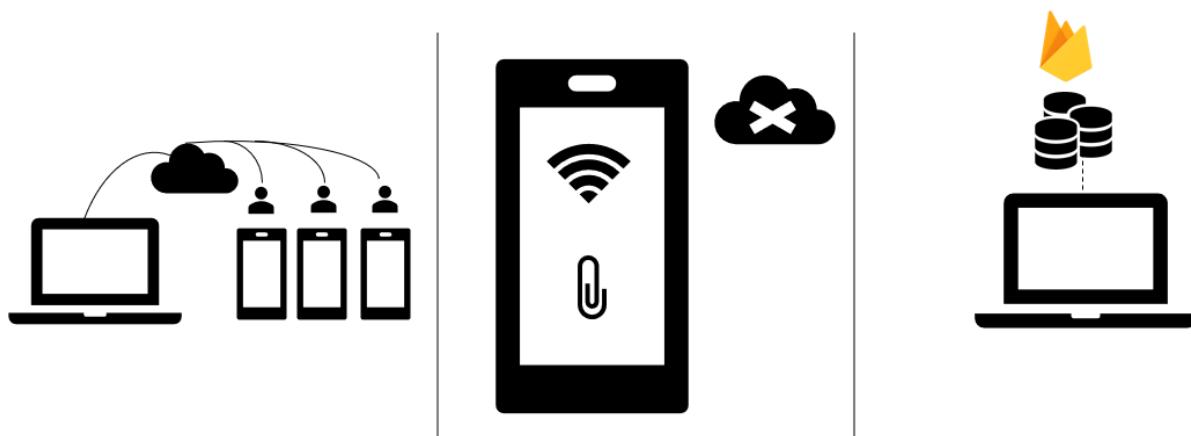
FIGURE 6. The Real-time Database (adapted from Google 2019)

The data set is changed and upgraded due to the dissimilar database, and integration real-time database with Cocoa Pods, or Gradle to promote the access time with clients. This implementation also provides the written ability while offline but still keeps the security for clients. These five steps are the basic paths to create a Firebase Real-time Database: Integrate the Firebase Realtime Database SDKs, create Realtime Database References, set Data and Listen for Changes, enable Offline Persistence and secure data. (Google 2019.)

3.4   Cloud Storage for Firebase

Videos, photos and documents are stored online through Firebase Cloud Storage service that is backed up on Google Cloud Storage. A simple API is applied to build and manage an infrastructure to deal with large files. (Tanna and Singh 2018.). Hence, documents are shared with particular users with the Real-time Database Rule. It means this storage is cached since it is integrated with Firebase Authentication. Through Firebase SDKs, it is effortless to upload and share files on mobile devices that are accessible for both Google Cloud and Firebase. Moreover, it is not necessary to transfer the document to another provider due to the automatic scale on Cloud Storage. Firebase declarative security is available according to file types, filename or size. Firebase SDKs applies robust operation even when the network is disqualified, if a video is not successfully uploaded, when the internet connection is qualified, it will continue to transmit that video depending on where it stopped. (Google 2019.)
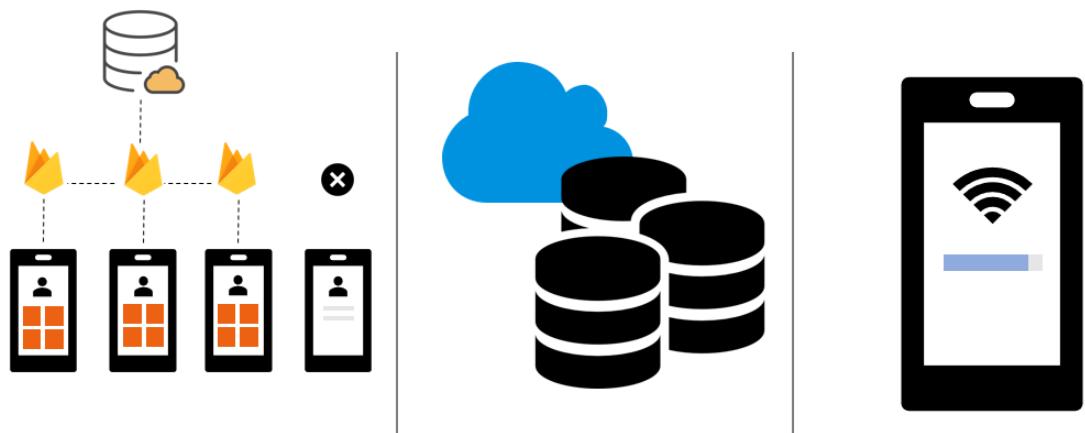
FIGURE 7. Cloud Storage for Firebase (adapted from Google 2019)

To comprehend this task, Firebase SDKs platform is built to interact with Firebase Cloud service. Admin SDK allows to read, programmatically send, access and generate Firebase Auth communicating with Firebase from the privileged environment. The following steps indicate how the Cloud Storage functions: integrate the Firebase SDKs for Cloud Storage, create a reference, upload or download and secure your Files. (Google 2019.)

3.5   Firebase Hosting

Firebase Hosting helps web app to host their static and dynamic sites by using files such as HTML, CSS, and JavaScript. It is an application that operates static web-hosting providers to serve several demands. Users have fast access to the sites and developers do not have to register a HTTPS connection certificate to run the web app since it has working principle with SSL. Based on Firebase Command Line Interface (CLI), Firebase is developed and processed in seconds. The CLI is installed before applying Firebase hosting which requires node.js for developing a system. (Moroney 2017.)

As applying Firebase Hosting into a modern website, the content is secured completely toward zero-configuration SSL. Because Firebase Hosting is cached on SSDs, and CDN edges, the substances are received fast. Furthermore, it furnishes with undo function when the development has an error, so the Firebase hosting supplies full version of management. (Google 2019.)
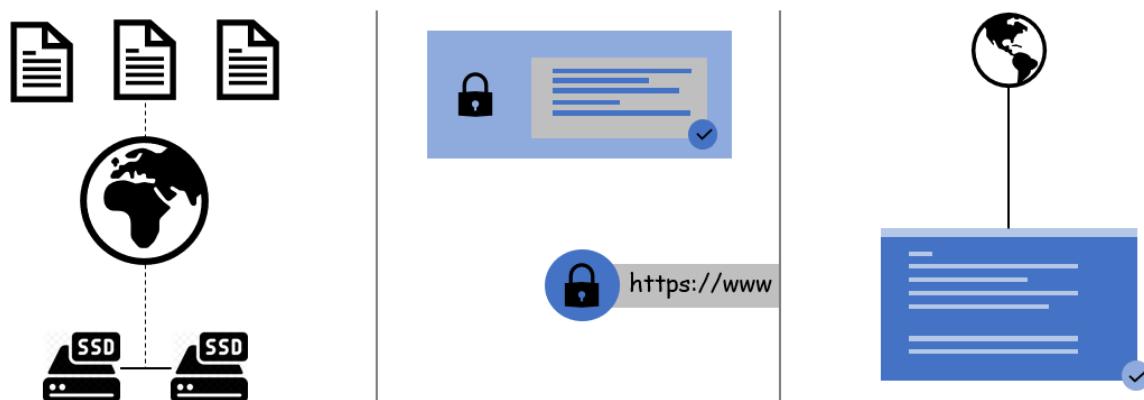
FIGURE 8. Firebase Hosting (adapted from Google 2019)

To execute Firebase Hosting, Firebase CLI is regarded as a tool with the complete version for sites, apps or Progressive Web App (PWA). The steps should be marked to implement the features, infrastructure and tailored tooling on front-end: Install the Firebase CLI, set up a project directory, deploy the site. (Google, Firebase 2019.)

3.6   Firebase Test Lab

This is a cloud-based infrastructure testing app. Web users utilize a variety of devices with different software versions, therefore Firebase test lab is established to examine the development quality and its appearance. Robo test is one feature in Firebase test lab, which intelligently automatic test deploys and executes functions like features. Beyond the Robo test, Firebase test lab joins in an advanced app, when the app is simulated as an interaction with coding script to verify the results. (Google 2019.)

The test lab is available for both IOS and Android version. Developers can recognize an error on the layout of a specific device via a Google data center. The Firebase console is already an integrated test lab, with forwards integration with test labs such as Continuous Integration (CI) system and Android Studio. (Google 2019.)
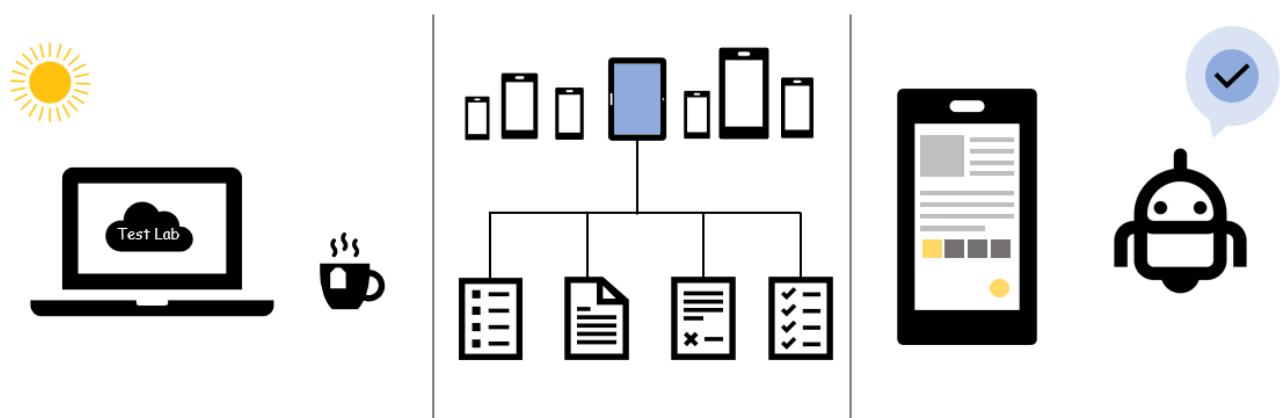
FIGURE 9. Firebase Test Lab (adapted from Google 2019)

A real device is flashed with the Google database center and APIs. It allows the developer to check their app with functions and configurations in real life. A creator can customize settings to verify placement: get the app ready for testing, choose a test environment and a test matrix and run the test and review test results. (Google 2019.)

3.7   Firebase Crashlytics

This functionality is used to perfect Google App quality, where developers observe web crashing. Firebase crashlytics was released on Fabric and brought by Google to become a part of the Firebase Crash Reporting system as an acquisition. Before starting the Firebase Crash Reporting, Crashlytics should be applied where it is the upgrade for stability issues. (Moroney 2017.)

At present, Crashlytics solves diverse problems based on the stack traces and avoids manual tracking. It works on problems while indicating the prevalence and rigour of those issues, therefore the problems can be found faster. Resolve common crashes is offered by Crashlytics by capturing the errors and related events to the issues. Alert and relapse possible errors are the surplus advantage of the Crashlytics. Those reinforcements are the strong provisions for Firebase to perfect their app. (Google 2019.).
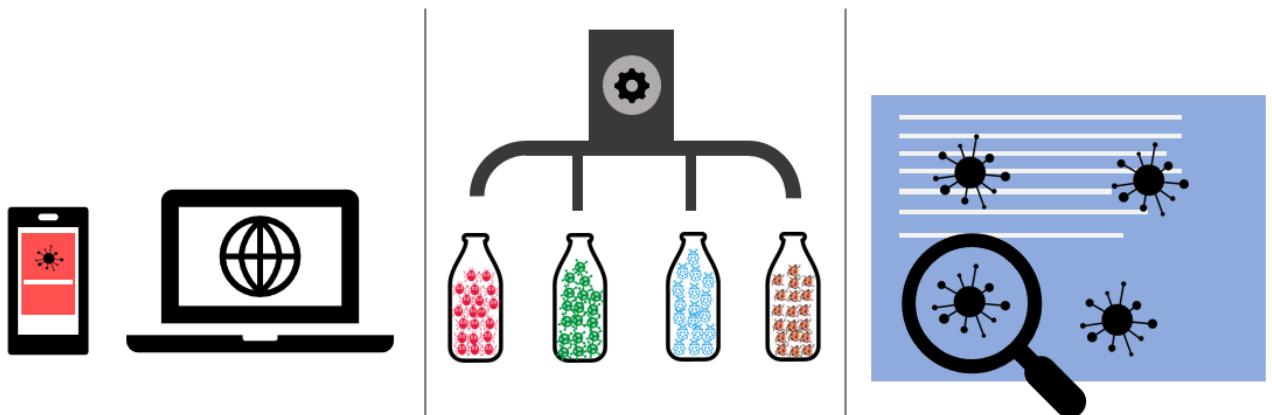
FIGURE 10. Firebase Crashlytics (adapted from Google 2019)

When developers click Firebase console to leave Crashlytics to go to the app, it starts gathering problems. The SDK, in this case, is influential via CocoaPods or Gradle to the crashlytics system. The steps should be followed: connect the App, integrate the SDK, check report in the Firebase console. (Google 2019.)

3.8 Performance Monitoring

Performance Monitoring provides insights about performance issues and automatically addresses the problem. The app performance is related to network latencies, so this feature monitors HTTP/S request and checks other elements consisting of waiting time to load, responding time, or pay loading size. Developers can also monitor the original problems outwards adding many codes. The issues are demonstrated as countries, devices and versions, hence the developer could access to the bottom line of the trouble. Performance data is reported via Performance Monitoring SDK, and it begins with measuring the time consumed from the app is opened to the app reacts automatically. There is another report called custom trace, which associates with client's codes. (Google 2019.)
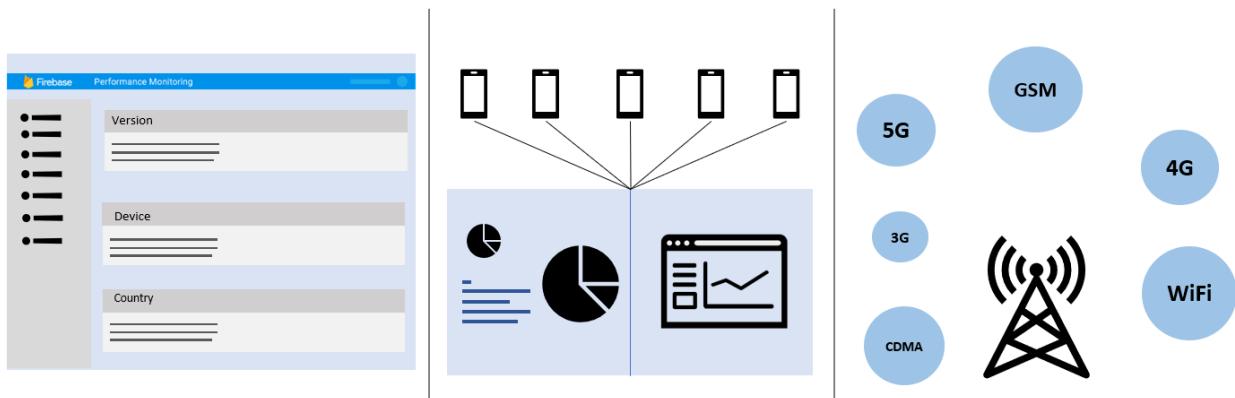
FIGURE 11. Performance Monitoring (adapted from Google 2019)

With no cost, the performance monitoring SDK joins in the app. Then the features like metrics, and custom traces are selected to be performed on the app background. During the developing progress, Firebase console is utilized to modify and improve the performance properties thanks to the specific conditions: add the Performance Monitoring SDK to your app, define custom traces and metrics for your app with the Performance Monitoring SDK, monitor performance data in the Firebase console. (Google 2019.)

3.9   ML Kit

As in figure 12, MK model acts as an API layer for different common features such as labelling images, texts, faces, and scanning barcodes. Instead of writing code to develop those features, clients simply need to execute a few code lines to transfer data from the app to the ML library. API's ML Kit is available on-device and on cloud service. Cloud-based APIs demonstrates the high technology in Google Cloud Platform machine to improve the quality of the result. For device-based APIs, ML kit can run offline and process fast. Furthermore, if clients have already possessed the ML model, Firebase also can host and serve the TensorFlow Model in the app. Developers merely upload that model to Firebase console and follow the instruction. (Google 2019.)
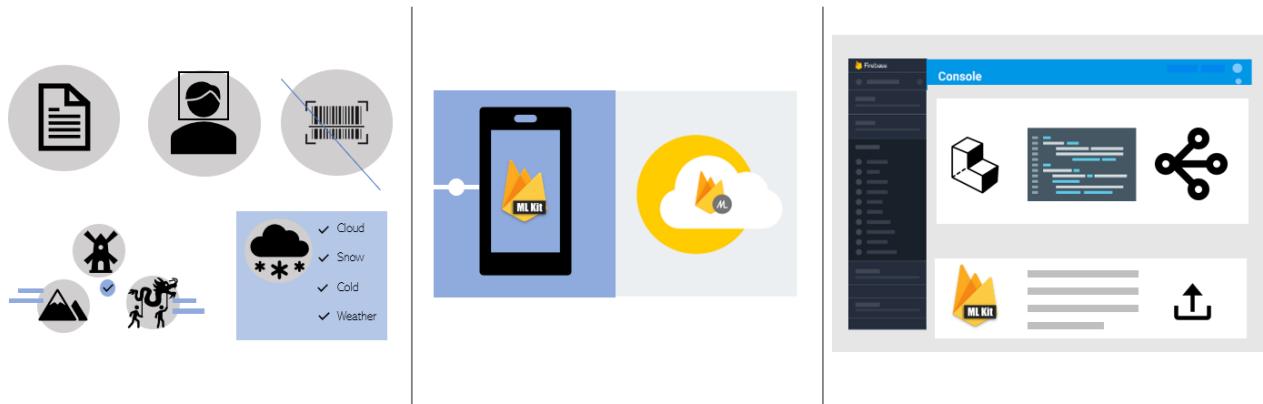
FIGURE 12. ML Kit (adapted from Google 2019)

Gradle and CocoaPods are used to integrate SDK. After that, data such as barcodes and images are imported to the ML model. The object or emotional states reorganizations are powerful features in the app automatically to yield metadata, and photo embellishment: Integrate the SDK, prepare the input, and apply the ML model to the data. (Google 2019.)

3.10   Cloud Function for Firebase

As in figure 13, Cloud Function is a part of Firebase and Google Cloud platform that permits the developer to manage less configures, such as updating the app or general securities related to Google services and Firebase products. The Firebase application is connected together by a Cloud function and executed on the Google server. It reduces boilerplate code via generating admin SDK, and third-party services

together with a Cloud Function. The command is deployed to automatically scale up the design's usage with the computing data. Thus, the updated configurations, credentials or decommissioning are accomplished without manual maintenance. Cloud Function undertakes the securities and privacy responsibilities on behalf of users. After adding a command line, the Cloud Function is insulated from the application logic to let client freely deploy codes on the main server. Therefore, developers prefer to master their app since those are served over Google features and the Firebase functions. (Google 2019.)

FIGURE 13. Cloud Function for Firebase (adapted from Google 2019)

To enforce this function, the Firebase project is deployed with a selected provider. Then the Cloud Function and Firebase CLI are installed to handle the desirable services with JavaScript. Firebase console can control and view a function through Firebase CLI: set up Cloud Function, write function and deploy and monitor. (Google 2019.)

3.11 The Growth Technologies

As in figure 14, the Growth Technologies are the key features supporting the client's app to execute smoothly which can be manually adjusted for each segment. Every technology performs its action running series to deploy a full version experiment to the app. From the path Analytics, predictions, testing to remote configurations and cloud message, each variant has different tasks to help analyze and develop the app for the developers. (Google 2019.)
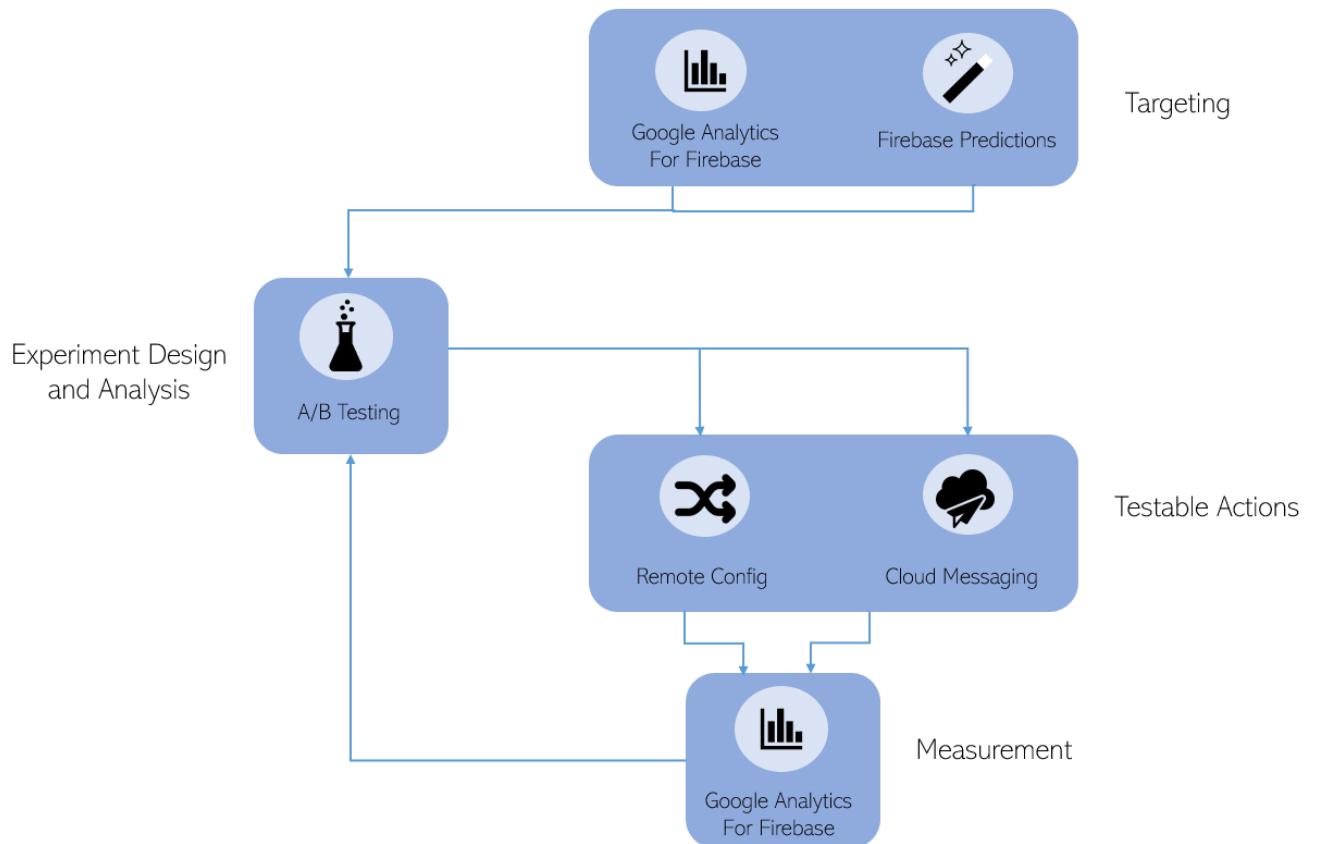
FIGURE 14. The Growth Technologies (adapted from Google 2019)

3.11.1 Firebase Remote Config

Remote Config conveys the responsibility to refresh modern content or behavior in the app to the end users by skipping the repeated download process. Within minutes, the remote configuration can dispatch the latest changes to the app without publishing the updated one. Throughout Firebase Analytics, remote configuration adjusts the app for various versions due to user behaviors. Nevertheless, remote configuration cannot optimize the new version based on the end user's comment, since there are thousands of hidden users that do not agree with that opinion. The conflict thus will occur if the character or appearance is published directly without any agreements. And the remote configuration leaves Firebase to create a new function for A/B testing. (Google 2019.)

FIGURE 15. Firebase Remote Config (adapted from Google 2019)

Remote configuration fetches and caches new parameter's value in the tasks under developers control after activating. Parameters are overridden as a service-side default in Remote Config REST API under the same condition with the current app. Set default data value is utilized according to the chosen parameter in the app, then the app is launched with the override fetched values: Install the app with Remote Config, set default parameter values, add logic to fetch, activate, get parameter values and update service-side default and conditional parameter values. (Google 2019.)

3.11.2 Google Analytics

Google Analytics views various statistics parameters to monitor the behavior of the user through purchasing data, crashing data, and effectiveness notification, in both Android or IOS app, to clearly apprehend the app usage. Diversity advertisement campaigns are launched via SDK through measuring the effectiveness of those ads and sending conversion data back to the client. The user properties via Google Analytics are unlimited events. The features can be observed in detail, e.g. the most purchased product or music types user listens to and shape a summary as demographics for these insights. Analytics function is automatically logged when a developer applies other Firebase features. The notification composer is activated to send messages to clients. More actions, if developers wish to share analytics data to other sources, can be taken to link the analysis data to BigQuery for presenting more complex data. (Google 2019.)

Google analytics can integrate with other functions: BigQuery, Firebase Cloud Message, Firebase Remote Config, Crashlytics, and Google tap manager. It offers services to different Firebase features for analyzing several values regards to the app. (Google 2019.)
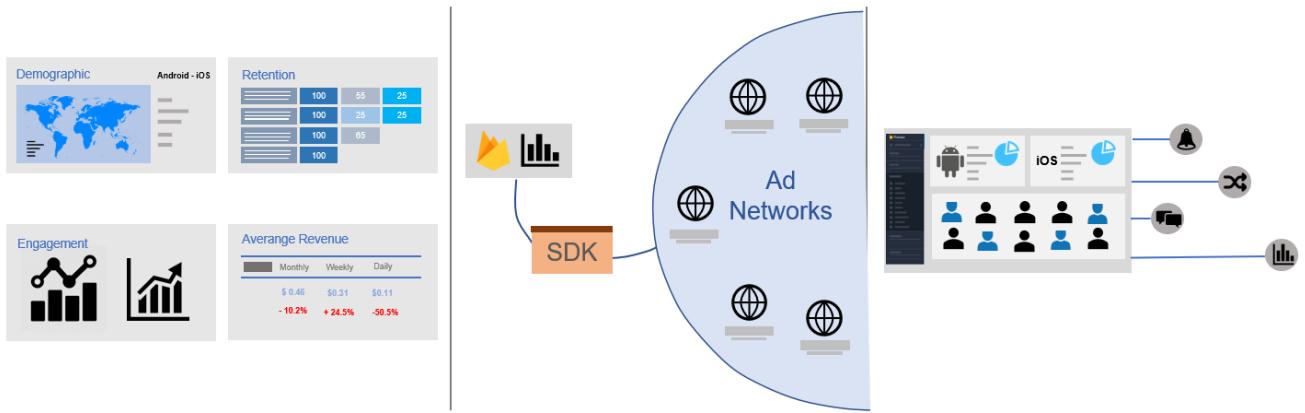
FIGURE 16. Google Analytics (adapted from (Google 2019.))

The app should be added to Firebase SDK, then the analytics is automatically logged with custom properties within hours, the target characteristics are connected with Remote config or Crashlyitcs, and so on: (Google 2019.) Connect your app to Firebase, log custom data, create audience and target audience.

3.11.3 Firebase Cloud Messaging

To support further on the client app, the app receives notifications through the Cloud Messaging. The notification is used to send data messages or determine the current state of their codes. The notification is sent to group or single device or subscribed devices. The subjects are data, expiration dates, sound or priorities depending on client control. Firebase Cloud Messaging (FCM) is a reliable channel to send messages from the app back to the server. Now monitoring the dashboard is more in details by integrating FMC with Firebase Analytics. Furthermore, A/B testing can also be joined, as its notifications within several versions can help the developer to look into the performance. These functions engage together to give the full version of Firebase Analytics platform. (Google 2019.)
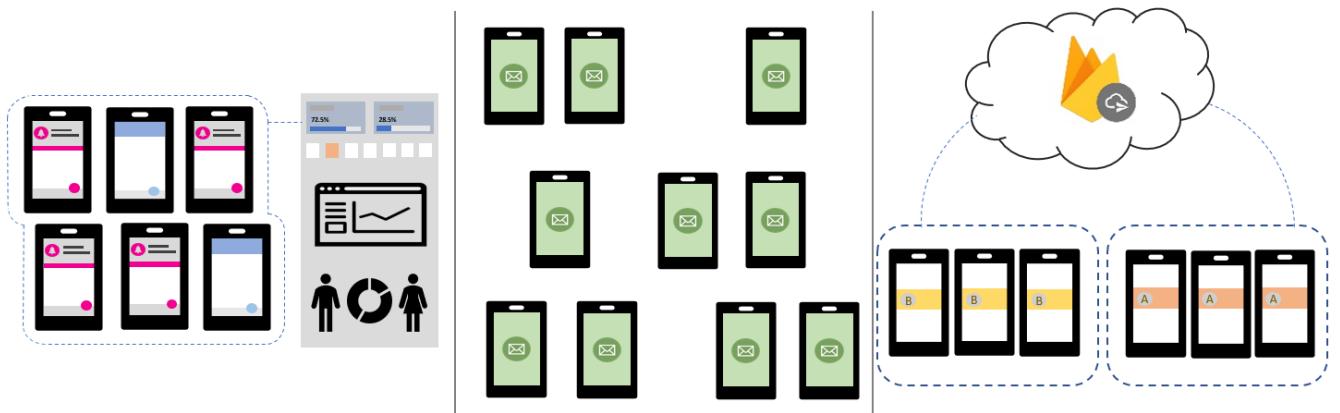
FIGURE 17. Firebase Cloud Messaging (adapted from Google 2019)

Firebase platform will instruct clients how to specify the function based on optional subjects. The communication section between developers and server is a server protocol or an admin SDK to build features. Nevertheless, the XMPP must be utilized in case of upstream messaging from the client app since Cloud Function does not allocate similar characters: Set up the FCM SDK, develop the client app and develop the app function. (Google, Firebase 2019.)

3.11.4 Firebase Prediction

Firebase prediction is an additional segment extending Remote Config to collect the potential customers that can purchase the promoted products in the app. Developers can predict the target group custom. It predicts user behaviors, then analyzes and responds to predictive segment combining with the data of the user sent to clients via cloud messaging. Those dynamics are linked and do support each other for the Firebase growth technology. As analytics, Firebase prediction can be distributed by BigQuery for further researches. (Google 2019.)
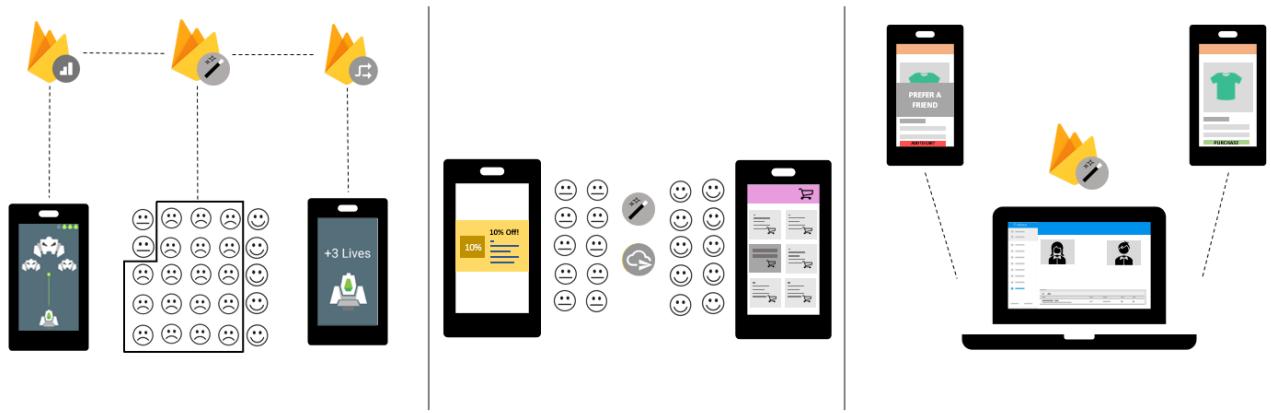
FIGURE 18. Firebase Prediction (adapted from Google 2019)

From Analytics, many events are recorded, and Firebase console starts to assemble predictions. The predictions data are constructed based on the Analytics or likewise on Remote Config parameters. The prediction segments then integrate with In-App Message to contact with the user in specific campaign or link with the Notification composer: Add Analytics to the app, enable Predictions and monitor prediction readiness, access prediction results from the app and reach the user in a certain prediction segment using the Notification composer or Firebase In-App Message. (Google, Firebase 2019.)

3.11.5 A/B Testing

This is an additional improvement when the Remote Config is used. In every business segment, A/B testing analyses and scales up results to the market achieving the set goals. The target trial can be any users or values, and be set flexibly to suit the app demand. It can be a group of users, specifying by countries, sex, ages, users who used to bump into crashes before. A/B testing works perfectly with Cloud Message, Analytics and Remote Config. The product experiment across users indicate the most effective features in the app to define the value that can be officially published via A/B testing. (Google 2019.)

FIGURE 19. A/B Testing (adapted from Google 2019)

The A/B testing can be integrated with Remote Config and Cloud messaging to evaluate the tested variants or with the Notification composer. Specifically, when Notification composer is utilized, Analytics should be utilized to set the goal. If Remote Config is applied, clients can also operate an Analytics event or conversion funnel to examine the goal. The implementation path should be: add Remote Config or Firebase Cloud Messaging to the app, define the variants to evaluate with an A/B test, define how to measure and monitor the experiment to find the suitable variant. (Google 2019.)

3.11.6 In-app Messaging

By integrating with analytics and prediction, in-app messaging advances capacities to exhibit updated information to the app quickly by commands. The users receive the latest promotion or new information of their data in the app, and minimize the consumed time when they are at the actual store. In-app messaging gets in touch with analytics and prediction to send messages to the user based on their demographics and behaviors, and clients can monitor the result of the user's behavior towards those promotional offers and the new updates via analytics. (Google 2019.)
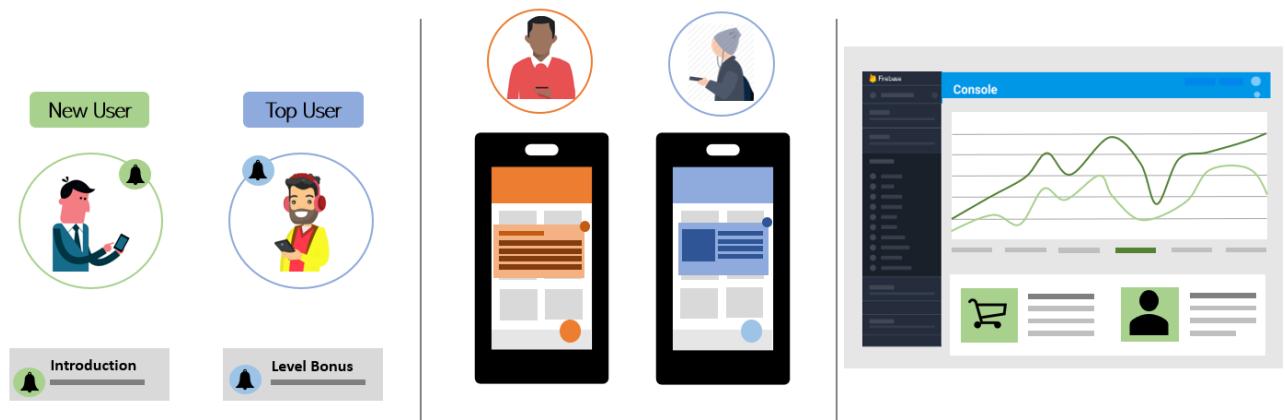
FIGURE 20. In-app Messaging (adapted from Google 2019)

Visit Firebase console to activate message. The messages are customized and adjusted via CocoaPods or Gradle by adding Firebase SDK to the app. This feature is unchallenging to work with if clients are already used to other Firebase key functions: Connect the app, integrate the SDK, and create the message. (Google 2019.)

3.11.7 App Indexing

The app index enforces the app towards Google search to accrete their ranking. When customers use app index, the app content is viewed right on the app, so they are close to the subjects. It also triggers an install button in Google search once the user searches for compatible content, hence it is convenient for the user to set up the app on the device. To apply the content, developers deploy an URL in the website app and verify them via Google. The end users who have already installed the app in the devices and when they search for similar content, the App Index then displays the same data as on an the app on a web search. When the users click on the content, Google directs them into the app. The app index API is available for both Android and iOS version if the developer wishes to build private, and public content and log action of the user. App index brings up efficiency when being combined with Admod to earn money for advertising. (Google 2019.)
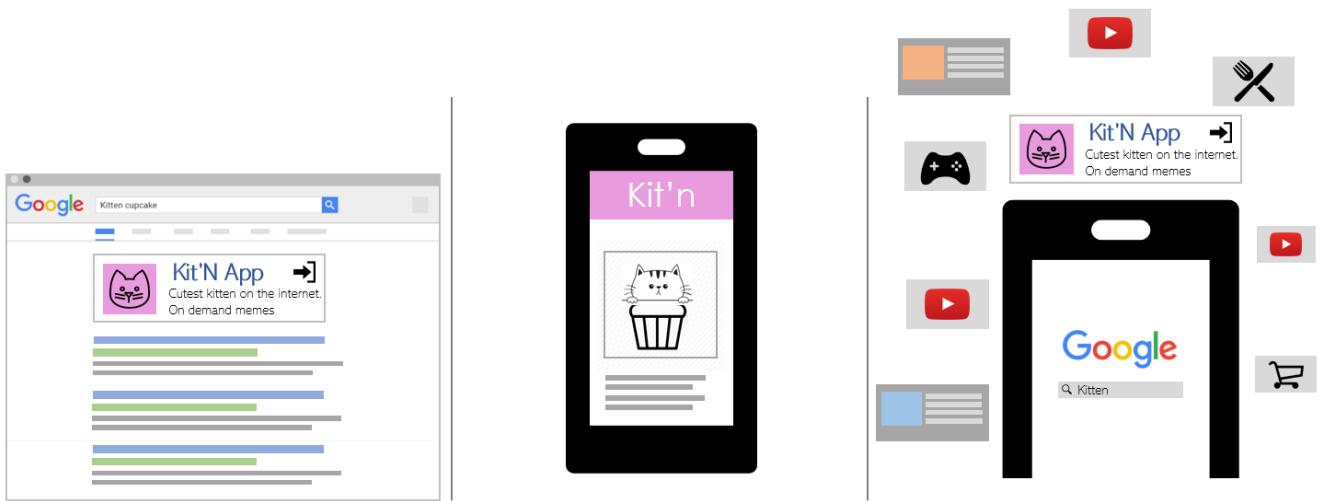
FIGURE 21. App Indexing (adapted from Google 2019)

The HTTP URL should be matched to the link on the app, so the app index is built in Google and Google assistant if the content adjusted is the personal content. For pubic content, iOS user can search for data on YouTube. The log users allow user enable to see the visited pages to speed up the searching. After implementing the app index, clients can operate the results via Search Review Tool to confirm the quality of content: set up the link, build an index, log users actions, test the implementation and measure impact. (Google 2019.)

3.11.8 Dynamic Links and App Invite

Dynamics links are deep links which are available for both IOS and Android version to lead the user to the location they wanted. By clicking the deep link in the app website, users can access the app if they have installed it or the link directs them to the Play store for the setting. Dynamics link converts conversation into new content without instructing users personally to activate the information they want. Dynamics link abbreviates various steps, and helps users proceed the open path effectively. Through a button, dynamics links show the user directly the main point from the website to an app on devices such as Google Map or Spotify's songs. It assists promotional marketing campaigns with showing the campaign content, consisting of the discount in every platform of a user in the app. This function hence optimizes the fastest method for old or new user of the app more often. Dynamics link connects with other Firebase functions to improve the app, it can be integrated with Remote Config, Analytics or A/B testing to track the app usage and behavior of the user. (Google 2019.)

Dynamics link goes with App Invite to invite the user to employ the app detail into a deep link. Users like to share data with their friends through dynamics link referrals to the suggested people that they usually talk with the Google machine. When the user clicks the link, it will lead the user to the installation section for downloading the app, and push the user to experience products of the developer. (Moroney 2017.)
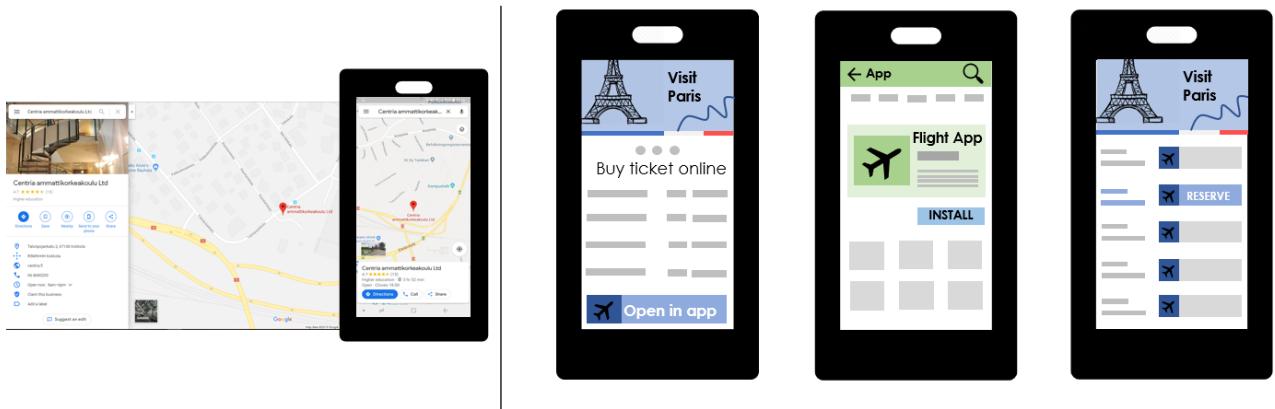
FIGURE 22. Dynamic Links and App Invite (adapted from Google 2019)

The developer integrates Dynamics link SDK into Firebase project to generate dynamics link for the app. Check the deep link after that to ensure its performance in Firebase console: set up Firebase and the Dynamic Links SDK, create Dynamic Links, handle Dynamic Links in the app and view analytics data. (Google 2019.)

3.12 Earning with AdMob

Admob is an API to monetize the mobile app to increase revenue with the in-app advertisement. It streams millions of ads from Google advertisers to provide developers with the simple method posting ads, maximizing the revenue, and augmenting competitiveness. (AdMob 2019.)

Admob integrated with Firebase platform can bring more opportunities for a client to apply video ads and adjust several contents without republishing the app. AdMob presents the ads in hundreds of markets, produces monetization reports, and helps developers consider their product strategy combines with many statistics by Analytics and other Firebase functions. To activate Admob to Firebase, the client should add Ad Units IDs in Firebase console from AdMob. AdMob manipulates the ads on the app by

using Google Mobile Ads SDK. It passes the insights of productive ads, revenues, or publisher-provided locations. (Google 2019.)

Similar to other features, it gets easy when clients utilize CocoaPods or Gradle to update the existing project on Firebase. The ads are generated in a way that its layout is resized or edited due to AdMod API in-app UI. Finally, the banner is connected from Firebase section with AdMod to publish the ads and earn profits: Connect the app, update project dependencies and create banner ads. (Google, Firebase 2019.)

4   CASE STUDY - Medirex

An application built with realtime database Firebase, collects users' daily emotions related to their surroundings with the questions based on the purpose of the data use from their phones. Based on the data saved in Firebase, the application has the ability to calculate statistics, which can be helpful in coming up with a solution to improve emotional health for a person. For instance, a company can utilize Medirex to survey how the working environment affects the employees' emotional status.

4.1   Questions

Questions are designed to evaluate whether the users feel great or poorly during the day. After assessing their own emotional state, they will come to more specific questions about if there is anything in their work environment or related to their personal skills to manage work that affects their mood. The application is entirely based on the questions and their given answers so they should be saved in a cautious way to make the most of Medirex.

How are you today?

○ Great

○ Poorly

Great

Poorly

What made the day especially good?

○ Support from work community

○ Working ability

○ Good time management

○ Refreshing breaks

What went wrong today?

○ Problems in work community

○ Poor working ability

○ Too busy

○ Leadership

:::

Did something affect your day in negative way?

○ Yes, what?

○ Bad ergonomics

○ Problems in work community

○ Tedious work tasks

○ Other, what?

○ Nothing

FIGURE 23. Medirex's questions

4.2 Design

Database, which relies on Firebase Realtime Database, is structured as flatly and easily to retrieve as possible. The data tree is built on a single purpose so when the data is fetched at a location, all fetched nodes are all what the algorithm needs to compute the output. Even though Firebase has the ability to reply to any data requests at a fast speed, there is a significant difference in reaction time of flattened data structure to that of nested data structure.

```
questions
{
    <mood_state> => great or poorly
    {
        <question_id> => for each question
        {
            question: string
            answers
            {
                <answer_id>
                {
                    answer: string
                }
            }
        }
    }
}
```

```
user_answers
{
    <date_stamp> => yyyymmdd
    {
        scores
        {
            <user_id>
            {
                old_score: number=> last score
                score: number=> average score here
            }
        },
        answers
        {
            <mood>
            {
                <timestamp>
                {
                    <question_id>: <answer_id>
                }
            }
        }
    }
}
```

FIGURE 24. Database structure

The "questions" part has questions and their choices designed to serve the application's purpose. Questions and choices has their own indexed key to use in "users' answers". For each question, there are 2 properties: "question" which contains the question itself and "answers" which has all the answers of the corresponding question.

```
⊟·· questions
   ⊟·· great
      ⊟·· 1
         ⊟·· answers
            ⊟·· 1
               └─ answer: "Support from work community"
            ⊟·· 2
               └─ answer: "Working ability"
            ⊟·· 3
               └─ answer: "Good time management"
            ⊟·· 4
               └─ answer: "Refreshing breaks"
         └─ question: "What made the day especially good?"
      ⊞·· 2
   ⊟·· poorly
      ⊟·· 1
         ⊟·· answers
            ⊟·· 1
               └─ answer: "Problems in work community"
            ⊟·· 2
               └─ answer: "Poor working ability"
            ⊟·· 3
               └─ answer: "Too busy"
            ⊟·· 4
               └─ answer: "Leadership"
         └─ question: "What went wrong today?"
```
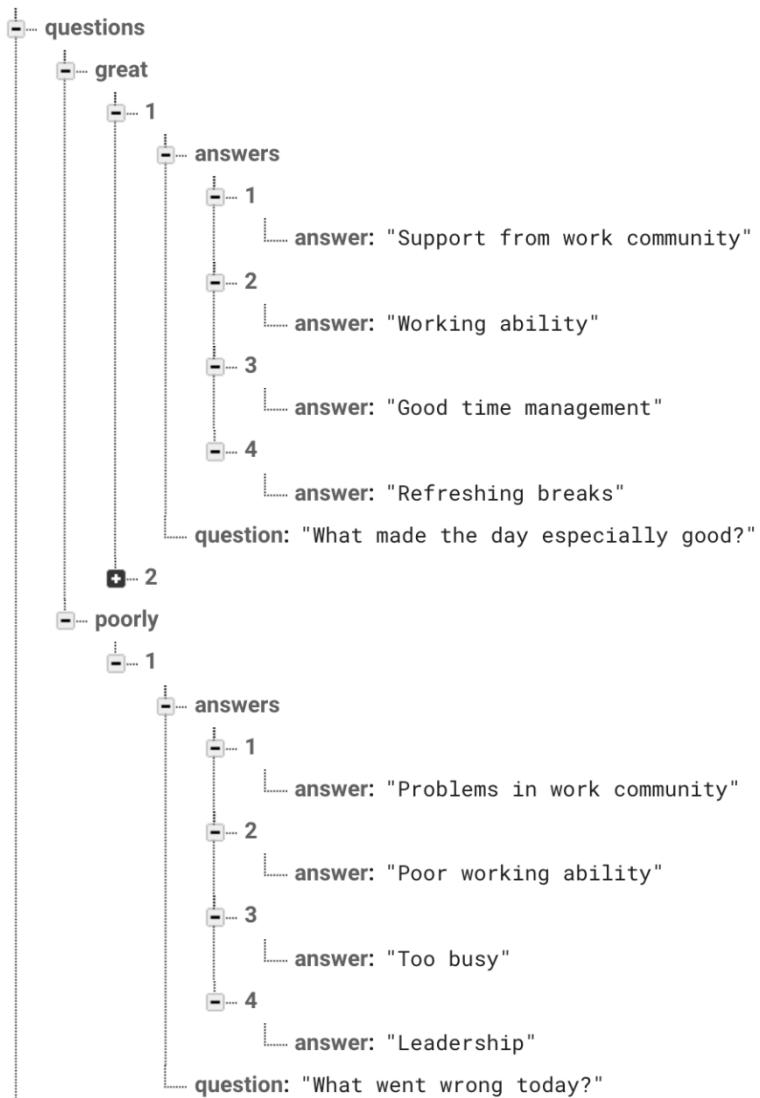
FIGURE 25. The "questions" database

The "users' answers" section is built to hold the 'answers' and 'scores' for each day. The answers are saved with the indexes in the "questions" part. Dates, mood and time to 'answers' and the user's score are stored with the user's id to 'scores'. The answers are equivalent of a score for that user. Only the avarage score and the last score are saved to the database but the answers for all questions stay in the database to form the statistics.

```
user_answers
   20171022
      answers
         great
            1422
               1: "2"
               2: "5 - weather"
            1529
               1: "2"
               2: "2"
            1630
            1803
         poorly
            0538
               1: "1"
            0812
               1: "3"
      scores
         abc
            old_score: 100
            score: 80
         ae3
            score: 70
         de3
            score: 40
         e2g
            score: 100
         edg
            score: 100
   20171112
```
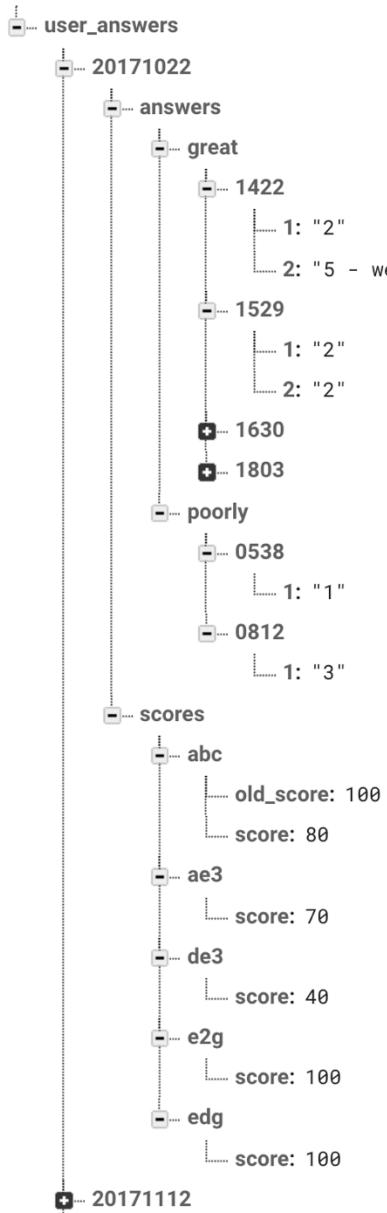
FIGURE 26. The "users' answers" section

4.3   Programming Language

Medirex is written on basic languages like jQuery, HTML and CSS together with strong cloud-hosted Firebase Realtime Database. In Medirex, jQuery performs requests to Firebase API to get the necessary data to calculate scores and numbers and creates animations. Then, HTML displays those important figures and text on the page and CSS organizes them to be easily observed by the users easily.

jQuery

```
function getAvgScore() {
    var scores_ref = ref.child(scores_path);
    scores_ref.on('child_added', snapshot => {
        total += snapshot.val().score;
        count++;
        var percent = (total/count).toFixed(1);
        document.getElementById('avgScore').innerHTML = percent;
        var moodStatus = document.getElementById('moodStatus');
        var dayStatus = document.getElementById('dayStatus');
        if(percent < 50) {
            moodStatus.innerHTML = 'bad';
            dayStatus.innerHTML = 'bad';
        } else {
            moodStatus.innerHTML = 'well';
            dayStatus.innerHTML = 'good';
        }
        document.getElementById('avgScore_1').innerHTML = percent;
        document.getElementById('totalAnswer').innerHTML = count;
    });
}
```

CSS

```
body {
    margin: 15px 15px 15px 15px;
    width: 1487px;
}
.circle {

    width: 55px;
    height: 55px;
    border-radius: 50%;
    font-size: 18px;
    color: green;
    line-height: 55px;
    text-align: center;
    background: white;
    border: 4px solid green;
    font-weight: bold;
}
```

HTML

FIGURE 27. Medirex's example code

4.4 Goals

All data sent to Firebase are essential to help Medirex to build up informative reports and statistics. Medirex aims to show to all users the general status of the community on the home page and the details about how the answers of question are chosen on the statistic page. To reach the goals for long term, the application must be in possession of a smart data structure from the beginning since the growing number of users and bad data structure will make Medirex jammed at a point.

4.5 Testing

Below is the sample data for date 14/09/2019. There are 4 answers for great mood at 14:22pm, 15:29pm, 16:30pm, and 18:03pm and 2 answers for poorly mood at 5:38am and 8:12am. At 14:22pm, the user has chosen "Working ability" for question "What made the day especially good?" and "traffic" for open question "Did something affect your day in negative way?". As the score for user's id "abc", he has the current score of 80 and the previous score of 100.

```
20190914
    answers
        great
            1422
                1: "2"
                2: "5 - weather"
            1529
                1: "2"
                2: "2"
            1630
                1: "1"
                2: "5-traffic"
            1803   +   ×
                1: "1"
                2: "3"
        poorly
            0538
                1: "1"
            0812
                1: "3"
    scores
        abc
            old_score: 100
            score: 80
        ae3
            score: 70
        de3
            score: 40
        e2g
            score: 100
        edg
            score: 100
```
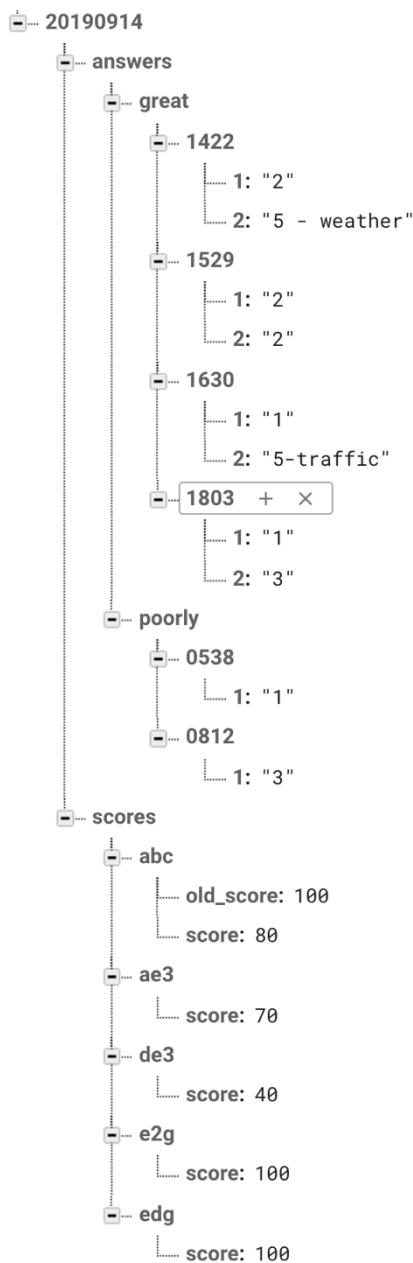
FIGURE 28. Sample data for testing

4.5.1 General report

On the home page, Medirex is expected to display the average value, 78, of all "score" values: 80 , 70, 40, 100 and 100. The total answers, 5, is the number of nodes in "scores": "abc", "ae3", "de3", "e2g" and "edg". "Best thing" is actually the mostly chosen answer for question id 1 in "great" and, answer id 2 – "Working ability" and answer id 1 – "Support from work community" have been both chosen twice for question id 1.

People of Kokkola are doing well!

Answer in total: 5

78.0% told today is a
good work day!

Best thing(s) today
Working ability, Support from work community

FIGURE 29. General report

4.5.2 Statistics

Medirex identifies total number of answers, 4, by the number of nodes in the "great": 1422, 1529, 1630 and 1803. The number for each answer chosen is the number of the nodes in "answers" of the corresponding state in "user_answers". For answer id 1 – "Support from work community" of question id 1 – "What made the day especially good?", is spotted in timestamp 1630 and 1803.

📅 Date

| 14/09/2019 | 📅 |

🔄 Go

🖨 Print

Great mood
Answers = 4

| What made the day especially good?	Answers	Probability
Support from work community	2	0.50
Working ability	2	0.50
Good time management	0	0.00
Refreshing breaks	0	0.00
Did something affect your day in negative way?		
Yes, what?	0	0.00
Bad ergonomics	1	0.25
Problems in work community	1	0.25
Tedious work tasks	0	0.00
Other, what?	2	0.50
Nothing	0	0.00

FIGURE 30. Statistics

4.6 Firebase - The Real-time Database Implementation

Firebase simplifies the procedure of configuring realtime database for an application by initializing the SDK with the application's configuration: apiKey, authDomain, and databaseURL. ApiKey is actually the Web API Key. AuthDomain is formed by project id and the path ".firebaseapp.com". DatabaseURL is a https url starting with project id and ending with ".firebaseio.com".

```
var config = {
    apiKey: "A███████████████████████████████",
    authDomain: "medirex-327d2.firebaseapp.com",
    databaseURL: "https://medirex-327d2.firebaseio.com"
};
firebase.initializeApp(config);
```

FIGURE 31. Firebase SDK for real-time database

4.7 Firebase - Cloud Storage for Firebase Implementation

Cloud Storage is quite handy when the application has to share and upload generated content, such as images and video. With Cloud Storage, those data will be saved in Google Cloud Storage bucket, an object with a lot of availability and global redundancy. It is as easy to set up as the Real-time Database. What Medirex needs to be able to start using Cloud Storage is to have storageBucket in the application's configuration.

```
var config = {
    apiKey: "A██████████████████████████████",
    authDomain: "medirex-327d2.firebaseapp.com",
    databaseURL: "https://medirex-327d2.firebaseio.com",
    storageBucket: "medirex-327d2.appspot.com"
};
firebase.initializeApp(config);
```

FIGURE 32. Firebase SDK for Cloud Storage

4.8 Firebase - Performance Monitoring Implementation

When the users of application increase in size, it is essential to monitor and get insight into the performance of the application. Adding Performance Monitoring library and initializing the service in the code are all required to send performance data to Firebase. The initial data of performance is shown in the Firebase console within one day after being set up.

Library for Performance Monitoring

```
<script src="https://code.jquery.com/jquery-3.2.1.js"></script>
<script src="https://www.gstatic.com/firebasejs/6.6.1/firebase.js"></script>
<!-- Performance Monitoring library -->
<script src="https://www.gstatic.com/firebasejs/6.6.1/firebase-performance.js"></script>
```

Initialization for Performance Monitoring

```
firebase.initializeApp(config);
var storage = firebase.storage();
// Initialize Performance Monitoring service
var perf = firebase.performance();
```

FIGURE 33. Medirex – Firebase's Performance Monitoring Implementation

4.9 Other Technologies

Once an application has initialized Firebase with apiKey, authDomain, and databaseURL, to start using more Firebase technologies, the developer only have to add libraries and a few code lines to initialize those libraries to or add configuration in Firebase console. For example: Firebase Hosting and A/B Testing.

Firebase Hosting Set-up

1 Install Firebase CLI

To host your site with Firebase Hosting, you need the Firebase CLI (a command line tool).

Run the following npm ☑ command to install the CLI or update to the latest CLI version.

```
$ npm install -g firebase-tools
```

Doesn't work? Take a look at the Firebase CLI reference ☑ or change your npm permissions ☑

☐ Also show me the steps to add the Firebase JavaScript SDK to my web app
The SDK includes Cloud Firestore, Authentication, Performance Monitoring and more. It can be added now or later.

Next

A/B Testing Set-up

A/B Testing

Run experiments to make key engagement flows more effective

Create experiment

Which service do you want to experiment with?   ×

▣ Notifications
Experiment with sending messages to engage the right users at the right moment

♫ Remote Config
Experiment with app behaviour using server side configuration parameters

How do I get started?

97%

FIGURE 34. Medirex – Firebase's other technologies

There are some other strong features built only for iOS and Android applications. One of them is machine learning kit, which can help developers recognize text, detect faces, and scan barcode. Firebase has made these mobile features ready to integrate with just by few clicks in the Firebase console. For instance: ML Kit, In-App Messaging.
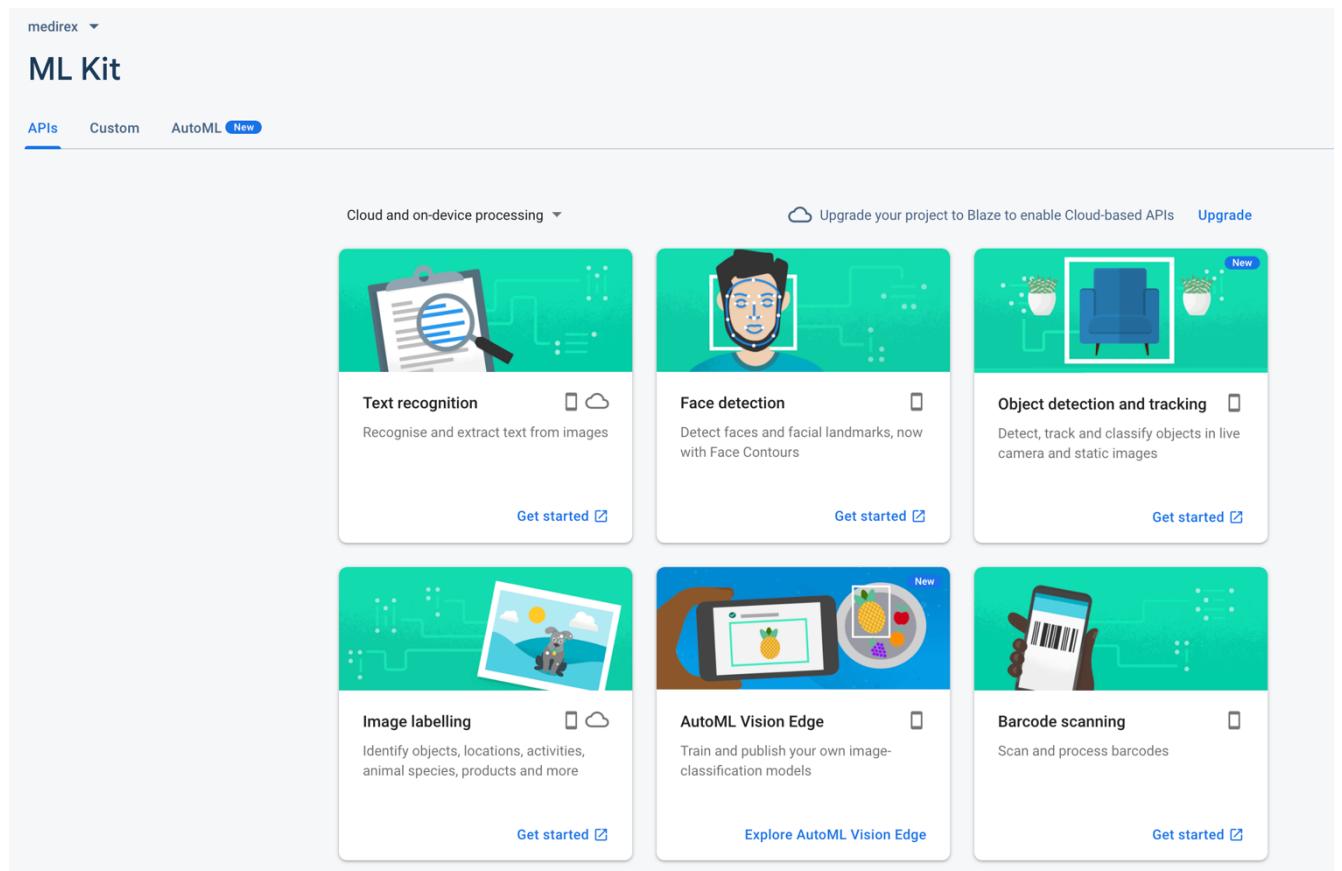

FIGURE 35. Firebase console for ML Kit (adapted from (Google 2019.))

5   CONCLUSION

In the boom of the technology industry, the fresh data is derived automatically and fast. The smartphone era today helps people connect to many things and wisely accomplishes any data request. It comes with the growth of applications, which is the result of technology development. When a subject is researched, there are surplus components which are integrated with and assists the subject to move forward. Following this principle, the advanced app requires many efforts and labor to implement the ideas, and expects for the cost efficiency and app quality.

To approach these goals, Google Inc. launches many operations to update and assist for any particular tasks from analytics, and statistics to report the issues to clients with the aid of Firebase. As using the property of Google, and Firebase, the client consumes less time to sync the data securely and deal with easier tasks. It involves app functions to achieve the desirable features and to feasibly activate in IOS, Android and web. The presence of Firebase goes beyond the expectation of a regular API. It enhances and supplies beneficial factors as improves the app performance. Via Firebase, barriers that hinder the user from enjoying smooth and qualified app no longer exists. Firebase team is the assistant for the app that minds the user experience, sends crashing to the developer through Firebase messages, syncs and tests the latest version with automation.

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