Integrability and Interoperability of Mobile Applications

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Features of mobile applications are presented. The characteristics of quality for the mobile applications are described. The categories of mobile devices are presented. The restrictions for all mobile devices categories are presented. Treated separately accessing integrability factors influence the level or growth paths and measurement indicators. Establish ways to integrate information through interfaces and appearances by database and by calling. The interoperability characteristic of mobile applications is presented according the using of output of the application by another application.
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1 Mobile applications

Mobile applications follow the same stringent business as Web sites; it is natural that users have the same expectations of them. Providers of mobile applications will make further efforts to gain a better understanding of users such as effectively to sell products, services and advertising for mobile devices.

In mobile applications environment:

- there is a large variety of devices and platforms on which applications run;
- there are many forms of authentication;
- there are many ways to store data;
- there are many restrictions imposed for data security and information operating by the application;
- are there many quality features to be observed.

Mobile applications have a specific set of rules defined and rigorously chosen as running operations on mobile devices:

- short starting time;
- receptivity of commands;
- interface easy to use;
- user interaction with the application to be minimal;
- the minimum number of modules of the software;
- precise definition of target group;
- functional structure homogenous;
- data security and confidentiality;
- similar level of quality of applications;
- reliability of applications in special conditions;
- minimal consumption of hardware resources;
- balance between using of hardware resources of the device;
- portability on generations of devices

A new application is integrated with other applications if both this application and other applications are built using a set of specific rules for all mobile applications and if the new application is taken directly from other applications because it follows the same set of rules as the other. Thus a mobile application is fully deployable if it is built by the same pattern as the applications they want to be integrated.

An existing mobile application is fully deployable if the call is picked up by another application of the system and the information provided on this call can be used by the calling application without multiple processing.

Mobile applications depend very much on the device characteristics, device platform and operating system implemented on mobile device running these applications. As there is a large variety of mobile devices and applications they need to present this diversity.

Mobile devices are divided into several categories:

- *basic terminals or simple phones* performed basic functions such as send / receive SMS, receive / initiate call; they are not able to use any wireless data communication and multimedia characteristics are limited;
- *feature phones* are mobile low-end mobile devices that have additional functions over and above standard mobile phones like camera, touchscreen and Wi-Fi capabilities; because technology changes rapidly features phones may be considered the low-end smartphones;
- *multimedia terminals* in addition to basic functions present additional functions such a powerful camera, large storage media, audio and video player;

- *mobile Internet devices* represent an intermediary class of mobile devices that are more than a smartphone and less than a tablet PC in terms of features; they are used mostly for Web browsing based on a wireless network connection; modern tablets are becoming the mobile Internet devices of the moment;
- *mobile standard PCs* are mobile computers that have all the features of a personal computer; Tablet-PCs, laptops/notebooks and ultra mobile PCs (UMPC) distinguish from a classic desktop computer by size, display, weight and peripherals.
- *fashion terminals* includes performance functions like multimedia terminals and has a special design;
- *smartphones* are high-end feature phones with advanced business functions, office applications, high-speed Internet connection, specific multimedia terminals functions, high-resolution touchscreens; they evolved from classic personal digital assistants (PDAs).

All categories contain devices with similar functions. For that is present the convergent character of the devices.

Devices on the base class or simple phones require following restrictions for mobile applications:
- monochrome display (black and white);
- small display size;
- minimal use of hardware resources ;
- enter the data via the alphanumeric keyboard;
- unable to connect to the Internet;
- unable to access the GPS information.

Restrictions imposed by the devices of class features mobile phones on applications are:
- data input is realized via touchscreen or via keypad;
- connect to the Internet;
- access to the GPS information;
- minimal use of battery, the battery has a reduced autonomy;
- the display size is not fixed and is different from device o device.

Multimedia terminals requiring the following restrictions on the mobile applications:
- data input is realized via touchscreen or via keypad;
- connect to the Internet;
- minimal use of battery;
- the display size is different from device o device.

Mobile Internet devices require these restrictions on mobile applications:
- display size is higher than a normal phone display;
- high autonomy of the battery;
- data input is realized via touchscreen;
- internet connectivity is a key feature of any application because the devices are used in this purpose.

Mobile standard PC devices imposed next restrictions for mobile applications:
- data input is realized via touchscreen;
- the display size is different from device o device;
- connect to the Internet;
- access to the GPS information;
- high autonomy of the battery.

Terminal devices in the fashion category requiring these restrictions for mobile applications:
- data input is realized via touchscreen or via keypad;
- connect to the Internet;
- the display size and the number of displays is different from device o device (exist devices with two displays);
- minimal use of battery.

Devices from smartphones category requiring these restrictions for the applications:
- the data is input via the touchscreen, the QWERTY keyboard or Half-QWERTY keyboard;
- connect to the Internet;
- access to the GPS information
- minimal use of battery;
- the display size is different from device o device.

An integrable application must meet all the restrictions imposed by mobile devices. Thus an application that is built to be integrable, must be constructed to comply with restrictions of mobile devices and applications specific set of rules that will be fully.

For the continuity, mobile applications interfaces should use the old interfaces from the application and to integrate the new functions addition to what exist.

An application uses a vocabulary of terms and special words. This vocabulary should be used in the next version of the application too. V_1 is vocabulary of terms for the version 1 of an application. Version 2 of that application use vocabulary V_2. V_2 should includes V_1: $V_1 \subseteq V_2$.

The same situation is for interfaces of applications: $I_1 \subseteq I_2$, where I_1 is the interface used in version 1 of the application and I_2 is the interface used in the second version of the application.

2 Integrability of Mobile Applications

According to [1], integrability is the ability to develop separate components of a software system which will work together. An integrable component of a software system is developed by a set of common rules to enable communication between them but differ in the problems solved and the target group you have. The problems solved are more specific and precise. Thus users can use only certain modules or components within a large software system.

According to [8] integrability is of two types:

- direct integrability;
- integrability by concatenation.

The importance of the applications integrability is given by:

- interconnect all customers systems in a single infrastructure;
- uniform introduction of data in a single system;
- reduce databases redundancy;
- enabling processing of large amounts of data through the process automation.

According to [8] the advantages of applications integrability are:

- new module are introduced with reduced costs;
- modified the business process accordance with the new requirements;
- allow the introduction of new process and new operations automatically when is necessary.

For each device there is a set of restrictions, and for each set of applications is a set of rules for the connections between them. A new mobile application to be integrated into the set of applications must comply with both sets of restrictions imposed by mobile device and set of rules imposed by those applications that wish to be integrable.

Component-Oriented Software Engineering (COSE) becomes more used and useful in software development [2]. Thus development effort and cost for a system are divided into components that compose the system.

According to [2] COSS is a software system modeled on integrable components developed independently. Components are developed based on architecture integration with the restrictions imposed by existing components.

According to [3] interactions between components of applications are described in connectors. Integration architecture is a software architecture that describes all solutions of two component systems interoperability.
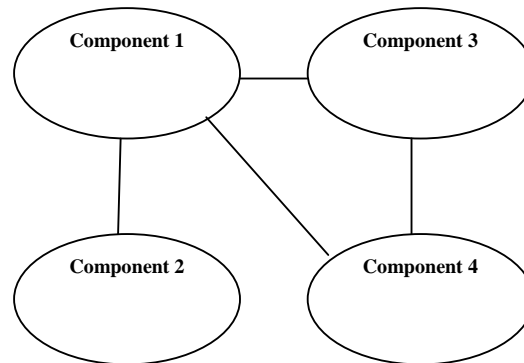

Fig. 1. System of four integral components

Figure 1 presents a system composed of 4 components. Components have the following interactions: (1,3), (1,2), (1,4), (3,4) made by connectors [3].

In the system shown in Figure 1 is built a new integral component with components 1 and 2. The result is presented in Figure 2.
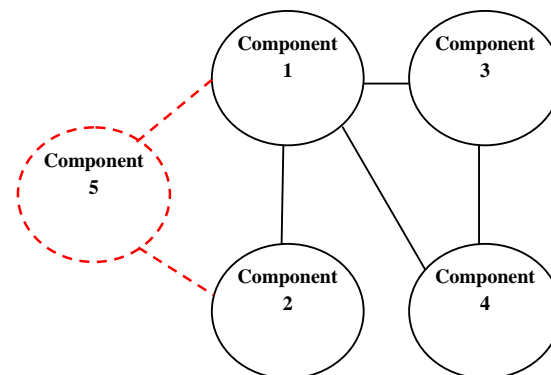

Fig. 2. Integrable system consists of five components

It is noted that the new component is integrally constructed with two components. Thus in building of this component took into account only the restrictions imposed by the two components. If the construction of the new components take into account the restrictions of all components in the existing system to obtain a system similar to that in Figure 3.
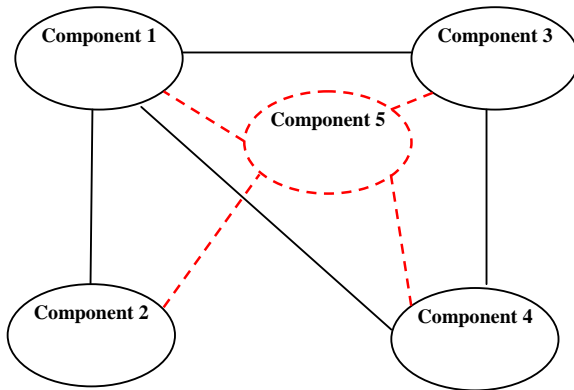
Fig. 3. System consists of five components fully integrated

A system made between more integrated components is like a puzzle, Figure 4, constructed from several pieces. As the puzzle pieces have different shapes and colors, the software components of a system are different problem to solve, and different inputs and outputs obtained after processing. The main condition for solving the puzzle is that neighboring parts can be joined and combined. Similarly, for an application to integrate all components have to be integrated with each other and work together for the satisfaction of the end user.
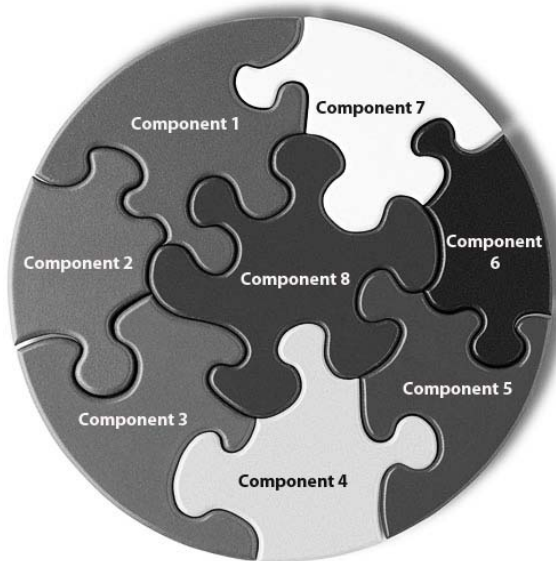

Fig. 4. Software system like a puzzle

Integrability has a very important and specific sub feature namely interoperability which is the ability of two or more components or software systems to exchange information between them.
In [4] are classified the levels of interoperability:

- no interoperability, there no exist collaboration between software components or systems;
- partial interoperability, only some components collaborate between themselves;
- total interoperability, all software components work together with all other components, is a level of interoperability preferable but difficult to reach.

In [5] the using of distributed applications in personal recruitment management is presents. For that the applications used should to integrate in the personal recruitments management and to use modules already developed in this environment. The application present in this paper is integrated with the outlook service for sending emails and with Skype service to initiate the conversation when the user press only one icon of a number phone in the application.

According to [6] interoperability is realized at the level of:

- data, counts the organization of data in databases or files;
- web services, is carried collaboration between applications written in different programming languages;
- programming model, is the principle that are built libraries, frameworks of a programming language;
- components, represent interoperability which is treated in this paper and involves collaboration between the different modules of the system or between systems.

In integrated applications the output provided by an application is used like an input by other applications. In mobile applications that provides as output a text, the interoperability is translates into ability to provide this text in various forms such as:

- send by e-mail, possibility to provide an e-mail address and send the output by mail to this address;
- send by SMS, use the application's output as input for a text message and send to a phone number specified or selected from the list of contacts;
- post on social network, sending text provided by a social network the user has logged in previously;
- save in a file system on the phone, the output text from the application is saved in txt file on local memory on the phone;
- save in a picture file on the phone, the output text from the application is saved in an image

file, like a screenshot on local memory of the phone;

- save in a file on the extern server, the output text from the application is saved in txt file on the server, in external memory;
- save in a picture on the extern server, the output text from the application is saved in an image file on the server, in external memory;
- save in a database on the extern server, the output text from the application is saved in a database on the server, in external memory;
- save in clipboard memory, the output text from the application is saved in the clipboard

memory, to allow its use where the user wants to paste it.

3 Weights of Interoperability Modules in Mobile Applications

Community considered to make records contains 100 people. Is a homogeneous collectivity because specialists who make up have:

- aged between 23 and 25;
- experience in developing software applications between 4 and 6 years.

From this collectivity, 81 people have completed the form shown in Figure 5:

Give scores: 0, 5, 10, 15, 20, 30, 50, 80, 100 to the following interoperability aspects:	
Interoperability of mobile applications that provides the output text or an image is reflected by:	**Score**
Send by e-mail	
Send by SMS	
Post on social network	
Save in a file system on the phone	
Save in a picture file on the phone	
Save in a file on the extern server	
Save in a picture on the extern server	
Save in a database on the extern server	
Save in clipboard memory	

Fig. 5. Form made for the community interviewing

For this questionnaire, respondents were not directly asked to point the alternatives with weights to avoid the situation in which two or more variants have the same weight in the end. Thus chose the scoring with different scores. Finally based on these scores is calculated the weight for each variant. Thus is avoided the

possibility to have two or more variants with the same weight.

From data analysis results from the survey it was observed that all variants of response obtained from a specialist at least the maximum score (100) and the minimum score (0). Frequency of occurrence is shown in Table 1.

Table 1. Frequencies of the minimum and maximum values

Alternative	1	2	3	4	5	6	7	8	9
The frequency of maximum	6	14	8	7	6	7	7	20	6
The frequency of the minimum	4	4	12	4	9	4	6	6	32

Based on the data obtained were averaged sum of the scores for each variant, the average of these scores, the printing is the level at which each variant is considered from the point of view of

specialists who participated in filling in the form. The weight of each variant represents the importance of those choices. These values are listed in Table 2.

Table 2. The average calculated based on the data obtained

Alternative	1	2	3	4	5	6	7	8	9
Amount	2965	3060	3145	2315	2370	3050	3150	3420	1635
Average	36,60	37,77	38,82	28,58	29,25	37,65	38,88	42,22	20,185
Weight	0,11	0,12	0,12	0,09	0,09	0,12	0,12	0,13	0,0651

The weights are given graphic variants in Figure 6. Note that the experts have given a high importance level for saving in a database on an external server, which has the highest weight.
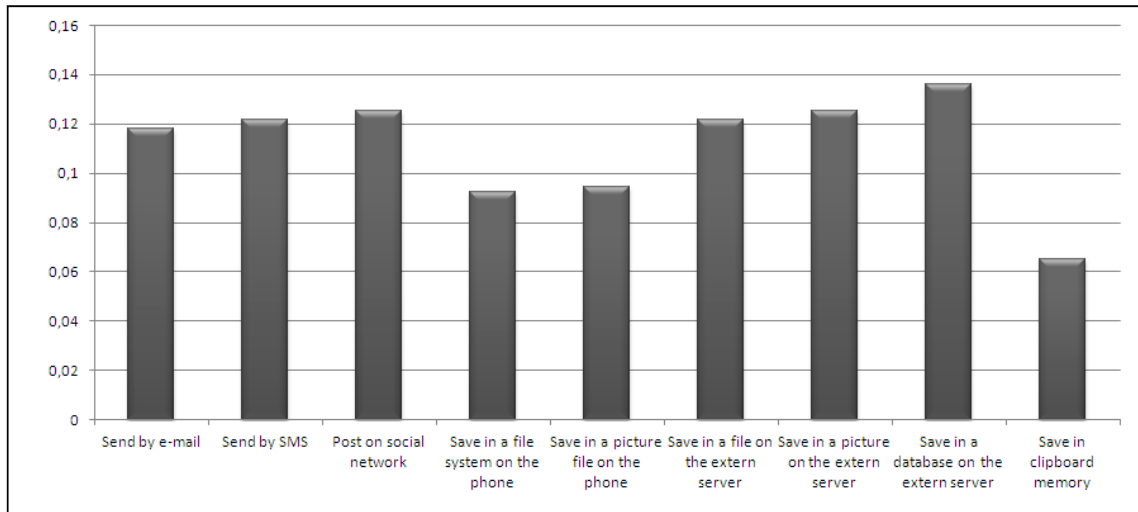

Fig. 6. The coefficients of the variants

If we remove the maximum and minimum values of the amounts calculated variants, weights will be changed. Are presented in Table 3 the new amounts calculated and the new weights without taking the maximum and minimum values.

Table 3. Weights of variants without the minimum and maximum scores

Variant	1	2	3	4	5	6	7	8	9
Weight	0,13	0,09	0,13	0,09	0,10	0,13	0,14	0,08	0,06
Total	2365	1660	2345	1615	1770	2350	2450	1420	1035

The correlation coefficient between the two series share is 0,600377.

To check the scores given samples shall be taken at random from the entire society, and will perform new calculations for the weights of variants and will analyze the changes occurring.

Thus, we provide two data sets with a population of 54 specialists. These are chosen randomly out of a total of 81 specialists who were interviewed. The weights determined on the basis of the two data sets do not show major differences between them, nor to those calculated on the basis of all the data. This is shown in Table 4.

Table 4. Weights calculated on the basis of sets with a population of 54 specialists

Variant	1	2	3	4	5	6	7	8	9
Normal weights	0,11	0,12	0,12	0,09	0,09	0,12	0,12	0,13	0,06
Set 1 of 54 rows	0,11	0,10	0,12	0,08	0,09	0,13	0,13	0,14	0,07
Set 2 of 54 rows	0,10	0,11	0,12	0,08	0,09	0,12	0,14	0,13	0,06

Figure 7 is a graph table 4. Between the three sets of weights no exists major differences.
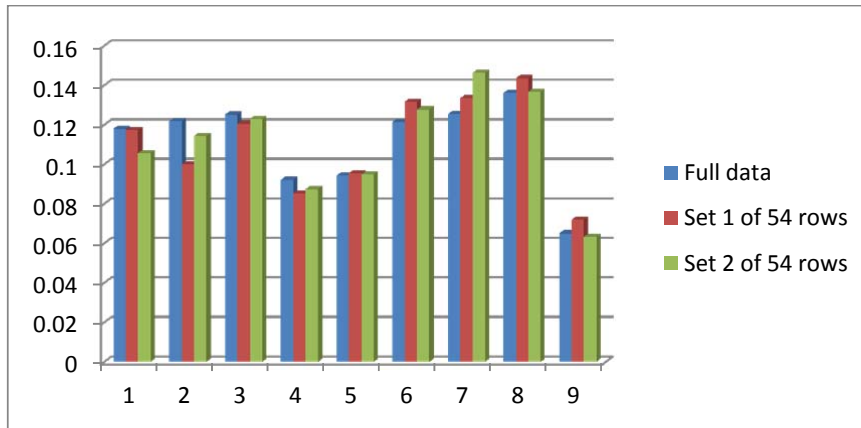
Fig. 7. Weights calculated on the basis of sets with a population of 54 specialists

In order to observe the behavior of the weights will get two sets of data with a sample of 40 specialists. And these sets will be chosen at random from those initial 81, too.

The weights determined on the basis of the two data sets do not differ too much from each other, nor to those calculated on the basis of all the data. This is shown in Table 5 and Figure 4.

Table 5. Weights calculated on the basis of sets with a population of 40 specialists

Variant	1	2	3	4	5	6	7	8	9
Normal weights	0,11	0,12	0,12	0,09	0,09	0,12	0,12	0,13	0,06
Set 1	0,13	0,14	0,11	0,08	0,06	0,12	0,13	0,13	0,06
Set 2	0,11	0,11	0,11	0,08	0,07	0,12	0,13	0,16	0,07

In Figure 8 is plotted, Table 5. Between the three sets of weights there are no major differences.
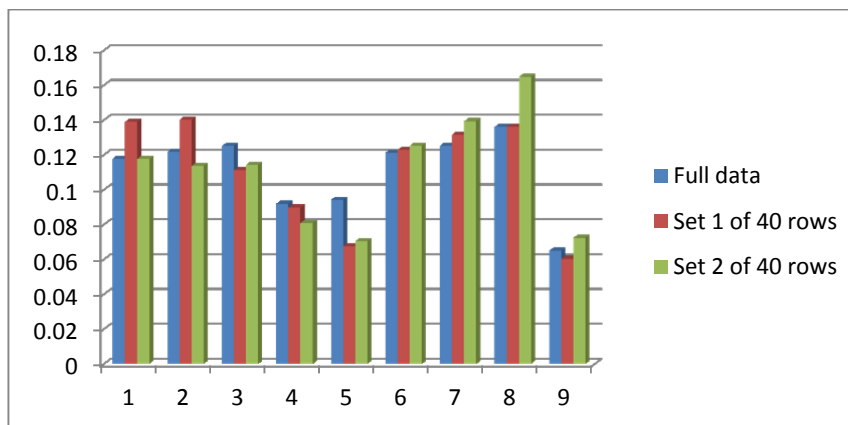

Fig. 8. Weights calculated on the basis of sets with a population of 40 specialists

These weights have a high quality evidenced by the fact that between the two different variants from all nine are not with the same weight, so these specialists differentiate very well variants of interoperability of mobile applications. Another reason for the quality is the fact that the group of experts was uniform. Weights obtained from the lower part of the group of experts are very close to those obtained on the basis of the data from all the specialists. The group therefore

homogeneously the data obtained are of superior quality.

4 Analysis of the Weights Obtained
Following analysis of data shows that two specialists have given the same score of all nine variants. Thus the two experts gave similar scores for the nine characteristics namely: 15, 10, 100, 5, 0, 50, 80, 30, 20. Other two specialists also gave similar scores of nine variants but different

from the first two specialists. Their order is: 30, 100, 20, 50, 80, 5, 15, 10, 0.

A number of 0 experts have provided the scores in ascending order (0, 5, 10, 15, 20, 30, 50, 80, 100).

A number of 0 experts have provided the scores in descending order (100, 80, 50, 30, 20, 15, 10, 5, 0).

In Table 6 are given the frequencies of occurrence of scores for each variant.

Table 6. The frequencies of occurrence of each score for variants

Variant / Score	1	2	3	4	5	6	7	8	9
0	4	4	12	4	9	4	6	6	32
5	8	9	5	16	12	3	11	7	10
10	10	9	9	10	10	10	7	10	6
15	9	13	2	11	12	11	9	11	3
20	7	9	11	10	8	10	9	9	8
30	13	9	10	10	7	13	5	7	7
50	12	8	8	9	10	12	10	5	7
80	12	6	16	4	7	11	17	6	2
100	6	14	8	7	6	7	7	20	6

Specialists, because they are people with experience in programming, are orientated to differentiate these variants of mobile applications interoperability and did not consider them on the all-important.

From the records of the scores obtained it can be seen that the group of experts is a homogeneous group, and composed of experienced people. Data does not show the subjectivity, which denotes the professionalism of specialists. The questionnaire is being treated with seriousness by the specialists.

The correlation coefficients between the series of weights based on the total population and those two samples of 54 specialists are highlighted in Table 7. They show close to very large values in the ratios calculated on the basis of two sets of data values in the ratios calculated on the basis of all the data.

Table 7. Correlation of series calculated on the basis of sets of 54 specialists

	Originals	Set 1	Set 2
Originals		0,90	0,93
Set 1			0,93
Set 2			

The correlation coefficients between the series of weights based on the total population and of the two data sets of 40 specialists are highlighted in Table 8. They show very high close ratios calculated on the basis of two sets of data values in the ratios calculated on the basis of all the data.

Table 8. Correlation of series calculated on the basis of sets of 40 specialists

	Originals	Set 1	Set 2
Originals		0,89	0,88
Set 1			0,85
Set 2			

The nine variants are independent and the weights are meant to differentiate. The largest share of the importance of identifying the variant of answer in relation to the group of experts, and the share of the lowest minimum importance to identifying the variant as compared with the group of experts.

These weights are representative because the group is homogenous and consists of specialists with great experience in software application development. The generalization of these weights becomes effective when taken inhomogeneous between them lots of specialists. Each lot to be uniform but between caches is not homogeneity.

So the nine variants of reply with regard to the interoperability of mobile applications have to be submitted to a homogeneous batch after other criteria than those experienced in the development of software applications and a large number of specialists.

6 Conclusions

Mobile phones have come a long way from simple devices used only for making calls and sending text messages to current smartphones used in any activity.

Technology continues to grow very much bringing new concepts and new tools in the mobile devices.

Development of mobile applications has features that distinguish it from conventional computer application development through testing and verification levels how to run on the device. In terms of testing and verification of how to react in real world mobile application development of these applications is more difficult than traditional application development.

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