Performance and Security Requirements for Complex Applications

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This paper presents the complex applications oriented on innovation. Are described and individualized types of complex applications. Are analyzed mobile applications in correlation with complex applications standards. A requirement of the complex applications is citizen oriented which is presented as a solution for providing the entities of the applications. Another important side of mobile applications is the innovation. Circumstances that trigger innovation are exemplified by offering particular demonstrations. Security is depicted as a fundamental requirement for complex applications. The process of securing computer systems is formalized into the concept of security management. Methods of managing network security by imposing security policies are enunciated.

Keywords: *Performance, Complex Application, Mobile Application, Security, Innovation, COIMA*

1 Complex computer applications

Mobile application is a set of coded instructions used by a mobile device to solve a problem.

Mobile applications depend on the characteristics of mobile device, platform of devices and operating system implemented on the mobile device.

The mobile applications are divided into next categories [1]:

- applications for general information are available to anyone wishing to get information in a particular area such as weather, TV program, horoscope;
- applications using personal data to login are applications in which a certain personal information is required for authentication, information which is verified with ones already existent on the server;
- applications with network communication, are applications through which users communicate with other remote users;
- economic applications, are those that are used for purchasing goods, doing payments, or other economic activities;
- games or entertainment applications, which users choose to access in their free time.

Citizen oriented informatics mobile applications or COIMA are a special type of informatics applications. They are instruments designed for giving solutions for day to day life concrete problems. Their essential characteristic is maximum results for users with minimal IT knowledge. They have user friendly interfaces and modern informatics applications being easy to use through touch screens and voice control.

In the modern society the use of IT is normal. More and more problems are being solved by COIA[14]:

- administrative: payment of bills, penalty charges, taxes, archives of important documents
- economics: fiscal year closing, e-banking, capital market activities, stock exchange, e-commerce, trips tickets
- social: discussion groups, conferences, video-conferences, socializing networks
- health: online consultation, interactive human body maps, various discussions about diseases, personal medical records viewing
- culture: e-cinema, e-library, e-museums, theatre shows, shows tickets
- entertainment: games, competitions, holiday planning

Complex COIMA imply more than information display from a database and

results recording after some simple processing. They involve data recording about user behavior through various ways and complex processing.

Innovation is the process of improving and perfecting a product, a method, a theory or a service with the sole purpose of accomplishing, at a higher standard, the objectives they were originally designed for. Innovation is focused on easing the work of the developer as well as for maximizing the satisfaction experienced by the end user.

When implementing IT projects aims at developing complex applications, a project manager should take into account the fact that standards and technologies, in this domain, are subject to change at a higher rate than usually occurs with other project types. According to Moore's Law, computing power doubles every 18 months [2]. Programming languages also evolve at a very alert pace. PHP 1.0.0 was released in 1995 and until the present day 24 new releases were made reaching the version PHP 5.3.9 [3]. DBMS are also rapidly changing.

The technologies involved in complex IT projects are state of the art. Methodologies for developing complex IT projects are newly introduced in the business sector. Scrum methodology was introduced to the marked in 1991[4]. Extreme Programming is a methodology first introduced in the mid 90's.

In developing complex computer applications an important part is played by free public intellectual property, better known as open source software [5]. Open source software is a type of application whose source code is freely available to the public to be copied or changed. In the open source category are available applications like Mozilla Firefox, NASA World Wind and OpenOffice.org, operating systems like Android and Linux, programming languages like Pearl, PHP, Ruby and Python, software servers like Apache, Drupal and WordPress [6].

When we are talking about complex software applications that are being used for operating with sensitive personal information, we must always take into consideration the risks that the information is exposed to, and the methods that are used to compromise it, thereby it is crucial for the reliability and the trustiness of the system that integrates the software application, to ensure that the security threats are handled in a responsible manner, according to a well-defined methodology. The process through which security risks and threats are monitored, analyzed, prevented, remediated is called Security Management. For managing the security of the complex information systems, computer security providers have built specialized software applications and tools.

In the present, when speaking of complex information systems, we are referring to systems that have many components involved, having situation where these components are geographically distributed with the need of interaction and communication for achieving the intended purpose of the systems, and in these situations, where the systems are opened for interaction worldwide, security management becomes a real challenge.

When talking about information security we consider the situations where the information is stolen, the information is damaged or the access to the information is being denied. In order to steel or damage the information, one needs to gain access to that information, and there many ways of gaining fraudulent access. For protecting the information against these threats and for having an organized way of managing them, complex security systems have been created. Most security management tools were built around a multi-agent architecture. From the important security providers that have implemented complete solutions for an active protection against cyber-threats and continuous management of these threats we mention:

- McAfee – With the Virus Scan Enterprise Suite for the active protection and the ePolicy Orchestrator for the management and configuration of the protection agents.
- Symantec – With the Symantec Endpoint Security Client used as an active protection agent and Symantec

Enpoint.cloud used as a security management console.
- BitDefender – With the BitDefender Endpoint Security for the active protection and cloud based management console named BitDefender Cloud Security for Endpoinds.

As it is seen the trend is to move the security management applications *in the Cloud*, for reducing maintenance costs.

2 Designing complex applications using techniques oriented on innovation

The incremental innovation process in complex applications is characterized by gradual improvement of the development time, development cost, implementing speed, reliability and user satisfaction.

Radical innovation in complex applications is defined as that process which generates major changes in the industry often resulting in the changing of market structure. Radical innovation opens up new commercial, economic or social opportunities. New markets may arise while those already established may see a decline.

In many scenarios, market demand may dictate the direction complex application's innovation will follow. An eloquent application is banking software. As commercial banks began to increase their customer portfolio, a practical need to develop an efficient managing system of that portfolio occurred. The software used in banks over 20 years ago had only primary accounting functionalities. The demand was there, innovation occurred and complex applications where developed following a new set of standards. Currently even money transfer is done using complex software applications.

Innovation based on the offer occurs when the market is saturated and the operator must differentiate itself from his competitors in order to evolve. An application of this concept is the real estate market. During the economic boom numerous portals and websites related to real estate where developed. To be competitive all these portals had to incorporate innovative elements. In addition to photos of a property videos began to be available. Properties began to be pinpointed automatically on the map. Real estate websites began to evolve into complex applications by incorporating legislation information, interior design simulations, loans and alternative financing options.

Random innovation takes place without a particular reason, without being triggered by an event and sometimes even without being needed. In a complex software application there are processes and components which, if mildly altered, dramatically improve the efficiency of the entire mechanism. These processes and components were used successfully, until the implementation of innovation, and could have been used successfully further on if not for random innovation.

The quality of complex software applications is strongly correlated with degree of innovation they incorporate. Innovative projects are those that define the standards and higher quality standards mean software applications are cheaper and more reliable.

Factors influencing quality of innovative projects are: development time, development team, the end beneficiary, management and financial resources.

Criteria for assessing the quality of complex applications: functionality, reliability, usability, maintainability, security, portability and scalability. Optimization of innovative complex application is achieved by improving the defining quality features of a project [7]. In order to optimize a complex application you have to refine its functionalities, increase its reliability or usability, ease its maintainability, enhance its security improve its portability and scalability.

In order to quantify the usability associated with a complex application the degree of usability indicator will be used. The indicator is represented by Ud and depicts to which extent a user interact with the application without encounter any difficulties. The Ud indicator is determined by the following assertion:

$$Ud = \frac{1}{k}\sum_{i=1}^{k}\frac{P_iL_i}{P_iD_i + i}$$

where:

Ud - degree of usability

P_iL_i - instances of an application

P_iD_i - possible actions

P_i - current instance

L_i - instance level

D_i - derived instances

k- total number of instances

The Ud indicator takes values in the range [0,1]. Where an application with U=1 is an application with the highest degree of usability and a software with U=0 has the lowest degree of usability. A website with only one page and no links is extremely easy to use. This kind of website will have for k=1, P_1=1, L_1=1, D_1=1 the indicator U value equal with 1.

Every application will exhibit to the user a finite number of instances. An instance is defined in a web application as a web page and in desktop application as a window. Too many instances and the user might get confused. Too few instances and features might get congested.

An action is regarded from the point of view of a computer user as a click. A clickable area is defined by the existences of a link. *Possible actions* refer to the number of links that is found on an instance. Too many links and the users get confused. Too few links and some features get insufficient exposure.

The current instance is the page or the window the user is active on.

Instance level refers to the depth of an application and determines how many clicks away are from the home page or the main page of the application. In web applications the ideal depth level is 3. From the home page you should be able to access every feature by executing maximum three clicks.

Derived instances determine the number of instances directly linked to the current instances. If you are in the home page of a website, the pages you access by executing only one click determines the number of derived instances. Every click represents a derived instance.

3 Performance requirements for citizen oriented m-applications

COIMA makes it easier for user to get the desired solution. Everybody could solve the problem if he has access to internet using a computer or any other device. User uses high performance COIMA software by using special equipment provided: touch screens for information about a shopping center's map for a better orientation, interactive materials for step by step assisting in certain activity realization, equipment for describing touristic points of interest in different areas of a town, getting queue numbers in waiting rooms.

COIMA performance is given by following factors:

- cross platform running without problems
- facile communication with other applications
- concurrent access
- continuously running, with back-up servers for resumption of activity when system fallings
- performance data base management systems
- no data loss
- high quality reliable input devices
- user friendly interface

For developing performance COIMA the classic application development cycle is used: analyze projection, implementation, testing and maintaining. All the time the target group and user's effort minimization are minded. The expectations are analyzed without thinking to a way of achieving them. The data structures are chosen, program's classes and the links between them are designed. The code is written using an evolved programming language. Various test data sets are used for testing the application which, once released is maintained by qualified persons.

For performance, indicators are defined. The indicators are used for building metrics for performance measurement. A performance indicator is functionality. Functionality

depends on the way of interaction between application's extern agents and the application itself, in concordance with inputs and outputs [13] Extern agents are users, other programs which are interacting with the application, peripheral devices. User's interface is very important for a better functionality. The higher the performance of interaction the better the functionality is.

For minimization of the user effort, his actions are reduced. For the user's interface, the weight of input elements is measured by reporting to the total number of interface elements. The user's effort indicator I_{Ef} is given by

$$I_{Ef} = 1 - \frac{E_{in}}{TE},$$

where:

E_{in}- The total number of input elements in user's interface

TE – Total number of user's interface elements

The indicator measures user's effort in his interaction with the application. To increase the value of I_{Ef} the total number of input elements in the user's interface has to be decreased.

4 Performance of complex mobile applications

In use of computers the users develops activities with long duration in time, and in use of mobile devices they develop activities with short duration, from several seconds to several minutes, when they are in other activities.

Important characteristics for mobile applications are[8]:

- start time is very important to be short for mobile application because it is used for activities of short duration and frequency, if the start time is long, the user need to wait too much time for that application.
- receptivity of the application, if it does not respond in time to restore the user control, and so there will be two or more tasks to be solved, which will further aggravate the application activity. It is recommended that when an order is received, the user is notified that the order is processed, because they do not give another command.
- interface of the application should be minimal, simplistic and the results to be those expected. The application must not contain many modules, modules that will not be used or are used by very few users. An application must be designed for a specific target group and to solve their problems.

Software quality is a set of technical characteristics, economic and social attributes of the application.

These attributes or characteristics are grouped in [9]:

- economical characteristics, expressed by costs for design, development, implementation and use, savings of material resources, human, financial, increases efficiency and productivity, viewed the costs and savings and analyzed together to determine whether product realization;
- social characteristics, showing the impact on user product, a product may change the routine, lifestyle, behavior.
- technical characteristics, these features have the largest share and are discussed extensively in the literature. They are subject to the definition of international standards by specialized organizations.

For the analysis of mobile applications is taken into account the following aspects that help to determine the correct quality level of the application:

- battery consumption;
- RAM memory used;
- CPU processing power;
- hard disk memory used.

The indicator of RAM memory consumption I_R is given by:

$$I_R = 1 - \frac{v}{mv},$$

where:

v – value of RAM memory consumption for current application

mv – maxim value of RAM memory of mobile device

This indicator determines performance of complex applications for mobile devices in

terms of memory consumption when running the application. RAM memory is very important for mobile applications because mobile phones not have as much memory as a desktop system.

5 Security requirements for complex applications

Depending on the domain where the software applications are being used, security requirements that must be met by these applications are different and need to be adapted in order to get the best protection.

When having applications that deal with components running on mobile devices the risks that these applications are exposed, increases. This is due to fact that compared to classical computers, mobile devices are more likely to be lost or stolen. The mobility of the devices also comes with a security price considering the fact that the sources for malicious software and information security risks are increasing considerably due to the multiple communication paths offered by the mobile devices. In order to ensure the portability, mobile devices usually have limited resources, in terms of processing power and internal memory, making security solutions harder to implement. For increasing the security of the mobile applications there are at least two factors to be considered:

- The information that is stored locally on the mobile device has to be encrypted, so in the case the device is lost or stolen the data will not be available to an unauthorized person.
- The information is stored on remote computers in a Cloud, in this way the information is easily verified and validated due to the high processing power on the remote systems. Also, with this approach, is not that easy to lose or damage the information due to the physical security of the devices that are storing the information.

For Citizen Oriented Informatics Applications, considering the characteristics depicted in Figure 1, we identify a set of security requirements.

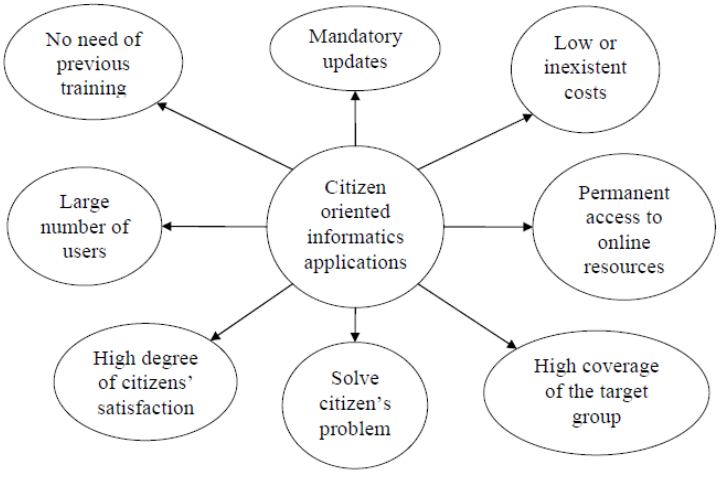

Fig. 1. Citizen oriented informatics applications' characteristics [12]

Looking to identify points that are potential vulnerability generators we take into consideration the large number of users. Having more users means handling more data, handling more data requires more data storage, and eventually this will increase the complexity of the application overall.

Using a large database with personal information, makes the application highly attractive for those interested in Identity Theft with the purpose of using the information for financial benefits. In order to reduce the risks related to fraudulent data access the following security requirements must be strictly met by these applications:

- The application must protect itself against SQL injection attacks, by using

additional validation over the data that a user sends for processing
- Strict access control for users, so a user will not have more access than needed
- Information administration application should run on a separate server, preferably behind a firewall and an IPS (Intrusion Prevention System)

Having an application depend on online resources, makes that system vulnerable to Denial of Service and Distributed Denial of Service attacks, thereby mirroring servers and additional access points are needed as backups, for ensuring that the COIMA is operable at least 99% of the time in a year.

In the case of innovation oriented applications the risks of facing security vulnerabilities increases due to fact that the development of such applications is mostly concentrated on generating the innovation. With the attention focused on the business view, security aspects are ignored, most of the times. Innovation involves development of new technologies which are primarily immature, until they gain enough market share to justify the continuation of development. The immaturity of innovative applications generates scenarios that were not considered when designing the application thereby some of these scenarios will generate security related issues.

Table 1. Citizen oriented Informatics Applications Vulnerability factor

Measurement Construct Identification	
Measurement construct name	Citizen oriented Informatics Applications Vulnerability factor
Numerical identifier	Organization specific
Purpose of measurement construct	To evaluate vulnerability exposure for a citizen oriented informatics application
Control/Process Objective	To solve the problems of the citizens, not the problems of the organization for which are developed [11]
Control/Process	The citizen will access the informatics application, will authenticate and will select the specific of the task he wants to resolve. In order to be able to authenticate and resolve different tasks, the citizen needs to be enrolled in the system, providing sensitive personal information needed for real world identification.
Object of Measurement and Attributes	
Object of Measurement	Citizen Oriented Informatics Applications Systems
Attribute	Vulnerability
Base Measure Specification	
Base Measure	B1. Number of enrolled users (NEu)
	B2. Number of succeeded cyber-attacks(NSa)
	B3. Number of security patches that were not applied (NMSp)
	B4. Number of accesses from mobile devices (NMDa)
	B5. Number of accesses Na
Measurement Method	M1. Run a COUNT query on the database used for storing citizens personal information M2. Count all the cases where the citizens have reported unauthorized transactions on their accounts, and also proven security weaknesses of the applications M3. Run vulnerability scanners on the computer system running the application M4. Count the number of accesses being made from mobile devices

	M5. Count the total number of accesses
Type of Measurement method	B1 to B5 Objective
Scale	B1-B5 Integers from 0 to infinity
Type of Scale	B1-B5 Ordinal
Unit of measurement	Percent
Derived measure specification	
Derived measure	Vulnerability rate used for tracking the exposure to attacks of a citizen oriented application
Measurement function	$V_e = (0{,}1 * \frac{NEu}{NMaxUsers} + 0{,}5 * \frac{NSa}{NTotalAttacks} + + 0{,}3 * \frac{NMSp}{NTotalSecurityPatches} + 0{,}1 * \frac{NMDa}{Na}) * 100.$
Measurements results	
Indicator interpretation	When this indicator ranges between 0-15% means Low vulnerability rate, involves no to minor security updates on the application. 15-35% - means Medium vulnerability rate, involves making security updates as soon as possible for covering security flaws 35%-60% - means High vulnerability rate, involves immediate update of the security patches and application configurations 60%-100% - means Critical vulnerability rate, dramatic updates are needed for the application itself and also immediate update for the security patches is required.

The experience fix the structure of a software metric and develop new approaches.

6 Metric of performance for complex applications

For each indicator set out above shall analyze the properties of sensitivity, non-catastrophic character and compensatory character.

Each indicator shows these properties. Sensitive character is given if the values of variables in the formula change then the final value of the pointer changes accordingly.

Non-catastrophic character that is given by the values of variables used to calculate the indicators are strictly positive.

Compensatory character of the indicators present is given for different values of the variables used in the calculation of indicators to obtain different values of the indicators.

For the Ud indicator:

$$\sum_{i=1}^{k} \frac{P_i L_{0i}}{P_i D_i + i} = \sum_{i=1}^{k} \frac{P_i L_{1i}}{P_i D_i + i}$$

$$Ud(L_1) = \frac{1}{k} \sum_{i=1}^{k} \frac{P_i L_{1i}}{P_i D_i + i}$$

$$L_1 = L_0 + h$$

$h_i = h$ because h is not influenced by i

$$Ud(L_1) = \frac{1}{k} \sum_{i=1}^{k} \frac{P_i (L_0 + h)_i}{P_i D_i + i} = \frac{1}{k} \sum_{i=1}^{k} \frac{P_i L_{0i} + P_i h_i}{P_i D_i + i} = \frac{1}{k} \sum_{i=1}^{k} \frac{P_i L_{0i} + P_i h}{P_i D_i + i}$$

$$= \frac{1}{k} \left(\sum_{i=1}^{k} \frac{P_i L_{0i}}{P_i D_i + i} + \sum_{i=1}^{k} \frac{P_i h}{P_i D_i + i} \right) = \frac{1}{k} \sum_{i=1}^{k} \frac{P_i L_{0i}}{P_i D_i + i} + \frac{1}{k} \sum_{i=1}^{k} \frac{P_i h}{P_i D_i + i} =$$

$$\frac{1}{k} \sum_{i=1}^{k} \frac{P_i L_{0i}}{P_i D_i + i} + \frac{h}{k} \sum_{i=1}^{k} \frac{P_i}{P_i D_i + i} = Ud(L_0) + \frac{h}{k} \sum_{i=1}^{k} \frac{P_i}{P_i D_i + i}$$

The Ud indicator is sensitive.

$$Ud(L_0) = Ud(L_1)$$

$$\frac{1}{k}\sum_{i=1}^{k}\frac{P_iL_{0i}}{P_iD_i+i} = \frac{1}{k}\sum_{i=1}^{k}\frac{P_iL_{1i}}{P_iD_i+i}$$

$$\sum_{i=1}^{k}\frac{P_iL_{0i}}{P_iD_i+i} = \sum_{i=1}^{k}\frac{P_iL_{1i}}{P_iD_i+i}$$

For k=1 $\frac{P_1L_{01}}{P_1L_1+1} = \frac{P_1L_{11}}{P_1L_1+1} \Rightarrow \quad L_0 = L_1$

For k=2

$$\frac{P_1L_{01}}{P_1L_1+1} + \frac{P_2L_{02}}{P_2L_2+2} = \frac{P_1L_{11}}{P_1L_1+1} + \frac{P_2L_{12}}{P_2L_2+2} \Rightarrow$$

$$\frac{P_1L_{01}}{P_1L_1+1} - \frac{P_1L_{11}}{P_1L_1+1} = \frac{P_2L_{12}}{P_2L_2+2} - \frac{P_2L_{02}}{P_2L_2+2} \Rightarrow$$

$$\frac{P_1(L_{01}-L_{11})}{P_1L_1+1} = \frac{P_2(L_{12}-L_{02})}{P_2L_2+2} \Rightarrow (L_{01}-L_{11}) =$$

$$(L_{12}-L_{02}) \Rightarrow (L_0-L_1) = (L_1-L_0) \Rightarrow$$

$$L_1 = L_0$$

Using mathematical induction we prove that $Ud(L_0) = Ud(L_1)$ only if $L_1 = L_0$. This means that the Ud indicator doesn't have a compensatory nature.

For the user's effort indicator I_{Ef}:

$$I_{Ef}(E_{in_0}) = 1 - \frac{E_{in_0}}{TE} I_{Ef}(E_{in_1})$$

$$= 1 - \frac{E_{in_1}}{TE}$$

$$E_{in_1} = E_{in_0} + h$$

$$I_{Ef}(E_{in_1}) = 1 - \frac{E_{in_0} + h}{TE}$$

$$I_{Ef}(E_{in_1}) = I_{Ef}(E_{in_0}) + \frac{h}{TE}$$

$\Rightarrow$ I_{Ef} is sensitive.

For the indicator I_R :

$$I_R(v_0) = 1 - \frac{v_0}{vm}$$

$$I_R(v_1) = 1 - \frac{v_1}{vm}$$

$$v_1 = v_0 + h$$

$$I_R(v_1) = 1 - \frac{v_0 + h}{vm}$$

$$I_R(v_1) = 1 - \frac{v_0}{vm} + \frac{h}{vm}$$

$$I_R(v_1) = I_R(v_0) + \frac{h}{vm}$$

Thus this indicator is sensitive.

For different values of v the indicator I_R have different values, thus this indicator have the compensatory character.

I_R have catastrophic character only if the vm is equal with 0, but that can't real, because all devices have RAM memory, thus the indicator is non-catastrophic.

For V_e indicator:

$$V_e(na_0) = \left(0{,}1 * \frac{NEu}{NMaxUsers} + 0{,}5 * \frac{na_0}{NTotalAttacks} + 0{,}3 * \frac{NMSp}{NTotalSecurityPatches} + 0{,}1\frac{NMDa}{Na}\right) * 100$$

$$na_1 = na_0 + h$$

$$V_e(na_1) = V_e(na_0) + \frac{0.5 * h * 100}{NTotalAttacks}$$

From the above relations we see that this indicator is sensitive.

$$If\ V_e(na_0) = V_e(na_1) \Rightarrow$$

$$\left(0{,}1 * \frac{NEu}{NMaxUsers} + 0{,}5 * \frac{na_0}{NTotalAttacks} + 0{,}3 * \frac{NMSp}{NTotalSecurityPatches} + 0{,}1\frac{NMDa}{Na}\right) * 100 =$$

$$\left(0{,}1 * \frac{NEu}{NMaxUsers} + 0{,}5 * \frac{na_1}{NTotalAttacks} + 0{,}3 * \frac{NMSp}{NTotalSecurityPatches} + 0{,}1\frac{NMDa}{Na}\right) * 100 \Rightarrow$$

$$na_1 = na_0 \Rightarrow \text{non - compensatory character}$$

The structural stability for every indicator is very important when the users want to determine the optimal re-engineering moment.

7 Conclusions

In our days the applications and the devices on which they are running on, are very complex and for developers is more difficult to satisfy the performance requirements for these kind of application. In this paper are presented four type of complex applications and each one has attached an indicator to determine the performance of an application. The performance requirements of a complex application are focused towards the following criteria: functionality, reliability, usability, maintainability, security, portability and scalability. The backbone of any applications is its functionalities, so performance is increased by refining its main features. Performance is not necessarily determined by reliability but it become redundant without it. Increase the reliability of an application before performance even becomes an issue. Complex applications should be citizen oriented in order to achieve a higher level of usability. Maintenance is a very important aspect of an application's life cycle. Maintenance should be cheap, scarce and easy otherwise performance will be counterbalanced by costs. Security should be tight and should not interfere with common functionalities. A complex application without a high level of portability is bound to fail. This means numerous ease of access to the applications should be available. Mainframes and personal computers are overrated. Mobiles, tablets, e-Book readers are the next generation of devices that complex applications should be compatible with. The human nature is complex and applications have to evolve in order to keep up its fastidiousness. For that matter, scalability is a key factor. New modules and functionalities should be artless to add and an increased number of users should be easily accommodated.

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