Results of the implementation of IP Multimedia Subsystem in one Telecom operator for the ITIL Incident Management and Problem Management process

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Abstract — This paper describes the implementation and using of the IP Multimedia Subsystem (IMS) in one Telecom operator in Bosnia and Herzegovina. In the first part of the paper, is described the design, implementation and testing of the IP Multimedia Subsystem in one Telecom operator. In the second part of the paper, it is described a new organization structure of Telecom operator after releasing into production of the new IMS system. Measurements, which describe the implementation of IMS system in Telecom operator, are finished for two ITIL processes: Incident Management and Problem Management which are integrated into Service Desk function. Gap analysis is selected as the technique for these measurements. Final results show that the Incident Management is implemented with 80% of recommendations and Problem Management is implemented with 76% of recommendations. These results show that the improvement of the IMS system is needed and desirable.

Keywords — Billing system, IMS, ITIL V3, Service Desk, Incident Management, Problem Management.

I. Introduction

The IP Multimedia Subsystem (IMS) is a standardized IP-based architecture that allows the convergence of fixed and mobile communication devices, multiple network types, and multimedia applications [8]. Using IMS, applications can combine voice, text, pictures, and video in seamless call sessions, offering significant ease-of-use to subscribers and allowing service providers to drive branding through a common interface, while substantially reducing operating costs [7]. This subsystem allows to users to send multimedia files from TV to mobile phone or from mobile phone to TV, or to send SMS messages from TV to mobile phones [9].

Information Technology Infrastructure Library (ITIL) is the most popular methodology for the management of IT services [4]. ITIL has 5 phases, with 23 IT processes and 4 IT functions. Processes that will be covered in this paper are: Service Level Management [1], Supplier Management [1], Transition Planning and Support [2], Service Asset and Configuration Management [2], Release and Deployment Management [2], Service Validation and Testing [2], Evaluation process [3], Incident Management [4] and Problem Management [4].

The process of changing of Middleware system which is the central IPTV system is described in [5]. This paper is introduction in the research which is covered in this paper because it describes the process of changing of central IPTV system for the fixed telephony, unlike the research in this paper in which is described the process of changing central IPTV system for fixed telephony and mobile telephony and their integration in central IMS system. Other researches that are included in this paper are: implementation of the billing system for the x-play service of the triple-play sistem [6] and [7] in which is described how call service tracks callers in real-time communications and walkie-talkie communications can be effectively exercised in IMS. In paper [10] is described the methodology of the implementation of Information Security Management in IMS system. In paper [12] is described the complete process of the IPTV convergence into IMS system and advances of that implemented system. The authors have launched and developed system as a pilot service in their network. Based on this research, we did our research in one Telecom Operator in Bosnia and Herzegovina to show that IMS system is applicable in one real environment. Very similar research is [23] in which authors have described SIP applications servers and IMS service logic. They showed that these servers can be open services architecture (OSA) application servers or a customized applications for mobile networks using enhanced logic service environment.

The authors have published a few papers before this papers that are connected to the implementation of the ITIL framework. The most important are: [24] in which is described the implementation of the ITIL Supplier Management process in IPTV system of Telecom operator

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and [25] in which is described the implementation of the ITIL Information Security Management process in IPTV/VoIP system of Telecom operator. The result of the first paper is 75% of successful implemented ITIL recommendations for IPTV system and the result of the second paper is 67% of successful implemented ITIL recommendations for IPTV and VoIP systems. These both researches are done in the same environment as this research.

The IP Multimedia Subsystem relates to the models of traffic flow. There are many papers that analyze models of data traffic flow in multimedia networks. In paper [17] authors have described the model of data traffic flow in Cyber-physical networking systems (CPNSs). The same authors have used standard fractional Brownian motion (mBm) to increase the level of data traffic on Internet [18]. These authors have presented a theoretical representation of a stochastic traffic bound that consists of two items, the burstiness bound and the bound of long-term average rate [19]. Very interesting paper in this field is [20] in which authors have tested several high-level design principles for performance-driven ATM traffic controls based on resource reservation. They have concluded that a pragmatic traffic management approach that favors simplicity and robustness in the traffic control design rather than optimizing bandwidth efficiency is stressed. The survey which is done on Georgia Institute of technology in Atlanta [21] has showed the opinion of subscribers about using wireless and IP Multimedia Subsystem technologies. The results from this survey have showed that wireless and IP Multimedia Subsystem technologies are only for the young generations. Finally, in paper [22] are done analytical approximations for the first order and second-order statistics of the delay jitter experienced by a stationary traffic stream multiplexed at a major communication node. These approximations are then used to gain insight into the behavior of jitter in single mode under diverse system and traffic conditions.

In paper [26] is described the importance of interoperability of IMS products thus realizing an IMS based platform for enabling efficient deployment of new multimedia communication services. Paper [27] shows the design and importance of IMS system for mobile clients. Paper [28] proposes the service control method for NGN networks which are the core of IP network for IMS systems. In paper [29] is presented ITIL framework and its importance for the business today. Paper [30] presents Balanced Scorecard as the most popular technique for the measurement of ITIL processes. One similar technique which is called Gap analysis will be used in measurements in this paper.

Section II of the paper describes a new proposed IMS ITIL V3 model. Section III describes 11 basic steps that are used in the implementation of IMS system for Telecom Operator by using ITIL V3 recommendations. Section IV of the paper describes results of the implemented IMS system by using predefined tests and the release into a production of a new IMS system. Section V shows results of the IMS system implementation and financial costs needed for this implementation. Section VI presents a organization structure of the Service Desk for the IMS system. Section VII presents measurements which are done for the Incident Management process in the implemented Service Desk. Section VIII presents measurements which are done for the Problem Management process in the implemented Service Desk. In the conclusion of the paper are presented possible improvements of the implemented Service Desk.

II. Design of the IP Multimedia Subsystem by using ITIL V3 recommendations

Architecture of a new IMS system is shown on figure 1. The central component is IPTV Middleware which is directly connected to VoD Content Acquisition, Verimatrix CA/DRM Server, Head-end Encoder and Linear TV Content Source [9], [12], [14]. These servers are directly connected to VoD Streaming servers and to access network which is a connection to end user devices: TVs, mobile phones and computers.

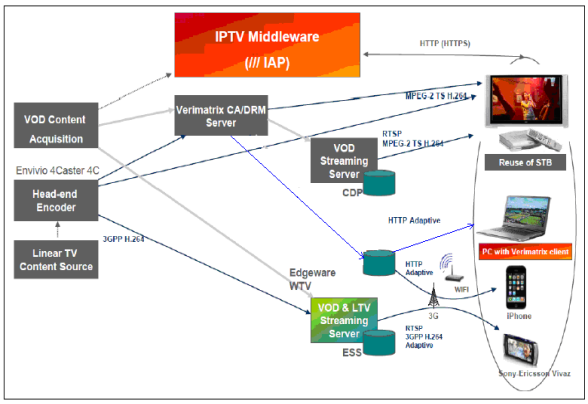

Figure 1. Architecture of a new IMS system

Because of the replacement with the old IPTV Middleware and Mobile phone system with a new IMS Middleware system it is needed to implement the following 13 steps in this specific order [5]:

1. Defining a list of specifications that the new IMS system has to have
2. Choosing an external company that needs to design and implement the new IMS system
3. Choosing an external company that needs to design and implement the new database for a new IMS system
4. Choosing an external company that needs to design and implement the new Provisioning system, Billing system and Mediation system for a new IMS system
5. Design of the new database which has to integrate fixed telephony database, mobile telephony database, IPTV database, VoIP database and Internet database
6. Implementation of a new IMS system by an external company
7. Implementation of migration scripts which have to migrate data from old databases to a new IMS database
8. Implementation of a new Provisioning system which is a connection between central information system and a new IMS system

9. Implementation of a new Billing system for a new IMS packages
10. Implementation of a new Mediation system for a new IMS packages
11. Testing of a new IMS system with all types of terminal equipment including new: database, Billing system, Mediation system and Provisioning system
12. Migration of data from old databases to a new IMS database
13. Release into a production of a new IMS system

We proposed a new IMS ITIL V3 model based on these 13 needed steps for the IMS implementation. Table I describes a new IMS model based on ITIL V3 recommendations.

TABLE I. NEW IMS ITIL V3 MODEL

Phase name	Action in the implementation of the IMS model	ITIL V3 process
Phase I	Defining a list of specifications that the new IMS system has to have	Service Level Management
Phase II	Choosing an external company that needs to design and implement the new IMS system	Supplier Management
Phase II	Choosing an external company that needs to design and implement the new database for a new IMS system	Supplier Management
Phase II	Choosing an external company that needs to design and implement the new Provisioning system, Billing system and Mediation system for a new IMS system	Supplier Management
Phase III	Design of the new database which has to integrate fixed telephony database, mobile telephony database, IPTV database, VoIP database and Internet database	Service Asset and Configuration Management
Phase IV	Implementation of a new IMS system by an external company	Release and Deployment Management
Phase IV	Implementation of migration scripts which have to migrate data from old databases to a new IMS database	Release and Deployment Management
Phase IV	Implementation of a new Provisioning system which is a connection between central information system and new IMS system	Release and Deployment Management
Phase IV	Implementation of a new Billing system for a new IMS packages	Release and Deployment Management
Phase IV	Implementation of a new Mediation system for a new IMS packages	Release and Deployment Management
Phase IV	Migration of data from old databases to a new IMS database	Release and Deployment Management
Phase V	Testing of a new IMS system with all types of terminal equipment including new: database, Billing system, Mediation system and Provisioning system	Service Validation and Testing
Phase VI	Release into a production of a new IMS system	Evaluation Process

Figure 2. shows a new IMS ITIL V3 model which has 6 phases in which are placed 6 ITIL V3 processes: Service Level Management, Supplier Management, Service Asset and Configuration Management, Release and Deployment Management, Service Validation and Testing and Evaluation Process.

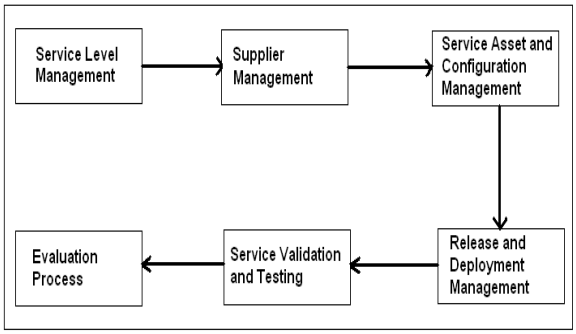

Figure 2. New ITIL V3 model for IMS architecture

III. IMPLEMENTATION OF THE IP MULTIMEDIA SUBSYSTEM BY USING ITIL V3 RECOMMENDATIONS

A. Implementation of the Service Level Management

Table II describes all IMS services that the implemented IMS system should have [13], [14]. All IPTV, mobile and VoIP functions of the IMS platform are described [15], [16].

TABLE II. IMS SERVICES THAT THE IMPLEMENTED IMS SYSTEM SHOULD HAVE

IMS service	Meaning of a IMS service
LiveTV	Emitting live TV channels as well as SD channels and HD channels directly on TVs. The platform should be secured by arranging the TV channels into certain categories like: all channels, favourite channels, domestic channels, regional channels, informative channels, sports and music TV channels.
MobileTV	Emitting live TV channels as well as SD channels and HD channels on mobile phones. The platform should be secured by arranging the TV channels into certain categories like: all channels, favourite channels, domestic channels, regional channels, informative channels, sports and music TV channels.
TV EPG	Electronic Programme Guide on TVs should support the option of program recording for 10 days in the past and 10 days in the future. For all shows in the EPG certain features should be defined like: the name of the show, starting time, ending time, show description and total playing time.
Mobile EPG	Electronic Programme Guide on mobile phones should support the option of program recording for 10 days in the past and 10 days in the future. For all shows in the EPG certain features should be defined like: the name of the show, starting time, ending time, show description and total playing time.
TV VoD	Video on Demand on TVs should enable to users the option of buying and watching movies for all types of

	categories. Every movie has to have its price, playing time, producers name, main actors name and a short description listed.
Mobile VoD	Video on Demand on mobile phones should enable to users the option of buying and watching movies for all types of categories. Every movie has to have its price, playing time, producers name, main actors name and a short description listed.
TV – Mobile VoD	This option should enable to users to watch some VoD content on mobile phones after they stopped with the emitting of the same VoD content on TVs (or to watch some VoD content on TVs after they stopped with the emitting of the same VoD content on mobile phones).
TV Timeshift	The option of direct recording of TV shows using a remote control for the Set Top Box. Maximum playing time of one recording should be 6 hours.
Mobile Timeshift	The option of direct recording of TV shows using a mobile phone keyboard. Maximum playing time of one recording should be 6 hours.
TV – Mobile Timeshift	This option should enable users to watch some timeshift recording on mobile phones after they stopped with the emitting of the same Timeshift content on TVs (or to watch some timeshift recording on TVs after they stopped with the emitting of the same Timeshift content on mobile phones).
TV multimedia sharing	TV multimedia sharing option should enable to users to send some file (for example, picture or sound file) from their TV to the TV of someone else.
Mobile multimedia sharing	Mobile multimedia sharing option should enable to users to send some file (for example, picture or sound file) from their mobile phone to the mobile phone of someone else.
TV – Mobile multimedia sharing	TV – Mobile multimedia sharing option should enable to users to send some file (for example, picture or sound file) from their TV to the mobile phone of someone else or from mobile phone to the TV of someone else.
TV SMS	This option should enable to users to send their SMS messages between themselves by using this option on their TVs.
TV – Mobile SMS	This opportunity gives users the option to send their SMS messages from their TV to the mobile phone of someone else or in other way from mobile phone to the TV.
TV Chat	TV Chat enables users to have the option of instant messaging by using their TV. Identification parameter by which the users are going to differ from each other is subscriber_uid that every user has to get when they activate the service. The option Chat should have a realized option of authentication respectively the possibility of accepting and rejecting users for chat.
Mobile Chat	Mobile Chat enables users to have the option of instant messaging by using their TV. Identification parameter by which the users are going to differ from each other is subscriber_uid that every user has to get when they activate the service. The option Chat should have a realized option of authentication respectively the possibility of accepting and rejecting users for chat.
TV – Mobile Chat	This option enables that one user is using TV in the conversation and the second one is using mobile phone. Identification parameter by which the users are going to differ from each other is subscriber_uid that every user has to get when they activate the service. The option Chat should have a realized option of authentication respectively the possibility of accepting and rejecting users for chat.
TV Radio	TV Radio enables emitting radio channels to users. Radio channels on TVs should be arranged into few categories: all channels, regional channels, informative channels etc.
Mobile Radio	Mobile Radio enables emitting radio channels to users. Radio channels on mobile phones should be arranged into few categories: all channels, regional channels, informative channels, sports and music TV channels.
TV games	The option that gives to user an opportunity to play an unlimited number of interactive 3D games on his TV. Every game has to have its price and the time period for a playing of that game for the same price.
Mobile games	The option that gives to user an opportunity to play an unlimited number of interactive 3D games on his mobile phone. Every game has to have its price and the time period for a playing of that game for the same price.
TV – Mobile games	TV – Mobile games is the option that gives to user an opportunity to buy some game on TV, to start a playing of that game on TV, that he makes a pause and after it, he continues with the playing of that game on mobile phone (or he buys some game on mobile phone, and he starts with a playing of game on mobile phone, than makes a pause on mobile phone and than continues with a playing of tha same game on TV).
TV Internet	The option of using Internet on TV by using a remote control. All contents on Internet should be available to users.
TV Caller ID	Support the option of exhibiting the VoIP number on the TV for all users which have the additional option of VoIP. The VoIP number should be shown on the TV when the user is receiving a call from another user.

B. Implementation of the Supplier Management

Criteria for the choice of an external company [1] (for the design and implementation of the new IMS system, for the company that needs to implement a new database for a new IMS system and for company that needs to design and implement the new Provisioning system, Billing system and Mediation system for a new IMS system) has two phases: phase of prequalification and the phase of the final

partner company choice. In the phase of prequalification all companies have to have all needed requirements defined in [5]. The phase of the final partner company choice is based on parameters defined in table III, table IV and table V. The percentage of these parameters is obtained on the basis of Telecom Operators management decision during the implementation of this project. In a case that 2 or more companies have the same final value, the winner is the company with a smaller price.

TABLE III. PARAMETERS FOR THE PHASE OF THE FINAL PARTNER COMPANY CHOICE FOR THE COMPANY RESPONSIBLE FOR THE IMS IMPLEMENTATION

The name of the parameter	The percentage of the parameter in a final decision
The lowest price	70%
The number of IMS implementations	15%
The number of IPTV implementations	10%
The number of VoIP implementations	5%

TABLE IV. PARAMETERS FOR THE PHASE OF THE FINAL PARTNER COMPANY CHOICE FOR THE COMPANY RESPONSIBLE FOR THE IMS DATABASE IMPLEMENTATION

The name of the parameter	The percentage of the parameter in a final decision
The lowest price	70%
The number of Information systems implementations	10%
The number of databases implementations	20%

TABLE V. PARAMETERS FOR THE PHASE OF THE FINAL PARTNER COMPANY CHOICE FOR THE COMPANY RESPONSIBLE FOR THE INFORMATION SYSTEM IMPLEMENTATION

The name of the parameter	The percentage of the parameter in a final decision
The lowest price	60%
The number of Information systems implementations	10%
The number of Billing systems implementations	10%
The number of Provisioning systems implementations	10%
The number of Mediation systems implementations	10%

C. Implementation of the Service Asset and Configuration Management

For the implementation of a new IMS database, it is needed to design and implement all of these tables that are important for defined IMS specifications: Subscriber, STB, Mobile phone, Modem, VoIP Adapter, System, VoD Content, TV Channel, Radio Channel, EPG and Game [9], [12]. The most important tables are: System and Subscriber, because all other tables are connected to these tables. Figure 3. shows Entity Relationship Diagram (ERD) for the formed IMS system.

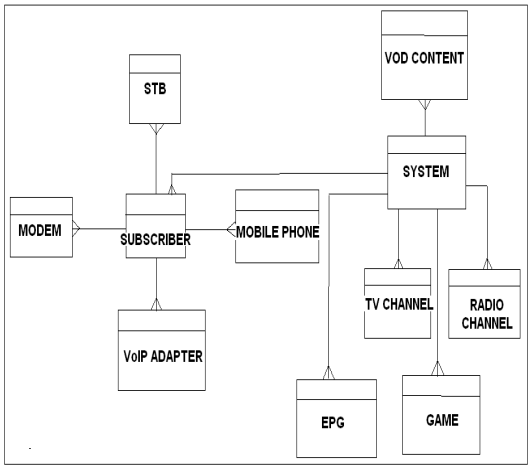

Figure 3. Entity Relationship Diagram for the formed IMS system

D. Implementation of the Release and Deployment Management

Realization of this process is based on the realization of 2 separated systems:

1. Provisioning system
2. Billing and Mediation system

1. Provisioning system

Implementation of the Provisioning system is based on the realization of these 49 steps [5]:

1. Adding new Set Top Box's
2. Changing existing Set Top Box's
3. Deleting existing Set Top Box's
4. Adding new Modems
5. Changing existing Modems
6. Deleting existing Modems
7. Adding new VoIP adapters
8. Changing existing VoIP adapters
9. Deleting existing VoIP adapters
10. Adding new mobile phones
11. Changing existing mobile phones
12. Deleting existing mobile phones
13. Creating a new user
14. Assigning a basic package of channels to the end user
15. Assigning an additional package of TV channels to the end user
16. Assigning an additional package of Mobile Internet
17. Assigning an additional package of Hosting
18. Assigning an additional package of E-mail addresses
19. Deleting an additional package of TV channels to the end user
20. Deleting an additional package of Mobile Internet
21. Deleting an additional package of Hosting
22. Deleting an additional package of E-mail addresses
23. Suspension of users (temporarily turned off)
24. Reconnection of users
25. Permanently delete users
26. Changing the name of the user
27. Changing the surname of the user
28. Changing the address of the user

29. Changing the location of the user
30. Changing the postal code of the user
31. Changing subscriber_uid of the user
32. Adding a VoIP number for the user
33. Changing the VoIP number of a user
34. Deleting the VoIP number of a user
35. Adding a mobile phone number for the user
36. Changing the mobile phone number of a user
37. Deleting the mobile phone number of a user
38. Adding new TV and radio channels
39. Changing existing TV and radio channels
40. Deleting existing TV and radio channels
41. Adding new VoD contents
42. Changing existing VoD contents
43. Deleting existing VoD contents
44. Adding new games
45. Changing existing games
46. Deleting existing games
47. Adding new content for EPG
48. Changing existing content for EPG
49. Deleting existing content for EPG

2. Billing and Mediation system

Table VI shows new tables in the formed database of Billing system that this system should get from the central information system of Telecom Operator [6].

TABLE VI. TABLE USER

The name of the field	The meaning of the field	The field indicates the price
USERID	The unique identification number of the user who has some x-play service	NO
USERNAME	The name of user	NO
USERSURNAME	The surname of user	NO
USERPHONE	The VoIP number of user	NO
USERADDRESS	The address of user	NO
USERCITY	The place of user	NO
VODREGION	The VOD region of user	NO
2 STB	The parameter that indicates if the user has 2 STB's	YES
PLUS	The parameter that indicates if the user has a PLUS package of additional TV channels	YES
HD	The parameter that indicates if the user has a HD package of additional TV channels	YES
MWI	The parameter that indicates if the user has an additional option of Message Waiting Indicator in his VoIP telephone	YES
PHONEBOOKPERMISSION	The parameter that indicates if the user uses the option of the restriction of his VoIP number in the Phone Book	YES

Table VII describes prices of additional IPTV services, table VIII describes prices of the Video On Demand service, table IX describes prices of calls from one network (VoIP or mobile network) to the another VoIP or Mobile network and table X describes prices for the different game categories [6].

TABLE VII. THE PRICE OF ADDITIONAL IPTV SERVICES

The name of additional IPTV services	The price of additional IPTV services
2 STB	Price 1
PLUS	Price 2
HD	Price 3
MWI	Price 4
PHONEBOOKPERMISSION	Price 5

TABLE VIII. THE PRICE OF VIDEO ON DEMAND PACKAGE

The name of VOD package	The price of VOD package
Category 1	Price 1
Category 2	Price 2
Category 3	Price 3
Category 4	Price 4

TABLE IX. THE PRICE OF CALLS FROM ONE NETWORK TO THE ANOTHER NETWORK

The name of calling network	The name of receiving network	The price
VoIP	VoIP (the same operator)	Price 1
VoIP	Mob (the same operator)	Price 2
Mob	VoIP (the same operator)	Price 3
Mob	Mob (the same operator)	Price 4
VoIP	VoIP (operator n)	Price n1
VoIP	Mob (operator n)	Price n2
Mob	VoIP (operator n)	Price n3
Mob	Mob (operator n)	Price n4

TABLE X. THE PRICE OF GAME PACKAGE

The name of Game package	The price of Game package
Category 1	Price 1
Category 2	Price 2
Category 3	Price 3
Category 4	Price 4

Billing system has to collect data from network element for IMS and it has to contain the data about consumption from Video On Demand service, VoIP service, Mobile Telephony service and Game service (tables XI, XII, XIII, XIV).

TABLE XI. TABLE VOD

The name of the field	The meaning of the field
USERID	The unique identification number of the user who has some x-play service
ID_VOD_CONTENT	The unique identification number of video content
VOD_CONTENTS_NAME	The name of video content

CONSUMPTION_START	The time when the video content is bought
VOD_CONTENTS_PACKAGE_UID	The unique identification number of video content category on which is based the charging of video content
VOD_CONTENTS_PACKAGE_NAME	The name of video content category on which is based the charging of video content

TABLE XII. TABLE VOIP

The name of the field	**The meaning of the field**
USERID	The unique identification number of the user who has some x-play service
USERPHONE	User's VoIP number
RECEIVEDPHONE	The telephone number of user who has received a call
CONSUMPTION_START	The time when the call is started
CONSUMPTION_END	The time when the call is finished
CONSUMPTION_DURATION	The time duration of the telephone call

TABLE XIII. TABLE MOB

The name of the field	**The meaning of the field**
USERID	The unique identification number of the user who has some x-play service
USERMOBILEPHONE	User's MOB number
RECEIVEDPHONE	The telephone number of user who has received a call
CONSUMPTION_START	The time when the call is started
CONSUMPTION_END	The time when the call is finished
CONSUMPTION_DURATION	The time duration of the telephone call

TABLE XIV. TABLE GAME

The name of the field	**The meaning of the field**
USERID	The unique identification number of the user who has some x-play service
ID_GAME_CONTENT	The unique identification number of game content
GAME_CONTENTS_NAME	The name of game content
CONSUMPTION_START	The time when the game content is bought
	The unique
GAME_CONTENTS_PACKAGE_UID	identification number of game content category on which is based the charging of video content
GAME_CONTENTS_PACKAGE_NAME	The name of game content category on which is based the charging of game content

When the Billing system collects data from tables VI, XI, XII, XIII and XIV, and according to the defined price described in tables VII, VIII, IX and X, then it can make a final sum of consumption for one calendar month for each user.

IV. TESTING OF THE IP MULTIMEDIA SUBSYSTEM BY USING ITIL V3 RECOMMENDATIONS

A. Implementation of the Service Validation and Testing Process

Table XV shows results of tests which are done after the implementation of IMS ITIL V3 model [11]. All tests that are important for the implemented IMS system are taken into consideration [8], [15]. Tests for the new implemented Billing system, Mediation system and Provisioning system are also taken into account [9]. Tests for the implementation of IMS platform have taken into account users from all geographical areas of Telecom Operator. Tests for the implementation of information systems have taken all provisioning and billing scenarios that are described in chapter III. These tests are done by using Automated Switchport Access Provisioning tool (ASAP).

TABLE XV. RESULTS OF THE IMPLEMENTED IMS MODEL

IMS service	**Number of tests**	**Number of successful tests**	**Success rate**
LiveTV	100	98	98%
MobileTV	90	86	95.5%
TV EPG	50	50	100%
Mobile EPG	40	37	92.5%
TV VoD	60	59	98.3%
Mobile VoD	50	45	90%
TV – Mobile VoD	60	57	95%
TV Timeshift	70	70	100%
Mobile Timeshift	60	58	96.6%
TV – Mobile Timeshift	60	59	98.3%
TV multimedia sharing	80	80	100%
Mobile multimedia sharing	80	79	98.7%
TV – Mobile multimedia sharing	70	68	97.1%
TV SMS	80	80	100%
TV – Mobile SMS	80	79	98.7%
TV Chat	60	55	91.6%
Mobile Chat	70	67	95.7%
TV – Mobile Chat	60	58	96.6%
TV Radio	70	70	100%
Mobile Radio	60	59	98.3%
TV games	70	69	98.5%
Mobile games	70	69	98.5%
TV – Mobile	60	60	100%

games			
TV Internet	90	85	94.4%
TV Caller ID	80	78	97.5%
STB actions	30	30	100%
Modems actions	20	20	100%
VoIP adapters actions	30	30	100%
Actions with users	60	59	98.3%
Actions with TV channels	30	30	100%
Actions with TV packages	20	20	100%
Actions with VoD contents	40	40	100%
Actions with EPG	30	30	100%
Actions with games	20	20	100%
VoD Billing	30	30	100%
Game Billing	30	30	100%
VoIP Billing	40	40	100%
MOB Billing	40	40	100%
Total Billing	50	50	100%

B. Implementation of the Evaluation Process

On the basis of these tests, a special team composed of 3-5 IT professionals should give a positive decision about the release of the new system into production [5].

V. RESULTS OF THE IP MULTIMEDIA SUBSYSTEM IMPLEMENTATION AND FINANCIAL COSTS

The total number of tests which are used for the testing of the implemented IMS ITIL V3 model is 2190. Results have shown that the number of successful tests is 2144. It gives the result of 98% successful implemented tests for IMS ITIL V3 model and it is basically "Quality of IMS service" which is shown on figure 4. Figure 4. shows the ratio between successful implemented tests and unsuccessful implemented tests for IMS ITIL V3 model.

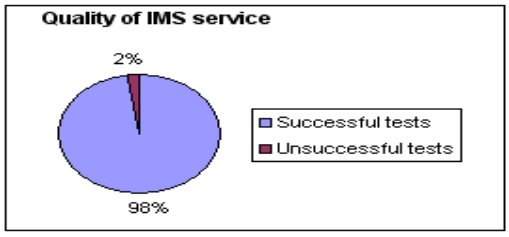

Figure 4. Quality of IMS service

The result of 98% successfully implemented tests for IMS ITIL V3 model is very satisfactory result. Separate results for 3 independent parts of the project show that the percentage of successful tests for the implementation of the IMS model is 97.3%, for the implementation of the database is 100%, and for the implementation of the Billing system, Mediation system and Provisioning system is 99.7%. Further improvements in the IMS ITIL V3 models are associated with the improvement of some IMS functions like: Mobile EPG, Mobile VoD, TV Chat and TV Internet. It is important to say that these are additional IPTV functionalities and all basic IPTV and mobile functionalities are working almost excellent. Table XVI explains the overall budget for each phase separately which was used in the implementation of this project. The total budget needed for the implementation of this project was 455.000 E.

TABLE XVI. FINANCIAL COSTS FOR THE EACH PHASE OF THE PROJECT

Phase name	**Action in the implementation of the IMS model**	**Financial costs**
Phase I	Defining a list of specifications that the new IMS system has to have	10.000 E
Phase II	Choosing an external company that needs to design and implement the new IMS system	45.000 E
Phase II	Choosing an external company that needs to design and implement the new database for a new IMS system	5.000 E
Phase II	Choosing an external company that needs to design and implement the new Provisioning system, Billing system and Mediation system for a new IMS system	20.000 E
Phase III	Design of the new database which has to integrate all databases	10.000 E
Phase IV	Implementation of a new IMS system by an external company	250.000 E
Phase IV	Implementation of migration scripts which have to migrate data from old databases to a new IMS database	5.000 E
Phase IV	Implementation of a new Provisioning system	40.000 E
Phase IV	Implementation of a new Billing system	35.000 E
Phase IV	Implementation of a new Mediation system	15.000 E
Phase IV	Migration of data from old databases to a new IMS database	10.000 E
Phase V	Testing of a new IMS system	8.000 E
Phase VI	Release into a production of a new IMS system	2.000 E

VI. REALIZATION OF THE SERVICE DESK WHICH IS RESPONSIBLE FOR THE MAINTENANCE OF IMS SYSTEM

Service Desk is implemented after the releasing into production of the new IMS system. Service Desk is responsible for the management of two types of events: incidents and problems. In ITIL terminology, for the management of the incidents is responsible process which is called Incident Management and for the management of the problems is responsible process which is called Problem Management. Table XVII. shows the structure of departments in the implemented Service Desk for the IMS model. This table shows that the total number of departments in the implemented Service Desk is 65 (40 departments responsible for the solving of incidents and 25 departments responsible for the solving of problems). The total number of employees is 488 (372 are working in departments responsible for the solving of incidents and 116 are working in departments responsible for the solving of problems).

TABLE XVII. STRUCTURE OF DEPARTMENTS IN THE IMPLEMENTED SERVICE DESK FOR THE IMS MODEL

The name of Service Desk department	**Number of employees in each department**
Department which is responsible for the solving of incidents with TV	27

channels	
Department which is responsible for the solving of incidents with mobile TV channels	12
Department which is responsible for the solving of problems with TV channels	5
Department which is responsible for the solving of incidents with EPG for TV channels	4
Department which is responsible for the solving of incidents with EPG for mobile TV channels	3
Department which is responsible for the solving of problems with EPG for TV channels	2
Department which is responsible for the solving of incidents with Video on Demand for TV channels	5
Department which is responsible for the solving of incidents with Video on Demand for mobile TV channels	4
Department which is responsible for the solving of incidents with Video on Demand when a user switches the view of one movie from TV platform to Mobile platform or from Mobile platform to TV platform	4
Department which is responsible for the solving of problems with Video on Demand service	6
Department which is responsible for the solving of incidents with Timeshift on TV channels	3
Department which is responsible for the solving of incidents with Timeshift on mobile TV channels	2
Department which is responsible for the solving of incidents with Video on Demand when a user switches the view of one timeshift record from TV platform to Mobile platform or from Mobile platform to TV platform	2
Department which is responsible for the solving of problems with Timeshift on TV channels	3
Department which is responsible for the solving of incidents with a sharing of multimedia files between users on TV channels	10
Department which is responsible for the solving of incidents with a sharing of multimedia files between users on mobile TV channels	8
Department which is responsible for the solving of incidents with a sharing of multimedia files between the first user who is using TV platform and the second user who is using mobile TV platform	12
Department which is responsible for the solving of problems with a sharing of multimedia files between users on TV channels	6
Department which is responsible for the solving of incidents with a sending of SMS messages between users on TV channels	11
Department which is responsible for the solving of incidents with a sending of SMS messages between users on mobile TV platform	9
Department which is responsible for the solving of incidents with a sending of SMS messages between	9

the first user who is using TV platform and the second user who is using mobile TV platform	
Department which is responsible for the solving of problems with a sending of SMS messages between users on TV channels	8
Department which is responsible for the solving of incidents with a Chat option between 2 users who are using TV platform	9
Department which is responsible for the solving of incidents with a Chat option between 2 users who are using mobile TV platform	15
Department which is responsible for the solving of incidents with a Chat option between the first user who is using TV platform and the second user who is using mobile TV platform	12
Department which is responsible for the solving of problems with a Chat option	5
Department which is responsible for the solving of incidents with radio channels on TV platform	8
Department which is responsible for the solving of incidents with radio channels on mobile TV platform	7
Department which is responsible for the solving of problems with radio channels	3
Department which is responsible for the solving of incidents with TV games on TV platform	7
Department which is responsible for the solving of incidents with TV games on mobile TV platform	10
Department which is responsible for the solving of incidents with TV games when a user switches the play of one game from TV platform to Mobile platform or from Mobile platform to TV platform	8
Department which is responsible for the solving of problems with TV games	7
Department which is responsible for the solving of incidents with a Internet on TV channels	6
Department which is responsible for the solving of problems with a Internet on TV channels	2
Department which is responsible for the solving of incidents with a Caller ID option on TV channels	5
Department which is responsible for the solving of problems with a Caller ID option on TV channels	2
Department which is responsible for the solving of incidents with some options on Set Top Boxes for some specific users	22
Department which is responsible for the solving of problems with some options on Set Top Boxes for some specific users	8
Department which is responsible for the solving of incidents with some options on Modems for some specific users	35
Department which is responsible for the solving of problems with some options on Modems for some specific users	12

Department which is responsible for the solving of incidents with some options on VoIP adapters for some specific users	20
Department which is responsible for the solving of problems with some options on VoIP adapters for some specific users	8
Department which is responsible for the solving of incidents with IMS users from the central information system	14
Department which is responsible for the solving of problems with IMS users from the central information system	5
Department which is responsible for the solving of incidents with TV channels from the central information system	8
Department which is responsible for the solving of problems with TV channels from the central information system	4
Department which is responsible for the solving of incidents with TV packages from the central information system	9
Department which is responsible for the solving of problems with TV packages from the central information system	7
Department which is responsible for the solving of incidents with VoD contents from the central information system	6
Department which is responsible for the solving of problems with VoD contents from the central information system	2
Department which is responsible for the solving of incidents with EPG contents from the central information system	5
Department which is responsible for the solving of problems with EPG contents from the central information system	2
Department which is responsible for the solving of incidents with TV Games from the central information system	3
Department which is responsible for the solving of problems with TV Games from the central information system	2
Department which is responsible for the solving of incidents with VoD Billing	5
Department which is responsible for the solving of problems with VoD Billing	2
Department which is responsible for the solving of incidents with Game Billing	4
Department which is responsible for the solving of problems with Game Billing	2
Department which is responsible for the solving of incidents with VoIP Billing	4
Department which is responsible for the solving of problems with VoIP Billing	2
Department which is responsible for the solving of incidents with Mobile Billing	4
Department which is responsible for the solving of problems with Mobile Billing	2
Department which is responsible for the solving of incidents with Total Billing	21
Department which is responsible for the solving of problems with Total Billing	9

VII. MEASUREMENTS OF THE IMPLEMENTED SERVICE DESK FOR THE INCIDENT MANAGEMENT PROCES

Measurements are finished in September 2011 in the implemented Service Desk. These measurements took 30 days from 1st September 2011 to 1st October 2011. Gap analysis is taken as the technique for these measurements. This technique measures how far are key performance indicators, which are got directly from measurements, from critical success factors which are predefined values. This distance is shown in percentages and this result shows how much is implemented some specific key performance indicator. Table XVIII. shows the implementation of key performance indicators for Incident Management in implemented IMS system in Telecom operator. The percentage of the implementation of all key performance indicators for Incident Management is 80.40 %.

TABLE XVIII. KEY PERFORMANCE INDICATORS FOR INCIDENT MANAGEMENT

Key Performance Indicator (KPI)	**Results for each Key Performance Indicator (KPI)**	**Critical Success Factors (CSFs)**	**The percentage of the successful implementation of each KPI**
Number of repeated incidents for TV channels	15	13	86%
Number of repeated incidents for EPG	5	8	100%
Number of repeated incidents for VoD	9	8	88%
Number of repeated incidents for Timeshift	11	10	91%
Number of repeated incidents for Multimedia Sharing	8	10	100%
Number of repeated incidents for SMS	35	50	100%
Number of repeated incidents for Chat	21	10	48%
Number of repeated incidents for Radio	4	6	100%
Number of repeated incidents for Games	2	5	100%
Number of repeated incidents for terminal equipment actions	91	30	33%

Number of repeated incidents for actions from Information system	25	20	80%
Number of repeated incidents for Billing system	16	15	94%
Number of incidents resolved remotely by the Service Desk for TV channels	12	10	83%
Number of incidents resolved remotely by the Service Desk for EPG	5	5	100%
Number of incidents resolved remotely by the Service Desk for VoD	5	6	100%
Number of incidents resolved remotely by the Service Desk for Timeshift	7	5	71%
Number of incidents resolved remotely by the Service Desk for Multimedia Sharing	7	5	71%
Number of incidents resolved remotely by the Service Desk for SMS	28	30	100%
Number of incidents resolved remotely by the Service Desk for Chat	14	5	36%
Number of incidents resolved remotely by the Service Desk for Radio	3	4	100%
Number of incidents resolved remotely by the Service Desk for Games	1	3	100%
Number of incidents resolved remotely by the Service Desk for terminal equipment actions	40	15	37%
Number of incidents resolved remotely by the Service Desk for actions from Information system	15	15	100%
Number of incidents resolved remotely by the Service Desk for Billing system	10	10	100%
Average time for resolving an incident for TV channels	16h	24h	100%
Average time for resolving an incident for EPG	35h	24h	69%
Average time for resolving an incident for VoD	20h	24h	100%
Average time for resolving an incident for Timeshift	30h	24h	80%
Average time for resolving an incident for Multimedia Sharing	21h	24h	100%
Average time for resolving an incident for SMS	5h	8h	100%
Average time for resolving an incident for Chat	25h	12h	48%
Average time for resolving an incident for Radio	38h	24h	63%
Average time for resolving an incident for Games	18h	24h	100%
Average time for resolving an incident for terminal equipment actions	132h	48h	36%
Average time for resolving an incident for actions from Information system	98h	24h	24%
Average time for resolving an incident for Billing system	125h	72h	58%

VIII. MEASUREMENTS OF THE IMPLEMENTED SERVICE DESK FOR THE PROBLEM MANAGEMENT PROCES

The same technique (Gap analysis) and the same time period (September 2011) is taken for the measurement of the Problem Management. Table XIX. shows the implementation of key performance indicators for Problem Management in implemented IMS system in Telecom operator. The percentage of the implementation of all key performance indicators for Problem Management is 76.02 %.

TABLE XIX. KEY PERFORMANCE INDICATORS FOR PROBLEM MANAGEMENT

Key Performance Indicator (KPI)	**Results for each Key Performance Indicator (KPI)**	**Critical Success Factors (CSFs)**	**The percentage of the successful implementation of each KPI**
Number of registered problems for TV channels	4	3	75%
Number of registered problems for EPG	6	2	33%
Number of registered problems for VoD	5	5	100%

Number of registered problems for Timeshift	4	2	50%
Number of registered problems for Multimedia Sharing	3	5	100%
Number of registered problems for SMS	4	3	75%
Number of registered problems for Chat	7	5	71%
Number of registered problems for Radio	4	3	75%
Number of registered problems for Games	2	3	100%
Number of registered problems for terminal equipment actions	16	10	62%
Number of registered problems for actions from Information system	12	7	58%
Number of registered problems for Billing system	6	5	83%
Number of incidents per problem for TV channels	4	3	75%
Number of incidents per problem for EPG	2	2	100%
Number of incidents per problem for VoD	7	5	71%
Number of incidents per problem for Timeshift	4	3	75%
Number of incidents per problem for Multimedia Sharing	3	5	100%
Number of registered problems for SMS	8	5	62%
Number of incidents per problem for Chat	4	5	100%
Number of incidents per problem for Radio	5	4	80%
Number of incidents per problem for Games	3	3	100%
Number of incidents per problem for terminal equipment actions	15	10	67%

Number of incidents per problem for actions from Information system	8	4	50%
Number of incidents per problem for Billing system	5	3	60%
Time that is needed for the identification of the problem for TV channels	72h	96h	100%
Time that is needed for the identification of the problem for EPG	48h	72h	100%
Time that is needed for the identification of the problem for VoD	120h	72h	60%
Time that is needed for the identification of the problem for Timeshift	96h	48h	50%
Time that is needed for the identification of the problem for Multimedia Sharing	60h	72h	100%
Time that is needed for the identification of the problem for SMS	10h	24h	100%
Time that is needed for the identification of the problem for Chat	32h	24h	75%
Time that is needed for the identification of the problem for Radio	60h	72h	100%
Time that is needed for the identification of the problem for Games	60h	96h	100%
Time that is needed for the identification of the problem for terminal equipment actions	80h	48h	60%
Time that is needed for the identification of the problem for actions from Information system	192h	48h	25%
Time that is needed for the identification of the problem for Billing system	264h	120h	45%

IX. Conclusion

Measurements from section 7 and section 8 of this paper show that the most key performance indicators are well implemented for Incident Management and for Problem Management. Figure 5. presents the total successful implementation of key performance indicators for Service Desk (in which is included the result of 80.4% of successful implemented key performance indicators for Incident Management and 76.02% of successful implemented key performance indicators for Problem Management).

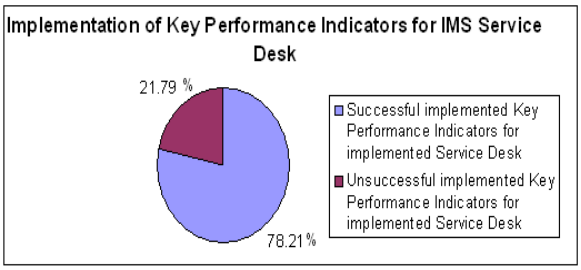

Figure 5. Implementation of Key Performance Indicators for IMS Service Desk

There are four main key performance indicators in which Incident Management and Problem Management achieved bad results: the time needed for detecting and solving problems for terminal equipment, the time needed for detecting and solving problems with a Chat option, the time needed for detecting and solving problems with adding, editing and deleting IMS users, TV channels and IMS packages and finally the time needed for detecting and solving problems connected to users bills. The solution for solving these problems is to increase the number of employees in these departments. Table XX. shows the current number of employees in these departments and the future number of employees in these departments. The current number of employees in these 18 departments is 213 and according to the new plan it should be 280 (the increase of 13.7% of new employees in Service Desk).

Future work of authors in this field is connected to the improvement of the existing ITIL framework. The aim of authors is to improve current framework to get a better results of the implementation of some telecommunication system in the future. The authors are doing these investigations in one real system in Telecom operator and are working on comparison with some other IT frameworks and standards.

TABLE XX. NEW ORGANIZATION STRUCTURE OF SOME DEPARTMENTS

The name of Service Desk department	**Current number of employees in each department**	**Future number of employees in each department**
Department which is responsible for the solving of incidents with a Chat option between 2 users who are using TV platform	9	12
Department which is responsible for the solving of incidents with a Chat option between 2 users who are using mobile TV platform	15	20
Department which is responsible for the solving of incidents with a Chat option between the first user who is using TV platform and the second user who is using mobile TV platform	12	15
Department which is responsible for the solving of problems with a Chat option	5	7
Department which is responsible for the solving of incidents with some options on Set Top Boxes for some specific users	22	25
Department which is responsible for the solving of problems with some options on Set Top Boxes for some specific users	8	10
Department which is responsible for the solving of incidents with some options on Modems for some specific users	35	40
Department which is responsible for the solving of problems with some options on Modems for some specific users	12	15
Department which is responsible for the solving of incidents with some options on VoIP adapters for some specific users	20	25
Department which is responsible for the solving of problems with some options on VoIP adapters for some specific users	8	10
Department which is responsible for the solving of incidents with IMS users from the central information system	14	18
Department which is responsible for the solving of problems with IMS users from the central information system	5	8
Department which is responsible for the solving of incidents with TV channels from the central information system	8	10
Department which is responsible for the solving of problems with TV channels from the central information system	4	6
Department which is responsible for the solving of incidents with TV packages from the central information system	9	12
Department which is responsible for the solving of problems with TV packages from the central information system	7	10
Department which is		

responsible for the solving of incidents with Total Billing	21	25
Department which is responsible for the solving of problems with Total Billing	9	12

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