Moving to the Cloud: New Vision towards Collaborative Delivery for Open-IPTV

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Abstract*— This paper provides a short description and visions about the convergence network architecture for an Open-IPTV model based *Cloud*. Also, it counts the benefits which derived from adoption of this architecture to mobility and security issues. With the new *Open-IPTV* model, the migration towards convergence networks between different *Content Providers* (CP) infrastructures becomes evident. This adaptation leads us to the *Cloud* Computing Revolution for CPs interconnections. The traditional mobility issues will be eliminated under the new umbrella conditions for the collaboration between the CPs. Moreover, the general management methodology will add value to the overall control between those providers. It's the first step from a technical perspective, and we consider it to help in resources optimization regardless of our exact choice of any content provider. This optimization will include the two cost relations that are very important to all providers: *Capital expenditure (CAPEX)* and *Operational expenditure (OPEX).

Keywords- Collaborative Computing; Domestic Cloud; Open-IPTV

I. INTRODUCTION

Recently, the aspect of *Cloud* network has proliferated within the Internet Service Providers ISPs. It enhanced all the multimedia business efficiencies though its establishment was few years ago. *Cloud* infrastructure solutions have matured and provided reasonable interoperability under the current Internet regulations and standards. While the cost of deploying delivery networks solution for IPTV has increased over the last several years, the operational expense of maintaining and managing the network also continues to rise.

As more and more IPTV application migrate to IP Multimedia (IMS) [2] services or Next Generation Network (NGN) [1] architecture, the cost of implementations and network troubleshooting for performance issues are increasing. Unlike traditional models, the collaborative *Cloud* model poses unique challenges given the transient and shared nature of the communication medium. The ability to effectively analyze and manage problems is indispensable for maximizing the Return-on-Investment (ROI) from the *Cloud* solution. We search for significant improvement in the IPTV network delivery performance for service and content providers.

A. Open IPTV

The current status of IPTV model can be summarized in Fig. 1. We have three models; IMS based standard model based on the IP Multimedia Subsystem core as a controller and NGN based standard model based on Next Generation Network architecture and finally the more famous business Internet model which is the Google TV model [9].

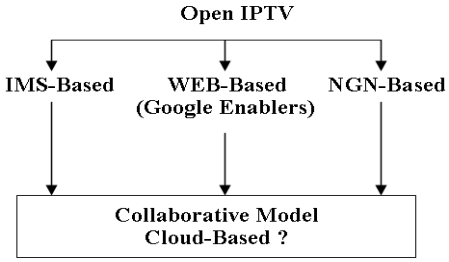

Figure 1: IPTV Models.

We expect a collaborative model (*Cloud-Based*) for IPTV delivery. This model will have some advantages over the other models in terms of low cost, good performance delivery and converged system in the domestic region.

B. Definitions

The Internet Protocol TeleVision (IPTV) term has found many definitions. But, the ITU-T definition [6] is the more intuitive one which said: "IPTV is defined as multimedia services such as television/video/audio/text/graphics/data delivered over IP based networks managed to provide the required level of QoS/QoE, security, interactivity and reliability." It is really a comprehensive definition.

In the next days, we expect a merging in IPTV technologies. Now, we mainly have three models:

- TV for normal access by traditional TVs (DVB-T).
- IPTV online channels for normal access by PCs or IP-phones.
- VoD which represents the offline case and access by same methodologies; PCs or IP-phones. The last two cases represent the web-based content.

The above three scenarios will be integrated into one scenario which represents the Future IPTV. This scenario will require a special convergence in the operator networks and some integration between different content providers.

For the General IPTV Models Management, there are two models:

- **The Managed Model**: it concerns access to and delivery of content services over an end-to-end managed network. Orange in France represents one type of this model.
- **The Unmanaged Model**: it concerns access to and delivery of content services delivered over an unmanaged network (e.g., The Internet) without any

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quality of service guarantees. YouTube represents one type of this model because there is no guarantee for QoS while accessing its videos through Internet.

This work provides a study for the current situation of IPTV delivery and how we can evolve *Cloud* starting from the current position in the access network. The main two aspects of *Cloud* computing that are interesting to our study are: *Infrastructure as a Service (IaaS)*, and *Software as a Service (SaaS)* [10]. With IaaS, a service provider delivers raw resources, like virtual machines, storage, and network bandwidth, as a service. With SaaS, a provider layers a specific software solution on top of those raw resources, and delivers it.

The rest of this work is organized as: Section II highlights some related work. In Section III, we introduce all existing terminologies related to IPTV. Section IV differentiates between the current model and our proposed one for collaborative delivery based on *Cloud* network for domestic access. Our model analysis is discussed in Section V. Section VI concludes our case study.

II. RELATED WORK

Cloud computing is a recent concept and there is few contributions in the field of collaboration in the domestic network. This is mainly due to the continuous competitive between different providers in the same region.

The concept of resources collaboration has been discussed in different places like [3]. They proposed the concept of Alliance as a general aspect of Virtual Organizations. Their Alliance concept is based on integration and collaboration between clients' requests or demands and providers resources. Moreover, they study the motivations from reforming the distinction in the current situation of organizations that will lead to good business model. The work mainly discussed the collaboration problems and some security aspects towards virtual organizations. Also, the work in [8] proposed the idea of on-demand *Cloud* service within IPTV based servers' virtualization. But, this work did not touch the area of domestic collaboration between different providers.

III. IPTV AND THE NEW OPEN BUSINESS MODEL

A. The Common IPTV Terminologies

- **Pay-TV:** this service refers to the subscription-based TV delivered in either traditional analog forms, digital or satellite. We have in different countries similar term called Packs Channels like Showtime, ART and so on.
- **TV-OTT:** TV Over-The-Top; it is one of the American modern TV term that provides a seamless consumer experience for accessing linear content through the broadcast network on a TV set, as well as non-linear services such as Catch-up TV and Video on Demand through a broadband IP network. It is also designed to allow the provider to extend content and the consumer experience to additional platforms including PCs, mobile, gaming consoles and connected TVs.
- **IPTV ''Follow-me'':** allows the user to continue access his IPTV service while moving and changing his screen. (Content Adaptation while Mobility).
- **Personal IPTV** "My Personal Content Moves with Me"): it means, allowing the user to access to his personalized IPTV content in any place in his domestic region and be billed on his own bill (*Nomadic Access*).
- **TVE:** TV Everywhere; it is the process of adding place shifting technology to (STB) set-top boxes and this required software S/W STB and also adapted (content optimization) to match all types of screens: Traditional TV, PC or laptop and Smartphone.
- **Open IPTV**: is the new model of TV service that will a borderless technology. It will be a hybrid model that merges the traditional Broadcasting TV with the Web-TV in one thing for nomadic services.

B. Physical Set-Top-Box (P-STB)

Definition:

This system represents the actual implemented scenario in the most developed countries. It mainly depends on physical *Hardware* of STB and leased connection between the consumer and content provider.

Advantages:

The service security assurance and bandwidth satisfactions are the most pros of this model. Also, the good management provided by the content providers.

Drawbacks:

With the present model of IPTV, the delivery is based on physical STB restricted to specific location. But, the consumers increasingly become *Anywhere Consumers* and they demand bandwidth regardless of their locations for satisfy their entertainments. So, the lack in this model is the inability for consumer satisfactions while changing their locations (*Mobility and Nomadic Access Aspects*). By experience, the new open model of the TV and the entire video delivery could be enhanced rapidly.

C. Software Set-Top-Box (S-STB)

Definition:

It is the new up to come system for IPTV business model. It will depend on *Software* instead of *Hardware* for controlling the received channels and videos.

Advantages:

It will satisfy the consumer desires for enjoying all their subscription videos *Anywhere*.

Drawbacks:

The operators have some fear from the management of user policies and authorizations while the clients are changing their locations.

As the future recommends the new Software model of Set-Top-Box (S-STB), we will not need to a strict physical location of IPTV services.

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D. Design Factors

Two factors press on the providers decisions while they are taking a new infrastructure investment:

- **Capital expenditure (CAPEX):** is representing the cost of network foundation and all non-consumable system devices and infrastructure.
- **Operational expenditure (OPEX):** is representing the running cost for provider network including all cost of operation and maintenance.

For the long term investments, the operators will reduce those costs in the domestic *Cloud*. Moreover, the new added services related to quality and interactivity will be costless.

IV. COLLABORATIVE ARCHITECTURE

The competitive space between different IPTV operators pushes them to implement high similarity in clients' services. This means that, the majority of VoD and IPTV channels are the same which reverse the culture and social interests of each country. Thus, if we make some convergence between the different providers it will not affect the overall policy of this country. Moreover, it will enhance the service delivery and reduce incremental cost for future service investments.

A. Current Architecture Status

The current architecture of content providers (as shown in Fig.2 as France case study) has mainly three layers:

Layer 1: Interconnection Layer (Infrastructure Providers)
Layer 2: Control Layer (Content Providers Islands)
Layer 3: Management Layer (The 3rd party hosting and cashing videos and channels servers)

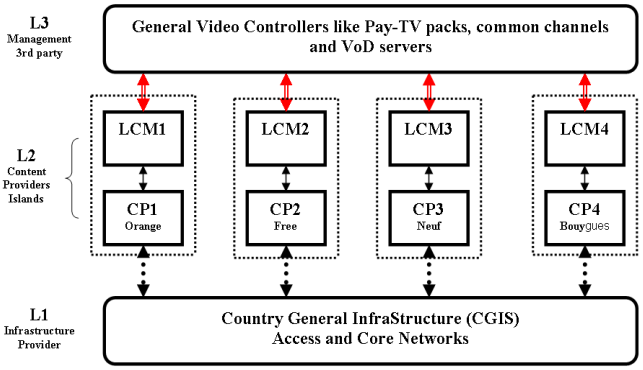

Figure 2: The current model of different islands content providers.

CP: Content Provider
LCM: Local Content Management
GCM: General Content Management
is the interface between CP access network and the core network
is the interface towards GCM and LCM

The isolations and different islands are the main features of this model. Each operator has large investments and local management for the same services provided by the others in many cases.

The open models require an open infrastructure design and also an open management policy. So, the providers must avoid their selfishness and think for two important things:

- the great benefits from the collaboration that will adopt cloud computing design
- the satisfaction of consumers towards new services

Thus, the Open-IPTV model needs a lot of cooperation between different partners for achieving remarkable success.

B. Proposed Architecture

The collaborative model design is illustrated in Fig. 3. This model proposes more interactions and collaborations between different operators. As mentioned, the S-STB is the future aspect for IPTV delivery; we use it as the point interface to multi-screen access client.

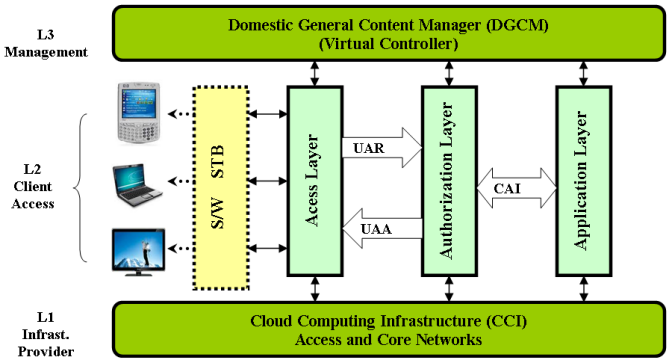

Figure 3: The proposed collaborative model for domestic cloud network to new IPTV system.

UAR: User Authorization Request
UAA: User Authorization Answer
CAI: Content Adaptions Interactions

The collaboration exists in the form of common access to CCI and DGCM layers by the client access layer. This case will lead us to new methodology of accessing which called Resource-On-Demand ROD. Moreover, this ROD will save the time and cost for service configuration. Another thing, UAR and UAA processes for clients' services authentication and authorizations pass mutually and independently of user access network. More over, the content adaptation for different screen has two aspects; one based the capability of S-STB and the other on the access device specifications. The CA process for the domestic sphere for the client is mainly done by STB.

C. Open-IPTV Model and Relation Aspects

To support a correct model, we need to explain the relations between the four billers that lead to a successful Open-IPTV model (see Fig.4) as follows:

- **Content Providers:** must study between them the content convergence so as to facilitate the consumer access methods and delivery and also the content adaptation to match different screens.
- **Operators:** must convince the delivery of Open-IPTV before missing the dominant and control of Web delivery because the service will come in the near future.
- **Infrastructure Providers:** it is the time to convergence infrastructure and *Cloud Computing* design to appear so as to enhance the user access methods and ameliorate the mobility and security user issues.

- **Consumers:** no way for the consumers from integrating him self with the new technology and new methodologies of future Internet services. If the consumer does not conceive with this developing then we will have a missing part in the ring or the cycle will not be completed. Client culture and motivations must be changed so as to help in the model successful.

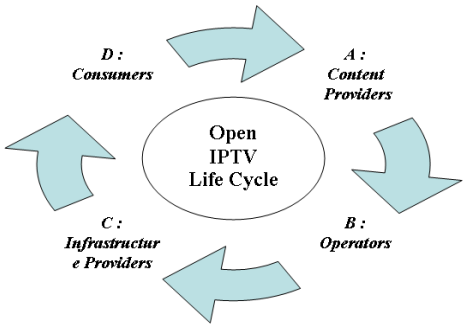

Figure 4: The Open-IPTV service billers

A: is the first point of the cycle and responsible for contents
B: is the service provider
C: is the network access part and the point of attachment for the client
D: is the last point of the cycle which represents the end user
(In some cases ***A, B, C*** can be represented by one provider)

V. THE MODEL ANALYSIS

This part provides some aspect and study analysis relevant to the new Open-IPTV model and the impacts on all members of the new life cycle as the following:

- The impacts of infrastructure integration on workflows and privacy policy.
- The impacts of applying and integrating convergence model between different content providers on:
  - consumer privacy protection measures
  - business operational cycle
  - Financial management performance.
- The optimization of resources under new collaborative conditions.
- The new behaviour of consumers under new methodologies of services accessing with different screens as shown in Fig. 5.

So, the content adaptation and the QoS assurance are the two factors which are affecting on studying multi-screen IPTV delivery and band width optimization. Moreover, these two factors are playing an important role *Cloud* migration. They are the turning point in the design and collaboration between different providers.

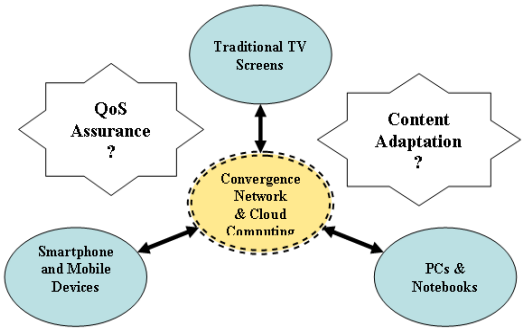

Figure 5: Open-IPTV model and Multi-screens consumer issues

A. Traditional Broadcast TV versus Web-TV

The future prospection for the relation between traditional TV watching and Web-TV in terms of average number of hours/month is shown in Fig. 6. Some IPTV weekly monitor sites [5] and specialist in technical and industrial reports [4] estimate that, the normal human in advanced countries like US and Europe watches traditional TV for 120 hours per month and Web-TV for 18 hours per month in 2010. But, this scenario will be inversed after the year 2019. They expected that, the Web-TV watching will exceed the traditional TV in 2020 and this excess will continue as shown in Fig. 6.

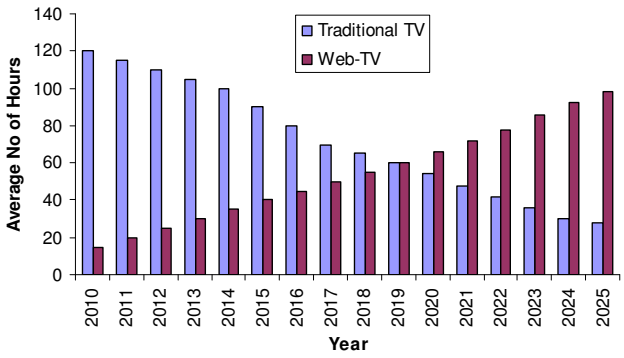

Figure 6: The expectation watching for Web-TV will exceed the amount of watching traditional TV by the year 2020.

New research shows that while TV broadcasts still dominate initial viewing, more users are turning to the new services like (TVE) to watch TV when they have time.

For some segments of the industry TVE is being able to watch any television show, any movie, any online video content anywhere you'd like on any screen, television, PC, mobile phone and, of course, the Smartphone at any time.

B. Cloud Design Motivations

Content providers businesses rely on the network (infrastructure) and the data centre (hosting servers). They are the key factor in providing a successful IPTV service. Without them, achieving business goals like increasing market share, customer satisfaction or operating margins and profitability is nearly impossible. However, over time, both networks and the data centre have matured and, in the process, become more complex than ever before. The adoption of new trends, applications and services over the years has brought with it inflexible designs, point product solutions, and a plethora of operating systems and management applications. This complexity leads to increased operating expenses in both the delivery and data centre networks and limits their potential. So, the traditional ways for enhancing the current state by hierarchal way are not suitable. They lead to more sophisticated network and high cost especially the *Capital Expenditure (CAPEX)* one. Also, by default, as a result of complexity the *Operational expenditure (OPEX)* will be augmented. So, we expect that the curve of cost will reach a high peaks.

From all causes mentioned above, we can conclude that the

mean two reasons for adopting *Cloud Design* are the reducing of high costs of investments and consumer quality assurance for satisfying the service. But, the migration towards *Cloud* is not easy from the providers' prospection.

So, we suggest the first step of moving to the *Cloud* by adopting the convergence mechanism between the current providers. Then the future *Cloud* will be the international one. We categorize the *Clouds* into two aspects as:

- Domestic Cloud: resulted from collaborative providers in the same country.
- International Cloud: is the co-operation between different domestic clouds over Internet.

C. Collaboration Culture and Benefits

The collaboration model as a first step to cloud design is considering as a new value added culture between different providers. It will reduce the whole cost for new services deployments and increasing the total revenue from the network services. As, the future IPTV services goes to future generation based on multi-screen multi-services, the development of content and service providers must take parallel path for achieving customers satisfactions.

- High availability
- Good scalability
- Minimum OPEX cost and moderate CAPEX cost
- Good interoperability between different providers
- More facilitations to clients access services like mobility issues

On the other hand, the realization part of Fig. 4 is not practically simple. This is because the huge cost for content provider implementations to adopt multi-screen systems flow adaptations. But, we think that the collaborative model will achieve the most cost reduction for this scenario.

D. Generating Domestic Cloud

The main problem which faced all content providers toward migration to *Cloud Computing* networks is the lack in security. If the content is very sensitive, the cloud can not guarantee its security as much as required. So, we are claim to the collaboration and re-evaluation of the current infrastructure and reuse it in a *Cloud* manner through domestic area.

The reliability and troubleshooting are also representing big difference between the *Cloud* providers and traditional ones. But, the new release of *Domestic Cloud* can adopt the convergence mode.

So, the cooperation between the existing providers for obtaining a convergence network could lead them to the future *Cloud* computing network as a suitable solution in this time. The trusting in sharing contents and resources is a way toward full migration to the concept of *Cloud*. We suggest the collaborative solution as a domestic *Cloud* network for all types of videos and IPTV service.

Actually, we noticed that in France the majority of IPTV providers provide the same group of VoD, channels, Pay-TV packs and other types of videos. They almost have 90% of the contents common. Parts of these videos are hosted by another party or cashing systems like AKAMAI system [7] and small parts of videos are hosted by the providers themselves. So, if they share their resources, they will provide good services and they can overcome on the bandwidth bottleneck problems. The benefits from this convergence are:

- Interoperability: get unified management for different providers' networks.
- Portability: achieve some degree of mobility between operators.
- Integration: obtain complete service
- Quality of Services (QoS): service assurance.

The successful model of the domestic cloud will lead to host international services which are the core stone of cloud networks and *International Cloud*. The third-party cloud service is the great objective but the route we follow must be taken step-by-step.

E. CAPEX vs. OPEX Analysis

All direct and indirect infrastructures and servers costs are representing the whole part of CAPEX cost. We estimate that, for the Cloud design, it can have more reduction of the essential costs till 80% of the total cost. Moreover, the reduction mainly depends on the degree of collaboration between the providers in the same domestic region.

Let the following assumptions:

N: is the number of providers mesh links in the domestic region.

C: is the total cost for each provider.

Then, the total CAPEX for all providers = $N*C$

For collaboration Model cost ratio, it will equal: $N*c/N*C$

Where $c = L*C^2$

So,

$$CAPEXc = (L*C^2)/C = L*C$$

Where:

CAPEXc: is collaboration CAPEX cost

L: is the infrastructure Link foundation between providers after collaboration and interoperability/compatibility added costs.

So, the profit from collaboration as a reduction in CAPEX:

$$R = N*C - L*C = (N-L)*C$$

If we have a third parity (Cloud provider), then the CAPEX for the current operators will be *Zero* and all costs will just be OPEX costs.

Therefore, the typical cost optimization regarding to traditional data center design versus *Cloud* design is really remarkable. The long term costs will be reduced. Also, the benefits from adoption of *Cloud* are the utilization principles of servers based needs. This means that, the using of the infrastructure only when there is a real need and releases it for other free use times. Moreover, the Cloud is the mean of scalability for multimedia delivery.

VI. CONCLUSION

Our work contributions were to: present state-of-the-art for new IPTV terminologies like (TVE, OTT, Pay-TV and Open

TV); illustrate the benefits in convergence networks design and their impacts on CAPEX and OPEX costs. Also, demonstrate the performance of future IPTV service against traditional TV and introduce the Multi-screen idea and the bandwidth optimization for multimedia delivery to different consumer's screens and then analyze the impacts of using *Cloud* computing infrastructure in the converged network to different providers.

Finally, we expect the demise of isolated content providers' islands over the Internet at least in the domestic regions. So, the gates are now opened for clients *Nomadic Access* to *Nomadic Services (NA to NS)*.

In the next work, an investigation will be conducted for some new IPTV use cases in the domestic region using *Cloud*.

VII. ACKNOWLEDGMENT

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