IPTV Services Personalization Using Context-Awareness

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The advances in IPTV (Internet Protocol Television) technology enable a new user-centric and interactive TV model, in which context-awareness is promising in making the user's interaction with the TV dynamic and transparent. Our research interest is how to achieve user-centric personalized IPTV services applying context-awareness. In this paper, we present a solution for IPTV services personalization introducing context-awareness on top of the IPTV architecture on one hand to gather different information about the user and his environment and on the other hand allowing each user to be distinguished to the system in a unique manner. Consequently, IPTV services personalization is achieved in a real-time manner for each user. We implemented the proposed solution on top of an IPTV platform considering the NGN IPTV architecture as a proof of concept and as a means to evaluate the performance.

Povzetek: Članek opisuje prilagajanje televizije IP posamičnim uporabnikom z uporabo konteksta.

1 Introduction

IPTV (Internet Protocol TV) presents a revolution in digital TV. In which digital television services are delivered to users using Internet Protocol (IP) over a broadband connection. The ETSI/TISPAN [1] provides the Next Generation Network (NGN) architecture for IPTV as well as an interactive platform for IPTV services. However, IPTV services personalization is still in its infancy, where the consideration of the context of the user and his environment (devices and network) and the distinguishing of each user in a unique manner still presents a challenge.

IPTV services personalization is beneficial for users and for service and network providers. For users, more adaptive content could be provided as for example targeted advertisement, movie recommendation, provision of a personalized Electronic Program Guide (EPG). The format of the content could also be modified according to the users' devices the network conditions which in turn allows for better Quality of Experience (QoE). IPTV services personalization is promising for services providers in promoting new services and opening new business and allows network operators to make better utilization of network resources through adapting the delivered content according to the available bandwidth.

Context-awareness is promising in allowing services personalization through considering in real-time the context of the user and his environment (devices and network) as well as the context of the service itself [2]. Through context-awareness, users can transparently interact with the IPTV system (users will no longer be required to give explicit instructions at every step while watching TV). In this paper we present a solution for IPTV services personalization that considers NGN IPTV architecture while employing context-awareness, allowing access personalization for each user and triggering service adaptation. We carried out the implementation of this solution on top of an NGN IPTV platform to verify its correct functioning and evaluate its performance through different performance metrics.

The remainder of this paper is organized as follows: Section 2 gives an overview on the related work. Section 3 presents the solution. Section 4 describes our implementation platform and Section 5 presents the performance analysis. We conclude the paper in Section 6 and present the future work.

2 Related Work

IPTV services personalization attracted the attention of the IPTV standards. Some services personalization are defined in TISPAN [1]: 1) Personal video recorder (PVR): is an end-user-controlled electronic device service that records linear TV and stores it in a digital storage facility, either in standalone Set-Top-Boxes (STB) or in the network. 2) Personal Broadcast Service: is a service providing the end-user with a way to advertise personal content (possibly including scheduling information) description so that other users can access such content. 3) Targeted Advertising: is a commercial advertising or public promotion of goods, services, companies and ideas, usually personalized according to the end-user's preferences. 4) Content Recommendation Service: recommends the contents to users according to the user's preferences. Although these services bring new experience to users, without considering the general context information the service personalization is limited.

Several solutions for context-aware TV systems have been proposed for services personalization. [3] proposes a context-aware based personalized content recommendation solution that provides a personalized Electronic Program Guide (EPG) applying a client-server approach, where the client part is responsible for acquiring and managing the context information, and forwarding it to the server (residing in the network operator/service provider side) which collects the TV programs and determines the most appropriate content for the user. A recommendation manager in the client side notifies the user about the content recommended for him according to the acquired context, including the user context information (user identity, user preference, time) and the content context information (content description). This work does not consider the network context and does not describe the integration with the whole IPTV architecture, however focuses on the Set-Top-Box (STB) as the client and a server in the network operator/service provider side. In addition, services personalization is limited to the content recommendation without considering any other content adaptation means.

A personalization application for context-aware real-time selection and insertion of advertisements into live broadcast digital TV stream is proposed in [4]. This work is based on the aggregation of advertisement information (i.e. advertised products type, advertised products information) and its association with the current user context (identity, activity, agenda, past view) in order to determine the most appropriate advertisement to be delivered. This solution is implemented in STBs and includes modules for context acquisition, context management and storage, advertisement acquisition and storage and advertisement insertion. This solution does not consider the devices and network contexts and does not describe the integration with the whole IPTV architecture, however focusing on the STB side in the user domain.

In [5], we proposed integrating a context-awareness system on top of IPTV/IMS (IP Multimedia Subsystem) architecture aiming to offer personalized IPTV services. This solution relies on the core IMS architecture for transferring the different context information to a context-aware server. The main limitation of this solution is its dependency on IMS which necessitates employing the SIP (Session Initiation Protocol) protocol and using SIP-based equipments, which in turn limits the interoperability of different IPTV systems belonging to different operators and which requires also a complete renewal of the existing IPTV architecture (currently commercialized) which does not employ IMS. Furthermore, the dependency on the SIP protocol limits the possible integration of IPTV services with other rich internet applications (which is an important NGN trend) and hence presents a shortcoming. Consequently, we aim by the solution presented in this paper to increase the integration possibilities with web services in the future and to ease the interoperability with the current IPTV systems. So we advocate the use of HTTP protocol, where the presented solution introduces context-awareness on top of NGN IPTV non-IMS architecture. In addition, a mechanism for personalized identification allowing to distinguish each user in a unique manner and a mechanism for content adaptation allowing the customization of the EPG (Electronic Program Guide) and the personalized recommendation are proposed.

3 Solution Description

3.1 Overview of the solution

The presented solution in this paper relies on a Context-Aware System, which we proposed in [5] while extending it and integrating it in the NGN IPTV non-IMS architecture. This Context-Aware System has been also implemented in this paper. The necessary communication between the Context-Aware System and the other architectural entities in the core network and IPTV service platform is achieved through HTTP and DIAMETER protocols while extending them to allow for the transmission of the acquired context information in real-time. In addition, we propose and implement in this paper a mechanism to distinguish each user in a separate manner through providing a personal identity for each user. This personal identity is used as a part of the user context. Finally, the presented solution provides and implements a mechanism for IPTV personalization based on each distinguished user and on the different context information acquired in real-time. We considered the following personalization means: the customization of the EPG to match the users' preferences, recommending the content best matching the users' preferences, and adapting the content according to the device used by each user.

3.2 Context information for the IPTV services

The International Telecommunication Union Telecommunication Standardization Sector (ITU-T) defines four main functional domains involved in the provision of an IPTV service [6]: a) Content Provider: owns or sells the content to be streamed to the Customer; b) Service Provider: provides The IPTV service; c) Network Provider: provides the connection between the Service Provider and the Customer; d) Customer: purchases and consumes the IPTV service.

From the IPTV function domains, four types of contexts can be defined for IPTV services:

i) User Context: includes information about the user, which could be static information, dynamic information and inferred information. Static information describes the user's personal information which is stored in the database (ex, name, age, sex, and input preference). Dynamic information is dynamically captured by sensors or by other services (ex, user's location, agenda, and usage history). Inferred information is high-level information, which is inferred by other information (ex, user's action “user is going to the bed' is inferred by the changed location”).

ii) Device/Terminal Context: includes information about the devices (terminals), which could be the device identity, status (turn on or off, volume), device capacity, and the device proximity with respect to the user.

iii) Network Context: represents the characteristics of the access link being used for accessing TV content. Network context information includes: a) Access network type: Information about available access networks enables selecting the most appropriate network; b) Available link bandwidth: this information is used by the IPTV system to select appropriate content format for example SD or HD, c) QoS information: this information is used to monitor the state of the network.

iv) Service Context: includes information about the service, which could be the content description, language, and format description.

3.3 Context-aware system

We follow a hybrid approach in the design of the Context-Aware System including a centralized server (Context-Aware Server “CAS”) and some distributed entities to allow the acquisition of context information from the different domains along the IPTV chain (user, network, service and content domains) while keeping the context information centralized and updated in real-time in the CAS enabling its sharing (and the sharing of users' profiles) by different access networks belonging to the same or different operator(s).

The CAS is a central entity residing in the operator network and includes four modules: i) A Context-Aware Management (CAM) module, gathering the context information from the user, the application server and the network and deriving higher level context information through context inference. ii) A Context Database (CDB) module, storing the gathered and inferred context information and providing the query interface to the Service Trigger (ST) module iii) A Service Trigger (ST) module, triggering the personalized service for the user according to the different contexts stored in the CDB. iv) A Privacy Protection (PP) module, verifying the different privacy levels for the user context information before triggering the personalized service.

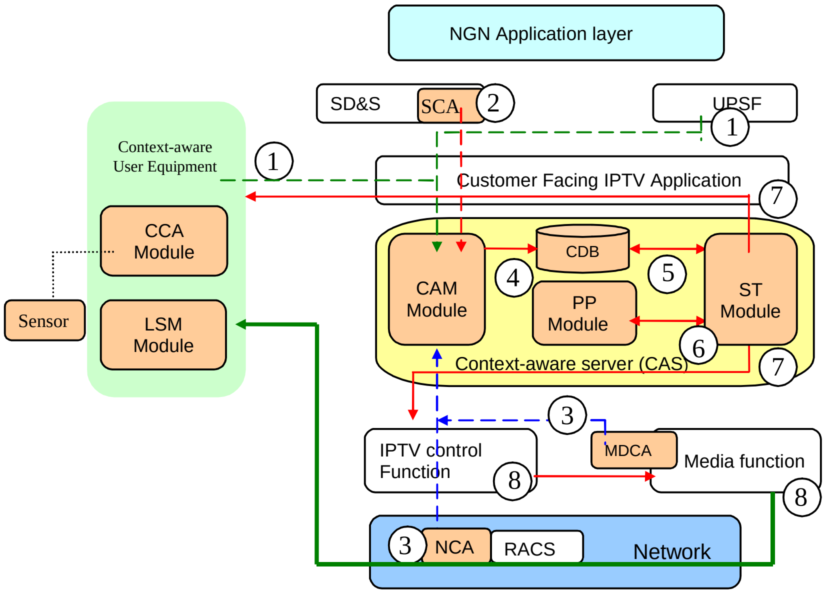
In addition, other distributed modules exist to gather different context information in real-time. In the user domain, the User Equipment (UE) includes a Client Context Acquisition (CCA) module and a Local Service Management (LSM) module. The CCA module discovers the context sources in the user sphere and collects the raw context information (related to the user and his devices) for transmission to the CAM module located in the CAS. Sensors are the frequently used context sources which can be present in the user sphere, in the environment or in the device and retrieve context information from them. While, the LSM module controls and manages the services personalization in local manner within the user sphere (example, volume change, session transfer from terminal to terminal, etc). In the service domain, the Service Context Acquisition (SCA) module collects the service context information and transmits it to the CAM, and the Media Delivery Context Acquisition (MDCA) module monitors the content delivery and dynamically acquires the network context information during the content delivery and sends it to the CAM. In the network domain, the Network Context Acquisition (NCA) module acquires the network context (mainly the bandwidth information) during the session initiation and transmits it to the CAM.

3.4 NGN IPTV-non IMS architecture with context awareness

This subsection shows the integration of the Context-aware Server in the NGN IPTV non-IMS [1] architecture together with the different protocols (and the protocols extensions) used for the communication between the different architectural entities. During the different communications for context information transfer, we use the RPID (Rich Presence Extensions to the Presence Information Data Format) [11] to present the context information while enhancing it to include more attributes for context information. Figure 1 illustrates the context-aware NGN IPTV non-IMS architecture.

The NGN IPTV architecture standard includes the following functions: Service Discovery and Selection (SD&S), for providing the service attachment and service selection, Customer Facing IPTV Application (CFIA), for IPTV service authorization and provisioning to the user, User Profile Server Function (UPSF), for storing user's related information mainly for authentication and access control, IPTV Control Function (IPTV-C), for the selection and management of the media function; and Media Function (MF), for controlling and delivering the media flows to the User Equipment (UE).

In the service plane, the SCA (Service Context Acquisition) module is integrated in the SD&S IPTV function to dynamically acquire the service context information making use of the Electronic Program Guide (EPG) received by the SD&S from the content provider which includes content and media description. The MDCA (Media Delivery Context Acquisition) module is integrated in the MF to dynamically acquire the network context information during a media session through gathering the network information statistics (mainly on packet loss, jitter, round-trip delay) delivered by the Real Time Transport Control Protocol (RTCP) [7]. In the network plane, the NCA (Network Context Acquisition) module is integrated in the Resource and Admission Control Sub-System (RACS) [8] extending the resource reservation procedure during the session initiation to collect the initial network context information (available link bandwidth). In the user plane, we use the UPSF to store the static user context information including user's personal information ("age, gender …"), subscribed services and preferences, and the CCA (Client Context Acquisition) and LSM (Local Service Management) modules extend the UE(User Equipment) to acquire



1. User and device context information and transmission
2. Service context information and transmission
3. Network context information and transmission
4. Context information storage in the CDB.
5. ST communication with the CDB for monitoring context information and services discovery.
6. ST communicates with the PP for privacy constraints verification.
7. ST requests to trigger the personalized services.
8. Adapted content to the UE

Figure 1: Context-Aware NGN IPTV non-IMS Architecture.

the dynamic context information of the user and his surrounding devices.

After each acquisition of the different context information (related to the user, devices, network and service), the CAM (Context-Aware Management) in the CAS (Context-Aware Server) infers the collected information and derives higher level context information which is stored in the CDB (Context Data Base). The ST (Service Trigger) module continuously communicates with the CDB module to monitor the context information, according to which the ST discovers the need for personalizing the established services or setting up a new services. Before triggering the service ST module communicates with the PP (Privacy Protection) module to verify if the corresponding service can fully use the existing context information. If there is no privacy constraint, the ST module activates the personalized services.

The communication and exchange procedures within the context-aware NGN IPTV non-IMS architecture take place as follows:

1) Contextual Service initiation: Figure 2 illustrates this procedure which is used to transfer the user's static profiles from the UPSF.

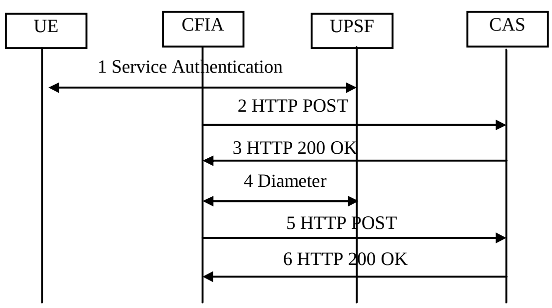


Figure 2: Contextual service initiation procedure.

After the classical IPTV service authentication (message 1), the CFIA registers the IPTV UE to the CAS service on behalf of the UE using the HTTP POST message (messages 2-3), then downloads from the user’s profile his static context information using Diameter protocol [9] (message 4), extended to include a User-Static-Context Attribute. The CFIA then transmits the user static context information to the CAS through HTTP POST message (message 5). When the CAS receives the context information, it sends a 200 OK response message to the CFIA (message 6) for acknowledgement.

2) Dynamic acquisition of context information of the user/device: This procedure is proposed allowing the CCA module in the UE to transfer to the CAS and continuously update the user/device dynamic context information. Figure 3 illustrates the user and device dynamic context information transmission. We use the HTTP POST message to convey the context information.

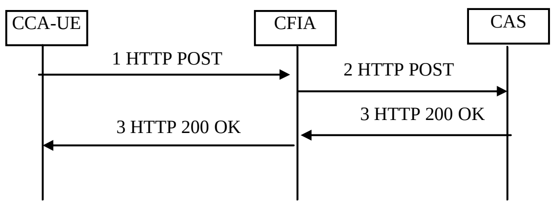


Figure 3: User/Device Dynamic Context Information Transmission.

3) Dynamic acquisition of context information on service: This procedure is proposed and is similar to the previously described one allowing the dynamic service context information transmission from the SCA to the CAS. The HTTP POST message is used to transmit the context information containing the service context.

4) *Network Context Information acquisition during the Session Initiation:* This procedure concerns the network context information transmission during the session initiation through extending the classical resource reservation process. In this latter, the IPTV-C receiving the service request sends a Diameter protocol AA-Request message to the Resource and Admission Control Sub-System (RACS) for the resource reservation. Based on the available resources (bandwidth information), the RACS will decide whether to do or not a resource

reservation for the service. An AA-answer message is sent by the RACS to the IPTV-C for informing the latter the results of the resource reservation (successful resource reservation or not). We extend this process in order to send the resource information (bandwidth) to the context-aware server. The bandwidth information is used by the IPTV system to select appropriate content format for example SD or HD. As illustrated in Figure 4, upon the reception of the service request (message 1), the IPTV-C sends a Diameter protocol AA-Request to RACS. Then the NCA generates a Context AA-Answer (CAA-Answer) message extending the AA-Answer message through adding a Network-Information Attribute Value Pair to include the bandwidth information. At last the IPTV-C forwards the received bandwidth information to the CAS using HTTP POST (message 4-5).

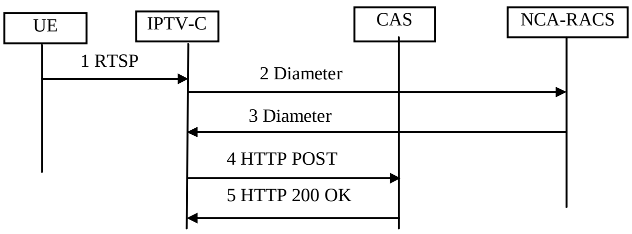


Figure 4: Network context information acquisition during the .Session Initiation

5) Dynamic acquisition of network context information. This procedure allows the MDCA to dynamically transmit the network context information related to the media session to the CAS, as illustrated in Figure 5. During the media session, the MDCA module acquires the network context information from the RTCP protocol statistic reports mainly indicating the jitter, packet loss and round-trip delay (message 1) and transmits to the CAS using HTTP POST (messages 2-3)

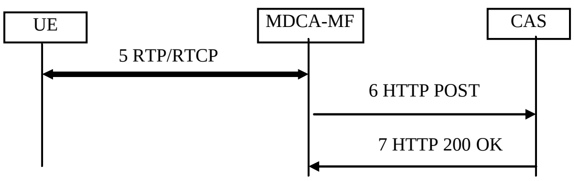


Figure 5: Network dynamic context information acquisition.

3.5 User's personal identification

Personal identification is an important step to achieve the service personalization and also the privacy protection. We propose the usage of a personal identity for user’s access and service authentication, which allows distinguishing each user in a personal manner. Following user’s authentication, the personal identity is stored in the CAS as a part of the user's context information. According to this personal identity, the CAS collects the user’s static context information from the UPSF and also other dynamic context information from the user's environment (for example user's proximity to the device). Based on the collected information, the personalized service is provided to the user. The radio-identification (RFID) [12] is a candidate technology to provide a personal identity and which we used in the implementation. However any other technology as NFC (Near Field Communication) or Bluetooth could be applied.

In order to personalize each user’s access, each user holds a unique RFID tag and identifies himself to the system. In addition, each user device (for example TV or PC Screen) is connected to an RFID reader indicating the identity of the device which is associated to the device location. When the user comes next to the device, the RFID reader of this device reads the user’s identity and sends it to the STB together with the device identity (presented by the identity of the RFID reader). The STB sends the user and device context information to the CAS, where the user location can be deduced with reference to the users’ device location. When the user watching the TV through the same device changes (or when the same user changes the device during mobility “moves from one room to another for example”), the personalized access following the same previous approach takes place.

3.6 IPTV Content Personalization

Within the ETSI/TISPAN Standard, IPTV content personalization is carried out through the recommendation which may take the form of a text message (notification) from CFIA (Customer Facing IPTV Application) or video recommendation streamed from MDF (Media Delivery Function) [10]. Within the Content Recommendation Service, two basic functions are proposed:

1) Aggregation of metadata for recommendations: (a) user's profile, preferences, consumed history, etc. b) Asset metadata for Content on Demand(CoD) and linear TV.

2) Generation of recommendations upon request of external triggers: for example a user sends service request or changes in the user's presence state.

We notice that this solution considers only the user's preference and consumed history as the criteria while the general context information is not considered (like device capacity, network states, location, time, user’s activity…etc). However, the general context information takes an important role for the recommendation service because the user's preference on IPTV content is not fixed and it changes depending on certain context such as time, location, activity, etc. Furthermore, certain contents are accessible based on some conditions. For example only the device which supports the High Definition (HD) could display the HD film. If a user chooses to watch TV through a terminal which does not support HD, the recommendation system should not propose the HD content for him.

We propose a mechanism for content personalization to provide the content best matching the user. Our proposed mechanism selects the content for each user based on the preferences and context and adapts the content according to the other context information for example the used device characteristics (supported resolution), and the content characteristics (High Definition "HD" or Standard Definition "SD" for instance). The content personalization mechanism employs the context information stored in the CAS following a Key-Value based model, in which each context type has a corresponded value. For example, each user can have several preferences, and each preference has a value ("preferred film type" of the user is "action"; "preferred sport" of the user is "football"). The Key-Value based model simplifies the content selection for each user.

The mechanism functions as follows: i) after the user identification and the context information collection, the ST module selects the user's preferred contents through comparing the content context information and the user's preference. Then it filters the selected contents according to the other context information (for example the resolution of the device through which the user watches TV, the content types "HD or SD") and then generates a personalized EPG. ii) user-centric recommendation takes place through listing the contents on the EPG in the order of user's preference, where the ST consults the CDB for the context information on the content and the user and then calculates the similarity between the content context information (content type, authors, etc) and the user's preference. iii) After generating the personalized EPG, the ST module sends it to the user and the LSM module automatically displays the content of the first program listed in the EPG (however the user has the possibility to manually select another program). iv) The ST module also sends the necessary context information to the Media Function to make the latter adapt content according to the context information (for example change the format of the content according to the resolution of the device).

4 Implementation and Platform

We implemented our personalized IPTV system (the context-awareness system, the personal identification and content personalization mechanisms) and we integrated the implemented modules on top of NGN IPTV non-IMS architecture. We achieved a proof of concept through the correct functioning of the proposed system and we carried out a performance evaluation through several performance metrics that are presented below.

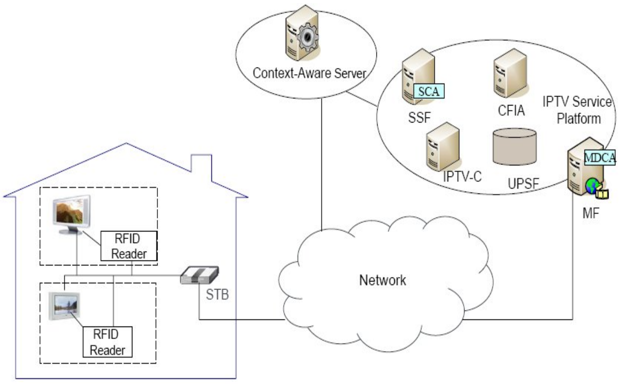


Figure 6: Implementation platform architecture.

Figure 6 illustrates the architecture of our implementation platform. The context-aware server (CAS) is developed based on a framework for HTTP services development. The NGN IPTV architecture is implemented on 5 machines for respectively the IPTV-C, CFIA, SD&SF, MF IPTV functional entities and the UPSF, while integrating the module implemented for context-awareness. At the end-user side, we implemented the STB containing three functional modules: traditional STB module (dealing with the authentication, session negotiation and service reception, etc.), Client Context Acquisition (CCA) and Local Service Management (LSM) modules of the context-aware system.

For the personal identification of each user and determining his proximity to the device, we employ the RFID technology to implement the solution proposed in Section 3.4. This technology is an implementation choice and not the absolute technology for our proposed mechanism.

5 System Evaluation and Performance Analysis

The platform with the implemented modules was firstly tested from the functional view and we observed the right functioning of the whole system with TV Live and VoD (Video on Demand) IPTV services. Then we evaluated the performance of the proposed solution for TV Live and VoD IPTV services and compared to the traditional IPTV case without personalization.

5.1 Performance metrics used

This subsection defines the metrics that we use in our performance analysis, which are: i) the delay of the personalized content selection (DPS), ii) the delay of the service initiation (DSI) and iii) the EPG Browsing time (EBT).

1) Delay of personalized content selection (DPS): defined as the consumed time from sending the first context update request from user until receiving the personalized EPG from the CAS. This delay includes the new context information transmission, treatment and the personalized EPG generation. The DPS reflects the performance of the CAS. Since there could be large number of users request the personalized content at the same time, we analyze the increase of the DPS with the increase of the end users.

2) *Delay of the service initiation (DSI):* defined as the consumed time from the start of the STB to the reception of the IPTV service (when the video starts playing). In traditional IPTV case, this delay includes the delay of user's authentication, session negotiation and video display. In our proposed solution, besides the mentioned delay, DSI also includes the delay of personalized content selection (DPS).

3) *EPG Browsing Time (EBT):* measures the user's quality of experience (QoE) level in terms of how quickly a user can find his preferred program from the displayed EPG. EBT presents the consumed time from

the display of the EPG until finding the user's preferred content.

To derive the EBT for the traditional EPG browsing, we consider that there are n programs on the EPG and that the probability of the preferred program (i) selection by the user is the same for all the programs (probability = 1/n). We also assume that during the EPG browsing, the user will watch the selected program for a duration (t') before switching to another program. So the expected traditional EBT can be calculated as:

$$E(EBT) = \sum_{i=1}^{n} \frac{1}{n}(i-1)\, t' = \frac{n-1}{2} t' \qquad (1)$$

We then introduce another important parameter "accuracy probability Pa", reflecting how well the personalized EPG programs meet the user’s expectation. It is calculated as the ratio of the amount of recommended content in which the user is interested to the amount of recommended content [13].

$$Pa = \frac{recommended \cap interested}{recommended} \qquad (2)$$

From the definition of the accuracy probability, the matching of the EPG programs to the user’s expectation has the following probabilities: the first program matching probability is (Pa); the second program matching probability is (1-Pa)Pa and the m^{th} program matching probability is $(1\text{-Pa})^{m-1}$Pa. So the expected browsing time for our solution can be calculated as:

$$\begin{aligned} E(EBT) &= \sum_{i=1}^{n} (1-p_a)^{(i-1)} p_a (i-1)\, t' \\ &= \left((1-p_a)\frac{1-(1-p_a)^{n-1}}{p_a} + (1-n)(1-p_a)^n \right) t' \end{aligned} \qquad (3)$$

5.2 Obtained results and analysis

From the Figure 7, we observe an increase of the delay of personalized content selection (DPS) when the number of end users increases. However the increase rate is small and slows down with the increase of users. When the number of user increases from the 50 to 400, the increase rate of the DPS is about 3%, and when the number of user increase from 400 to 1000, the increase rate of the DPS is about 0.5%.

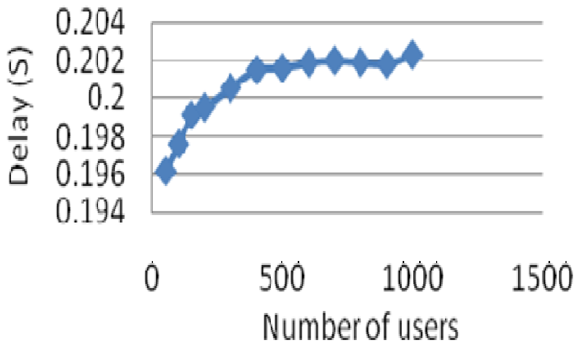


Figure 7: Delay of the personalized content selection.

Figure 8 presents the delay of the service initiation for both traditional IPTV and personalized IPTV cases. For traditional IPTV case, a delay of 1.75 and 2.12 seconds is observed respectively for the initiation of TV Live and VoD services. While, for the personalized IPTV case, a delay of 2.04 and 2.29 seconds is observed respectively for the initiation of TV Live and VoD services. This increase is mainly due to the consumed time for context information acquisition, treatment and personalization and service selection. Although we do not consider all the functions in the actual IPTV platform, compared with the average delay of service initiation which is about 2.9 seconds [14], the proposed solution does not impact the performance of the service.

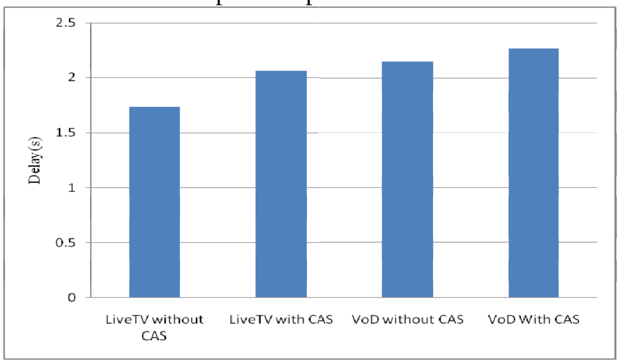


Figure 8: Delay of service initiation.

Figure 9 illustrates the obtained values for the EBT in the presence of various numbers of programs for the TV Live service. In the traditional IPTV case, the EBT linearly increases with the increase in the number of programs indicating poor QoE with the explosion of the number of programs. To calculate the EBT for our solution, we firstly measure the EPG accuracy probability (Pa) through verifying the matching of the received personalized EPG to the users in the case of different users with different context information changes. Among several services requests, the Pa was found to be 0.8 (i.e. about 80% of the recommended contents correspond to users’ interest). By substituting this obtained Pa value in equation (3) together with the change of the value of (n) reflecting the number of programs, we obtained the EBT values illustrated in Figure 7 for the personalized TV case. We observe a slight increase at first with the increase in the number of programs then a constant EBT value is shown in spite of the number of programs, thus confirming the gain in terms of QoE with our proposed solution with the increase in the number of programs.

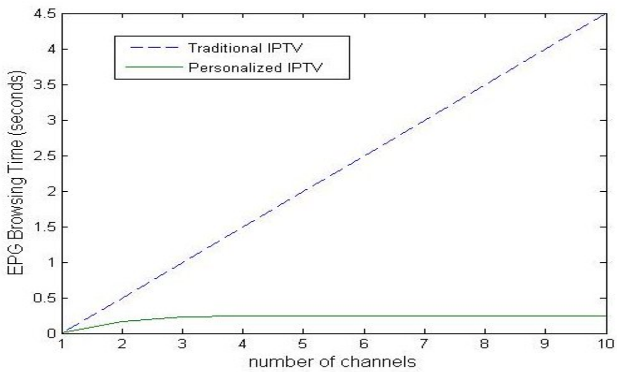


Figure 9: EPG Browsing time.

6 Conclusion

In this paper, we present a solution for IPTV services personalization that integrates a context-awareness system in the NGN IPTV non-IMS architecture allowing the consideration of different context information related to the user, his devices, the network and the service itself in real-time. We also provided a mechanism for user's personal identification to the IPTV system allowing distinguishing each user in a unique manner, and a mechanism for content personalization based on each individual user, his context and the context of his environment (devices and networks). We implemented our solution on top of an IPTV platform validating its correct functioning and evaluating its performance for TV Live and VoD IPTV service compared to classical IPTV case (with no personalization). We observed interesting results for our proposed solutions in terms of the personalized content selection and service initiation delays as well as the EPG browsing time. As a future work, we will analyze the performance of the whole system including more performance metrics and more scenarios for the user's interaction with the system and consider group personalization considering the contexts and preference of a group of users watching TV. Furthermore, we will communicate with real-end users to gather their requirements, know their constraints for this newly proposed personalization approach, and test the system ergonomics. We will then consider the end-users' feedbacks in our system.

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