User-centric Mobility Management in Cooperative Environments

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Abstract – **Internet services and models have been changing their paradigms due to the widespread of wireless technologies, multimedia user-friendly terminals and open-source content tools. These factors are modifying the way to deliver and consume Internet services, where the end-user plays a more important role in the control of content and connectivity. Future Internet models have to integrate properties that allow nomadic end-user experience for any application across multi-access or single-access networks, assuming that one or more operators are involved. In the future, to overcome these very dynamic and cooperative mobile scenarios, it is necessary to develop intelligent mechanisms for mobility management, centered on end-user and guaranteeing the best satisfaction and experience to him. This paper describes and analyses the user-centric mobility management paradigm in networks driven by Human behaviors, following peer-to-peer overlay schemes and cooperative environments. It will also be presented the main ideas and principals of an architecture, aiming to provide global mobility management in spontaneous wireless environments that self-adjust to any network topology change. This global mobility management is addressed from a decentralized perspective, ensuring a transparent access to Internet services. End-users will be able to access their subscribed services independently of the attachment point and location, based upon their own requirements and maintaining the best Quality of Experience (QoE).**

Keywords – **Mobility management, User-centric, context, prediction, cooperative, Quality of Experience.**

I. INTRODUCTION

Internet services and models are suffering a paradigm shift, product of three main factors: widespread wireless technologies; increasing variety of user-friendly and multimedia-enabled terminals, and availability of open-source tools for content generation. Together, these three factors are changing the way that Internet services are delivered and consumed, first of all, because the end-user has a particular role in controlling content as well as connectivity, based upon cooperation. Specifically focusing upon Internet access, Internet connectivity models that rely upon cooperation (user-provided networks) are already being commercially adopted in some networks (e.g., FON [1], OpenSpark [2] and Whisher [3]), from a nomadic perspective only. Nomadism can be seen as a property of global mobility management, property which relates to permanence of a subscribed environment, i.e., the possibility for an end-user to access his sets of subscribed services anytime, anywhere.

In addition to nomadism, global mobility management also incorporates session continuity. Session continuity requires features able to transparently and seamlessly diverting the active sessions to whichever access location and whichever terminal (and interface) that end-user activates at a time-instant. In other words, while an end-user is on the move, the active sessions (independently of the type of application in use) are kept running without noticeable interruptions. Both these properties must be incorporated into future Internet architectures and are also essential from a user-provided model perspective. The reason is that being user-centric and based on wireless technologies, these models rely on end-user mobility patterns to self-organize. Future Internet models have to integrate properties that allow nomadic end-user experience for any application across multi-access or single-access networks, assuming that one or more operators are involved.

Currently, the most popular solutions for global mobility management have in common a model, where a centralized and static unit (anchor point) is in charge of keeping some form of association between previous and current identities for a mobile node that roams across different networks. In user-provided networks, this model should rely on a distributed architecture which raises the need to develop efficient anchor selection mechanisms based on reputation models, as well as models providing incentives to be a anchor point. Moreover, time availability of an anchor point may be short in the presence of mobile connectivity Access Points (APs). This poses an extra stress on seamless mobility mechanisms, which may need to perform handovers more often. Nevertheless, the impact on seamless mobility depends considerably on mobility patterns of mobile users.

The recent interactive and personalized environments increase the complexity of todays internet. To support these scenarios, Peer-to-Peer (P2P) overlay networks appear in order to provide a good substrate for creating large-scale data sharing, content distribution and multicast applications. The P2P networks exhibit three essential characteristics, fundamentals to the distributed mobility management architectures: self-organization, since P2P network automatically adapts to the arrival, departure and failure of nodes; symmetric communication, peers act as both clients and servers; and distributed control, without any hierarchical or centralized organization.

The objective of this paper is to present the issues behind a global mobility management mechanism to operate in spontaneous wireless environments that self-adjust to any network topology change. The purpose is to ensure a transparent access to multimedia services for the end-user, who will be able to access his subscribed services independently from the attachment point, location, and based upon his own requirements (QoE). So, QoE needs to be addressed in different forms and in higher dimension to permit a more

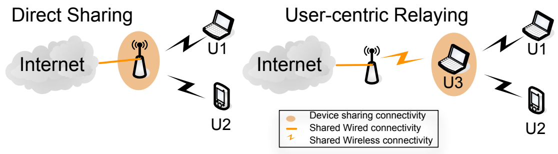

Fig. 1 - Basic user-provided connectivity models

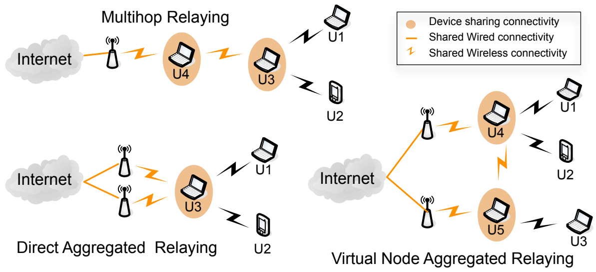

Fig. 2 - Enhanced user-provided connectivity models

personalized selection and delivery of content. In addition, global mobility management is to be analyzed from a decentralized perspective, given that considered environments will incorporate wireless local-loops that are based upon end-user willingness to cooperate.

The paper is organized as follows. Section II briefly presents the scenario to be addressed. Section III studies the related work in context-awareness network selection. Section IV analyses the mobility management, specially Mobility Anchor Point architectures and mobility prediction mechanisms. Section V explains the current P2P distributed architectures based in Distributed Hash Tables. Section VI describes the recent efforts to introduce social behaviors into the network management. Finally, Section VII presents the conclusions about the studied subjects.

II. COOPERATION SCENARIO

In the envisioned cooperative scenario, user's role becomes a provider of content and a special type of Internet service provider (micro-provider), be it as an individual or as a part of a specific community. Therefore, it is really important to characterize and understand the user-provided networks [4], beginning with the basic models (Fig. 1) recently adopted in restricted communities, and cooperative advanced models (Fig. 2) that can improve the mobility in a total sharing environment.

Direct sharing (Fig. 1) is one of the basic models, where the access to the internet services is shared by means of an AP. In these models, the users can be the owner of the AP, belonging both to a specific community. The AP is configured to allow the owners security enjoy their subscribed service, and at the same time, share the connectivity with other community members. This model requires modifications in the APs, bringing the advantage of connectivity not dependent on the users devices, only on the available APs.

The other basic model is the User-centric relaying (Fig. 1), where the main connectivity sharing capability migrates to the end-user devices. In this approach, the end-user device shares internet connection with other user devices of his community. The user that share connectivity can or

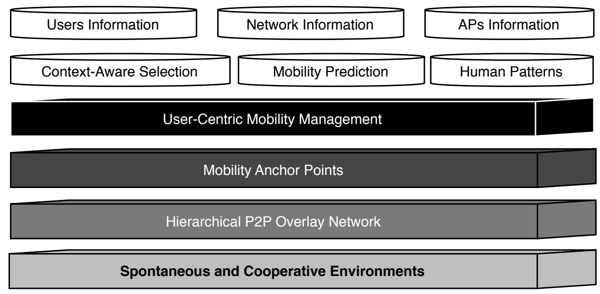

Fig. 3 - Layers Distribution of the subjects involved

can not be the owner of the AP, as explained in the previous model. In this model, the end-user becomes a micro-provider as follow by the Whisher [3]. This model does not need modifications in the APs, since they are transparent to this sharing process. In the network perspective, this model is more dynamic than the previous one, increasing the possible mobility scenarios according to the end-user mobility patterns.

Several enhanced models (Fig. 2) can be built combining the basic models, like Multihop Relay, Direct aggregated relaying and Virtual node aggregated relaying. The Direct aggregated relaying and Virtual node aggregated relaying can be implemented to optimize the sharing and relaying with load balancing and aggregated backhaul respectively. Several papers [4] [5] defend the user-provider networks relied in four main principals: connectivity sharing, cooperation, trust and self-organization.

One of the main principals of future user-provided models, Connectivity Sharing, is the goodwill of the users to openly share the connectivity with the others users of the same community, becoming micro-providers. The relaying of the end-user can be performed in active or passive sharing, since users share their own internet connection with or without knowledge of the relaying process. Furthermore, user-provider networks will follow the human patterns and behavior in order to increase the probability of radio connection in densely populated areas.

Cooperation is another main feature of user-provided networks, where users should receive incentives to share their connectivity, being compensated to share their resources. Users that share more their connectivity and services should receive better rewards.

Other fundamental principal for user-provider networks is the Trust based in social interaction and human interests. First, it is necessary to pre-establish a criteria to order the users behavior. So, a reputation mechanism needs to be introduced in order to award the well behaved users (e.g. more connectivity) and detect the misbehavior of the end-users.

Finally, the last pillar is the Self-Organization. This important feature allows to control the connectivity management in a decentralized approach. Since the topologies strongly depend on human mobility patters and social models, it is difficult to predict network changes, and techniques should be in place to allow the community to take advantage of backhaul capacity.

As previously refereed, the envisioned scenarios are based on the wireless cooperative and spontaneous environments (Fig. 3). So, users share the connectivity of their devices (router, PDAs ,laptops , etc.) with other users of the community to guarantee several possibilities of connection points with different features.

In order to dynamically coordinate the Mobility Anchor Points (MAPs) through the network and manage the user-centric mobility, a distributed control overlay network need to be adopted (Fig. 3). This distributed overlay network should absorb the main P2P concepts in order to provide peers selection, redundant storage, efficient search, data permanence and trust. P2P networks potentially offer an efficient routing architecture that is self-organized, massively scalable and robust in the wide-area, combining fault tolerance, load balancing and explicit notion of locality.

The architecture should self-adjust the distribution of MAPs (Fig. 3) considering the spontaneous aspect of the network elements. At each second, users, devices and APs appear in the network and this information should be real-time considered in the entire mobility management. The MAP should administer a group of Access Routers (AR) and user's devices of a certain area, communicate with other MAPs when a user moves to another area to maintain, not only connectivity, but also the session continuity.

This architecture is being planed for the mobility management (Fig. 3) in order to permit the frequent mobility of the end-users across the entire network. The envisioned solution decides the best option for each user at any time considering several processes, such as selection, prediction and human patterns. The mobility management also needs to maintain the content delivery while user devices connect/disconnect or even move across the network, guaranteeing QoE to the end-user.

The context-aware network selection (Fig. 3) needs to use all relevant information to guarantee the best satisfaction to the end-user. The envisioned scenarios need to guarantee a new higher level of the QoE, allowing individual mobility decision, according to the users and network information (profile, devices, location, ...). In the envisioned spontaneous scenarios, the study and integration of the human patterns and social behaviors are a great help to anticipate the network changes. Besides, the mobility prediction techniques based in users' knowledge (preferences and goals) and their spatial information, without assumptions about the users' movement history, can improve the mobility management.

The user-centric relaying scheme is included in the architecture, since to perform a mobility management the network collects all available information about users' devices and personal APs in the pretended location (Fig. 3). Since the user context information is always near to the end-user, it is easier and faster to perform a mobile selection decision in these cooperative and spontaneous environments. In an user-centric architecture that gives the higher priority to decisions centered in the end-user, the APs and network information (resources, Link Layer, historic , etc.) are also important to guarantee the best options to the end-user.

III. CONTEXT-AWARE NETWORK SELECTION

Communication and connectivity in future networks will take advantage of multihoming and cooperative environments if efficient and user-centric network selection processes are considered in the network architecture design. In this process, any relevant information that improves the personalization should be considered, increasing the QoE of the end-user.

Xuejun et al. [6] introduce a dynamic user-centric network selection process which optimizes handover across heterogeneous networks. A Satisfaction Degree Function (SDF) evaluates the available networks and selects the best one according to user's predefined criteria. The followed criteria incorporates not only the user policies but also information of several OSI Layers.

Jesus et al. [7] present an algorithm that allows a mobility decision manager to consider arbitrary criteria, such as user history or preferences. Since a typical mobility module uses quantitative and well-known information (e.g. signal strength or available resources), qualitative information must be fed into the mobility subsystem only after converting it to a suitable format. The algorithm is divided in 3 main stages: discard unsuitable possibilities; produce a set of possibilities considering resources available; and the feasible possibilities are ranked according to contextual information.

Latr et al. [8] proposed the design of an autonomic QoE management architecture. They present a knowledge plane supported by an autonomic layer that optimizes the QoE in multimedia access networks from the service originator to the user. It autonomously detects network problems and determines an appropriate solution for each issue. The viability of an implementation using neural networks is investigated, by comparing it with a reasoner based on analytic equations, trough the QoS and QoE metrics.

The well known concept of Always Best Connected (ABC) [9], followed by previous network selection proposals, focuses its attentions in maintaining every users best connected, choosing the best AP and even the best network core path for each user. This concept considers the heterogeneity and users preferences in the selection process and adaptation of content to user's device. However, this concept does not consider the total QoE of the user, having some gaps in several mobility scenarios. When a user travels in an airplane, the network should download all important content to the user without any order, like e-mail or even on-line important files. When a user is receiving a streaming of football game in bad conditions, the network should cancel the transmission of the video and good audio should be deprecated. When a user is receiving a stream of his favorite TV or radio program in very bad conditions, the network should understand this and forward the stream to his home media centre to record the program for the user to see later. These examples can not be totally considered into the ABC concept but they improve the QoE of the user. In an User-centric perspective it should be though in the concept of Always Best Experience (ABE), providing the best satisfaction to the end-user and maintaining the best QoE. The QoE concept should be considered in more higher layer,

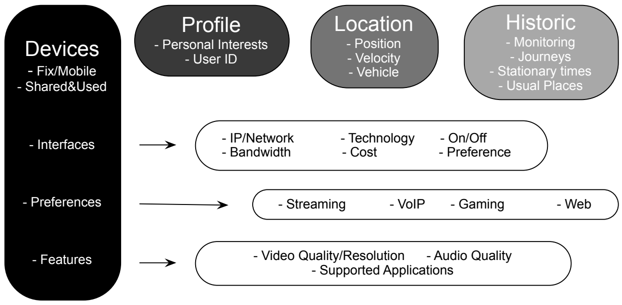

Fig. 4 - User Context

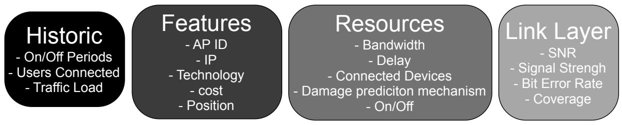

Fig. 5 - Access Point Context

increasing the abstraction and ambit of this concept. So, this differentiated experience according to each user, permits a higher personalization of the services, considering all kind of possibilities (devices, profiles, environments, internet providers, etc.) in the selection processes.

The User context has a huge importance in the decision process, since it is a user-centric proposal that focus its efforts in the improvement of the QoE to the users. Analyzing the context information used in the previous selection schemes, Historic and Location topics (Fig. 4) need to be introduced in order to bring a new level of experience and personalization to the users' delivery. The notion of time and space becomes really important to satisfy the real-time users' requirements. It is important to know the location of the users at any time and keep this historic information to optimize the entire process like a self learning process, as [8] suggests.

The user context should consider all available devices (Fig. 4) to the user (ex: notebook, PDA, television, stereo music, ...) in order to increase the range of possibilities to be selected, providing the best satisfaction to the end-users. Through this user context information, the best device and interface to received the specific content can be considered (e.g. High-Definition movies are received in the LCD instead of the PDA). With this amount of real-time information, the delivery of the content to the end-user can be improved, specially regarding to the personalization, mobility and speed.

The information related to each user is closer to him, in the near MAP. When a user changes to another network, the context information is transferred to the closest available MAP. Since that most of the information is dynamic, it is easier to update this information in real-time when the related database is very close.

Although the architecture is user-centric, to perform a good mobility selection, it is important to consider context information from the APs and even the network. Some of the existing proposals undervalue or even despise the context information of the APs. However, resources available and link layer (Fig. 5) are considered in some network selection proposals, being essential parameters in order to deliver the pretended content with necessary QoS to the users.

The several characteristics of the AP have an important role too, as the features presented in the Fig. 5. This AP information (e.g. Technology and Position) guarantees more detail in the mobility management process, and more personalization deliver in the desire cooperative mobile environments, where APs and users connect and disconnect all the time.

As refereed to users context, the historic (Fig. 5) become important in an architecture that aims to optimize the mobility management and improve the users experience. This historic information related to the APs behavior allows to predict the conditions (available, usability, load,...) of the APs when a user moves to another place, since the proposal fits in mobile and spontaneous scenarios, always changing the involved network elements of the scenario.

Note that, in cooperative environments, a connectivity point can be another computer or any device of another user. Considering all available information, a connectivity point can be chosen between all available devices in the range (ISP routers, personal computers, PDAs, personal wireless points, 3G antennas, ...).

IV. MOBILITY MANAGEMENT

Internet distributed services and multi-home mobile devices bring several challenges to the research community. One of these challenges is how to preform an intelligent management of the mobility in order to maintain sessions delivery to end-users in heterogeneous and quite mobile networks.

Mobility management is then divided into location management and handoff management components [10] [11]. The mobile roaming can be considered intradomain if the roaming happens between cells of the same domain; or interdomain, if the roam involves different backbones, protocols, technologies or service providers. Location management is the part of the system, responsible to locate the Mobile Node (MN) between consecutive communications. One of the tasks of the location management, called location registration or location update, is the periodical update of the relevant location of the MN. The other task of the location management is to determine the location of the MN according to the system database when the communication for the MN is initiated. Handoff management is the other part of the system, responsible to maintain the MN connectivity when it moves from one AP to another. When the signal strength goes down below a certain threshold value, a intrasystem handoff is needed.

A. *Mobility Anchor Points*

Currently, the most popular solutions for global mobility management share the same model, where a centralized and static MAP is in charge of keeping some form of association between previous and current identities for a MN that roams across different networks.

HMIPv6 introduces MAP entity to perform frequent handovers in an area (Fig. 6). Each MAP administers a group of Access Routers (ARs) in the same area. The number of

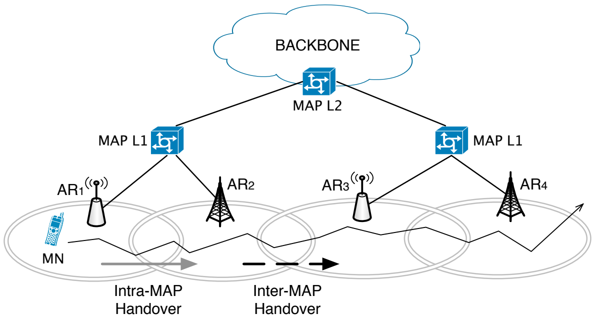

Fig. 6 - Multi-level MAP architecture

ARs beneath a MAP is defined as the regional size. Within a region, a MN is associated with two addresses: the Regional Care of Address (RCoA), indicating the MN's MAP, and the on-Link CoA (LCoA), indicating the AR that the MN attaches to.

The aim of HMIPv6 is to enhance the system performance by shielding the MNs' micro-mobility (Fig. 6). When the MNs roam within the region, the handover latency of HMIPv6 is smaller than MIPv6. However, this profit is obtained by paying two costs: increase of the handover latency caused by double-registration and longer pack delivery time.

HMIPv6's MAP regional size are critical for the system performance. The smaller regional size will lead to more frequent macro-mobility (handover across regions), triggering more frequent double-registration. While the larger regional size will generate a higher traffic load on the MAP, increasing the packet processing delay of MAP, and leading to the longer packet delivery latency.

Wang et al. [12] developed an analytical model to study the applicability of MIPv6 and HMIPv6. They design an Intelligent Mobility Support (IMS) scheme that selects the better alternative between MIPv6 and HMIPv6 for a user according to its changing mobility and service characteristics. When the HMIPv6 is adopted, IMS chooses the best MAP and regional size to optimize the system performance.

Lei and Kuo [13] introduced a Multi-level HMIPv6 networks approach to improve the capacity and reliability of these networks. This approache uses multiple MAPs above an AR, which provides access to the Internet for the MNs. The MN has to select a proper MAP using efficient MAP selection schemes, in order to improve the handover performance.

The MAP is a very useful concept in very mobile scenarios, like the proposed ones. A very mobile and personalized network requires the extension of the MAP concept in order to support not only the users' mobility but also the integration of all types of context information to perform intelligent and distributed decisions. This improved element, called Mobility Context Unit (MCU), is the main unit of the mobility distributed intelligence architecture. This element should be implemented in the edge routers, in the border between the core network and the access network. In specific cases, it could be necessary to configure the MCU in the APs or in the user devices. MCU saves all information about the user and APs near to it in order to quickly access

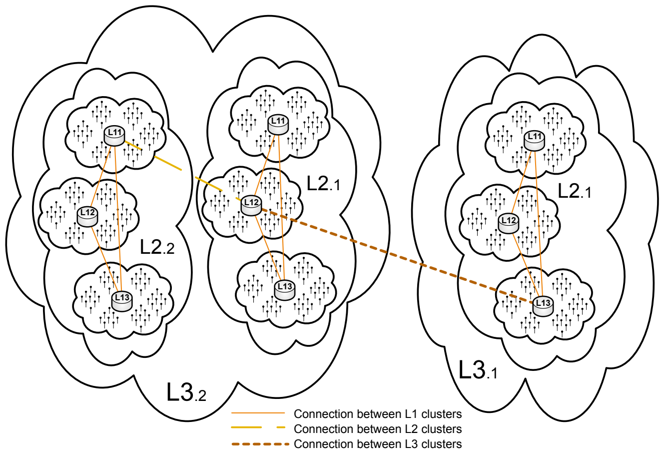

Fig. 7 - Distributed of the clusters according to different levels

necessary information. In order to reduce the network load caused by dynamic context update and the time to collect context, it is important to transfer the user's context to the closer MCU to the user. Users and APs must register in the near MCU, in order to become a member with an single ID and participate in the mobility process. A MCU can be described as a local intelligent unit that cooperates with other MCUs to delivery the content to user with the best QoE.

Concerning to the previous mentioned regional size, the previous proposals define this in a static way. However, the algorithm used to form the clusters (regional size) (Fig. 7) should base its decisions in several parameters, such as location, historic, amount of context, social. Geographic location is an essential parameter to group the low levels into high levels (ex: it is advantageous to aggregate exclusively MCUs (level 1) located in the same city in a level 2 cluster, since people usually move only inside their city). Historic of the utilization/interactions is the other main important information to be considered in the cluster choice of a certain level, since it is used to optimize the architecture along the time adjusting the clusters of different levels. (ex: In L3.2 of the Fig. 7, if L2.1 interacts several times with L2.2 to get context from L1.3, L1.3 should leave L2.1 and integrate the L2.2). In the definition of the levels into a regional size, it is very important to reduce the interaction between the higher levels, decreasing the time to perform a decision and the respective overhead in the exchange of information. The MIP and HMIP mobility approaches should not be integrated in the envisioned scenarios. In this very spontaneous scenarios, the APs and even the MAPs frequently change in the network, so the distributed architecture needs to control the mobility management to deliver the desired content in the recently selected AP. When the user performs an intra-MAP handover (Fig. 6), the MAP uses the proxy service to forward the content to the new AP without notifying the data source. However, when a inter-MAP handover (Fig. 6) happens, a more complex mobility management process needs to be done. The MAPs of different clusters levels need to interact to configure the necessary proxy settings and even interact with data source to change the content destination.

B. Mobility Prediction

With current advances in wireless technology, fast and accurate mobility prediction techniques have become one of the main topics in current research efforts. The importance of mobility prediction techniques can be seen at both the network level (e.g. handoff management and flow control) and service level (e.g. mobile location services). Several attempts try to solve the issues related to the mobility prediction, but most of the techniques are based on the historical movement patterns to calculate the probable future location.

Kumar et al. [14] propose a prediction-based location management centered in a Multilayer Neural Network (MNN). It is necessary to teach the MNN how to select the data from the users movement patterns in a period before prediction scheme activation.

According to [15], the are two main limitations in several prediction proposals relaying on individual user's mobility patterns. One limitation is associated with no available past history when users visit new places, leading to prediction failure. The other one is related to the long time mobility history that cause the despise of the recent information in prediction algorithm.

Soh and Kim [16] present a scheme to overcome these limitations assuming that user next movement tend to follow the pattern of nearby people, if they move in the same direction. This approach uses behavioral information to improve the prediction scheme in order to accurately and adequately deal with incomplete specified situations, partial or total absence of knowledge about the user previous movement patterns.

Samaan and Karmouch [15] developed a novel framework that accurately predicts the user trajectory and destination, put together the knowledge about the users (preferences and goals) and their spatial information, without imposing any assumptions about the availability of users' movements history. This framework was motivated by recent advances in user context modeling and previous research done by authors' research group [17], proposing a unified framework for a context negotiator/provider to automate the acquisition of users' context.

Since the envisioned architecture is designed based in spontaneous mobility scenarios, it is important to guarantee that the network performs the decisions as fast as possible and deliver the content in a personalize way. A mobility prediction mechanism based in historic and location maps, using some ideas of [15], should be included in the architecture to optimize the mobility selection and maintain the QoE to the user.

V. PEER-TO-PEER OVERLAY NETWORKS

The recently interactive and personalized environments increase the complexity of todays internet. To support these scenarios, P2P overlay networks [5] [18] appear as away to provide a good substrate for creating large-scale data sharing, content distribution and multicast applications. The overlay P2P networks provide several features such as: selection of closest peers, redundant storage, efficient search of data items, data permanence or guarantees, hierarchical naming, trust and authentication, and anonymity.

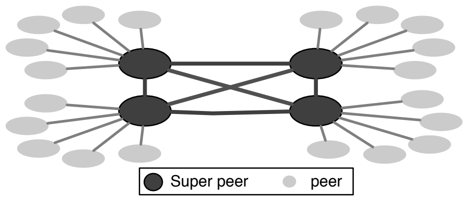

Fig. 8 - P2P architecture scheme

P2P overlay networks scheme (Fig. 8) disrupt the currently centralized control and hierarchical organization, presenting a distributed approach without an hierarchy or a centralized control. P2P approach has several advantages, such as efficient search, fault tolerance, robustness and scalability. P2P systems change the client-server paradigm, where a user is at the same time a client and a server. P2P networks can be divided into Structured and Unstructured.

Structured P2P systems, as Content Addressable Network (CAN) [19], Chord [20] and Pastry [21], control the arrangement of the peers, so the content is distributed at specific places to improve his efficiency. This approach uses a Distributed Hash Table (DHT) [22] to deterministically distribute the objects (values) throughout the peers with an unique data identification key. DHT-based systems attribute a unique random ID to each peer and also a unique identifier key to each data object (value). The keys are mapped by an overlay network protocol into a unique peer of the overlay network. The P2P overlay networks support storage and retrieval of {key,value} pairs in a scalable way. Each peer needs to maintain an updated routing table of the neighbor peers IDs with respective IP addresses. Theoretically, the system assures that any data object can be reached in an average of $O(\log N)$ hops, where N is the number of peers in the system. Different DHT-based systems present different organization strategies for the data, keys and routing. DHT systems are an important part of the P2P routing infrastructures, supporting the fast development of a wide variety of Internet-scale applications ranging from distributed file and naming systems to application-layer multicast.

Unstructured P2P system, as Kazaa [23] or Bittorrent [24], is formed by peers that join to the system with simple rules and without topology knowledge. Peers flood the network to discover other peers with the intended content. This flooding mechanism is advantageous to locate more desired items, but very disadvantageous to find the rare items. The Unstructured P2P overlay systems are Ad-Hoc in nature, presenting problems of scalability with a high rate of aggregated queries, increasing the system size, due to the overload in the peers. Besides the efficiency of the Structured networks for find rare items throughout a scalable key-based routing, they reduce the overhead compared with Unstructured networks.

As explained before, the DTH-based overlay networks are considered scalable because of their logarithmic increase in cost depending on the number of peers. However, in large scale systems this might still cause a problem since they have a logarithmic complexity depending. Besides, they only provide a one dimensional structure and do not profit from inherent clustering proprieties of some applications. Martinez-Yelmo and Mauthe [22] propose a generic hierarchical architecture based on super-peers, where a peer ID is composed by a Prefix ID and a Suffix ID. Prefix ID is only routed at the super-peer level and the Suffix ID at the peer level. The architecture was tested and analyzed with specific overlays CAN [19] and Kademlia [25].

In order to achieve a distributed architecture the P2P overlay networks principals and DHT routing systems' may be adopted. The Structured Peer-to-Peer overlay Network scheme can be used to perform the clusters according to the defined parameters. Besides the adjustment in the cluster space, the individual position of the MCU is well-known. The overlay scheme needs to be implemented in a hierarchical way, as [22] suggests, to perform a fast way of leading with information of each cluster level. Excluding the level 1 that is the MCU, each one of the other cluster level uses a DHT to exchange information (ex: in L3.2 of the figure 7, the L2.1 and L2.2 have both a DTH with 3 MCU and L3.2 has also a DHT (higher level) formed by L11(L2.2) and L21(L2.1)).

VI. NETWORKS DRIVEN BY HUMAN BEHAVIORS

With the fast technology development on mobile devices, contact based Delay Tolerant Networking applications as P2P file sharing, are ganing more research interests. Since in this applications the network is disconnected most of the time, information is thus exchanged opportunistically among people, a node only transmits data when it encounters another active device. As a result, understanding human mobility patterns and identifying the social dynamics behaviors become extremely important. Several Europe research initiatives direct their efforts to develop new architectures to support the future service requirements, based in self-organized networks.

The Socialnets EU project [26] focus his efforts in order to solve this recent paradigms, studding the social behavior and interactions between humans. Through the application of these fundamentals to the network and devices, it is expected the improvement of the highly effective pervasive communications and content provision.

The BIONETS EU project [27] [28] exploits the embedded devices to provide context-aware and leverages P2P interactions among mobile devices to ensure system-wide dissemination of services and data. BIONETS takes advantage from bio-inspired techniques and tools to develop network solutions to the emerged services and human needs. BIONETS draws truly user-centric models that naturally evolutes to an autonomic system in order to support the demanding social needs.

Since the relevance of mobility patterns and social behavior grew a lot in the new types of networks and services, it becomes really useful to perform studies about humans interactions, as [29] and [30]. HAGGLE EU project [31] focus its efforts to study the impact of human communication on the network and the application-driven (opportunistic) message exchanging, following a user-centric autonomic approach. [29] verifies not only pairwise dynamics (e.g. human contact and inter-contact duration), but also the dynamic of spontaneous groups.

The ideas of the previous projects became really important in the cooperative and spontaneous environments, since the patterns of the end-users can be studied in a self-learning process and introduced in future network decisions, in order to improve the service to the end-users. With the historic of the daily behavior of the users and their movements, the mobility management process increases their speed and accuracy.

VII. CONCLUSION

This work presents an overview about the state-of-the-art subjects mainly related with cooperative and spontaneous networks, mobility management, distributed overlay networks and networks driven by humans.

As described, the future cooperative and spontaneous networks bring several challenges to the mobility management, since the elements may constantly change.

A distributed architecture based in P2P and DHT principals may be a solution to perform the management of the mobility, integrating new functions, in order to deliver to the end-user the required content in a personalized way, guaranteeing the QoE in multiple forms. The location and historic context parameters become really important in the user-centric mobility management, improving the decisions and predictions.

The new networks driven by humans patterns and social behaviors try to recognize patterns and use them to improve the management of the network. These principals, together with mobility prediction mechanisms are very advantageous in the considered spontaneous and cooperative mobile scenarios.

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