

Enabling Adaptive Service Access Management for Next Generation Multi-Service Networks

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Abstract—This paper describes the Living Systems Adaptive Service Management, LS/ASM, Suite, an innovative and comprehensive middleware solution that assists operators with effectively delivering next-generation converged services by dynamically combining end-users and service-centric requirements with network-facing management and control functionality.

The main goal is to discuss how a comprehensive policy-driven and autonomic solution such as the LS/ASM Suite, spanning basic infrastructures and end-user devices and building adaptive control functionality directly into the corresponding elements, enables the shift of focus from technology to value-added services.

I. INTRODUCTION

The pervasive use of IP and the increasing availability of ubiquitous broadband access in combination with advanced wireless technologies are making network convergence a reality. In this way operators aim to empower Telecom end-users with the means to access a growing mix of value-added services and applications that are made available to them at any time, from any location and using any available access technology. This demands a common multi-access aware service delivery platform able to seamlessly offer a reliable, secure, easy-to-use and personalized service experience.

With this objective in mind, operators are expected to migrate towards a new kind of service management approach since most of the traditional client/server solutions turn out not to be neither very effective or entirely appropriate due to a lack of ability to handle the increasing dynamicity and diversity of multi-service networks. In this perspective, emerging solutions need to become increasingly “autonomic”, meaning that their components should be able to self-configure thereby dynamically optimizing their own operations according to the way their environment and usage model changes [17].

LS/ASM, the Living Systems Adaptive Service Management Suite, is a comprehensive and innovative solution that enables effective delivery of next-generation converged services by dynamically combining end user requirements and service provisioning policies with network-facing management and control functionality.

By automating selected low-level processes on both the users and operators sides and bringing more “personal intelligence” - users context and behavior awareness - and “network intelligence” - network services, content and resources awareness - throughout the whole service delivery chain, the LS/ASM solution realizes *Adaptive Service Access Management*, ASAM. The central idea behind the ASAM vision is to use autonomic techniques that enable operators to efficiently manage and optimize resource utilization, performance and end user experience. This is achieved by transparently tuning service parameters while taking into account changes in both the client and network context.

This paper first introduces the complex multi-service network context and highlights the main challenges associated with effective management of services and resources. The Adaptive Service Access Management, ASAM, approach is proposed as a means to address these challenges by integrating a set of features contributing to a more efficient and flexible usage of network resources and delivery of services. The LS/ASM Suite is then described in terms of its conceptual foundation as a means to realise the ASAM vision, its architectural design, key features and benefits, and several example deployment scenarios.

II. A CHALLENGING CONTEXT

In today’s competitive and converging Telecom markets, the increasingly ubiquitous and heterogeneous communication and computing environments offer attractive business opportunities to operators, but also pose significant new challenges in many areas of network and service management.

Telecom users are much more demanding. They request new services to support a seamless and consistent experience across multiple access technologies, devices and locations. They expect to be always best-connected, i.e., they expect anywhere and anytime access to the best available technology with the maximum capacity on offer, plus easy-to-use and problem-free services, all at ever lower prices.

The availability of new advanced end users devices enables a variety of multimodal deployment scenarios, as depicted in Figure 1, but also poses significant challenges in terms of service usability and personalization. In parallel, the widespread proliferation of multiple broadband access technologies such as cable, DSL, powerline, satellite, and wireless, is facilitating

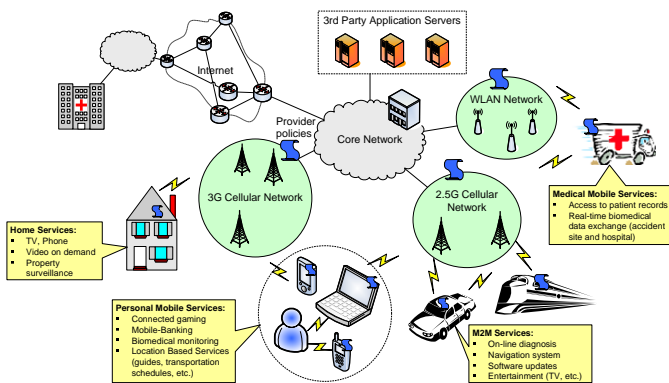


Fig. 1. A complex multi-service network scenario example.

the entry of new service providers in both the fixed and mobile Telecom sectors.

Therefore, to attract and retain customers, today's operators need a cost-effective means to deliver value-added and reliable services in a quick and flexible way. In this perspective, they need to make the best use of their current technology investments by optimizing the way network performance and availability are managed.

This is not an easy task, especially when considering that many operators must deal with a diverse mix of systems and processes that make it difficult to effectively monitor and tune services performance once delivered.

A. Adaptive Service Access Management

Because of the increasing deployment of multiple access technologies at the edges of networks, the management of next-generation services is changing rapidly. Intelligence and specific management functions need to be migrated towards the edge of the network and even onto the customers' premises/devices.

In particular, the set of functions including the selection and maintenance of one of several available communication channels and the adaptation of services taking into account a variety of criteria and changes in the environment is indicated as *service access management*. The major problems associated with this process are:

- The fast and appropriate adjustment of the relevant connectivity parameters to a continuously changing networking environment.
- The assurance of sufficient service quality and reliability, whose perception can vary from one person to another and thus needs to be addressed individually.
- In balance with the aforementioned points, the optimisation of resource usage and reduction of operational costs.

Adaptive Service Access Management, ASAM, addresses these issues by providing the means to dynamically adapt the configuration and usage of available network access resources in a reliable and cost-efficient way. This is achieved by embedding specialized "intelligence" into complex multi-technology and multi-service access networks, including end user devices. The central concept is to deploy smart techniques allowing

operators to efficiently manage and optimize resource utilization, performance and end user experience. This by transparently tuning service parameters (e.g., bandwidth, average delay), while taking into account changes in the context, including user profile/preferences, Service Level Agreements, SLAs, user location, terminal/devices features, and network resources.

ASAM bases its adaptivity on the capability to autonomously observe, extract, understand and use context information to consequently modify its functionality. Information exchange and correlation between client devices and access nodes, as well as between access nodes even of different technologies, is at the core of this approach. In particular, through dynamic mediation between (often conflicting) requirements on the client and network side, capacity for given connections requests is allocated by taking into account the status of the whole service provisioning chain. This requires accounting for a variety of parameters characterizing the connection to be created and consequent required network resources, and existing policies both on the user and provider side.

For this to be realized, flexible and distributed monitoring, configuration and maintenance tools need to be smoothly interfaced and integrated within the evolving networking environment and pre-existing management systems.

B. A New Solution Foundation

The strong limitations of traditional solutions for adaptive service management and thereby delivery are directly related to the lack of efficient methods and tools capable of flexibly and dynamically mediating between providers needs and end users requirements, while proactively monitoring and configuring required resources. This is compounded by the difficulties encountered by human operators when attempting to consider all factors that influence the service management process and make decisions in real-time.

In this perspective, a new kind of management solution is needed. A comprehensive policy-driven and autonomic architecture, spanning basic infrastructures and end-user devices that builds adaptive control functionality directly into the corresponding elements, enabling the shift of focus from technology to value-added services. This is very complex also because of the diversity of end user devices, network premises and legacy systems such a solution should be integrated with.

The LS/ASM Suite is an innovative ASAM solution that addresses these challenges by making use of multi-agent technology concepts and tools [12] in combination with powerful resource allocation algorithms and reasoning strategies. Autonomous software agents that adapt to changes in the environment, minimizing human intervention and service interruption provide a powerful mean to engineer a distributed and autonomic system that includes:

- Customizable and adaptive routines for automating and tuning repetitive information and control tasks.
- Coordination mechanisms enabling dynamic collaboration and aggregation of services.
- Abstraction of communication components to support context changes through adaptation of semantic grounding.

The central idea is that loosely-coupled distributed management functions and control methods can be well-modeled and implemented by making use of automated, goal-driven and proactive software entities. These lightweight components are able to operate on resource-scarce devices and support asynchronous communication with intermittent network connections. Moreover, according to the results of proactive monitoring information received from the environment within which they are embedded, the LS/ASM components directly assist with autonomic management of network resources. They are able to configure themselves and dynamically optimize their operations according to the way their environment changes and in-line with operator and client user policies. They thus assist with the speed-up and automation of simple, tedious and repetitive service management tasks currently performed most commonly by human operators. The ultimate result of this is potentially substantial cost savings to the operator.

C. Related Work

Although other approaches [9] [4] [10] [7] have been proposed in the literature that address part of the ASAM challenges, few, to our knowledge, deal with the specific case of dynamic mediation between network and client requirements and accommodate resource allocation and consumption accordingly.

In particular, the solution presented in [7] defines support for vertical handover in Radio Access Networks with selection criteria predominantly based on Quality of Service. A vertical handover decision module is described in terms of its placement and operation within a concrete provider system. This decision module can communicate with various network devices, including client devices, to determine radio access network selection based on QoS parameters. Some degree of negotiation takes place, but only between entities within the network and excluding the clients. The client devices remain passive.

The work described in [4] proposes a market-based architecture where software agents are used to negotiate the provisioning of a service by service providers to client devices. This article describes only a single, non-iterative, negotiation phase triggered by location change between a user device and service providers. It also has no account for cooperative offers created by multiple contributing network provider devices that have derived a proposal by negotiating amongst themselves. This approach also only considers providers that offer WLAN connectivity, rather than multiple possible wireless connection types (including cellular and WLAN technologies). All of these points are significant differences in comparison with the LS/ASM solution.

Other related approaches are discussed in Section V when discussing in more details the deployment of the LS/ASM solution in specific scenarios.

III. THE LS/ASM SUITE

As depicted in Figure 2, the LS/ASM architecture includes two main types of autonomic software components, which communicate by relying upon the use of common interaction

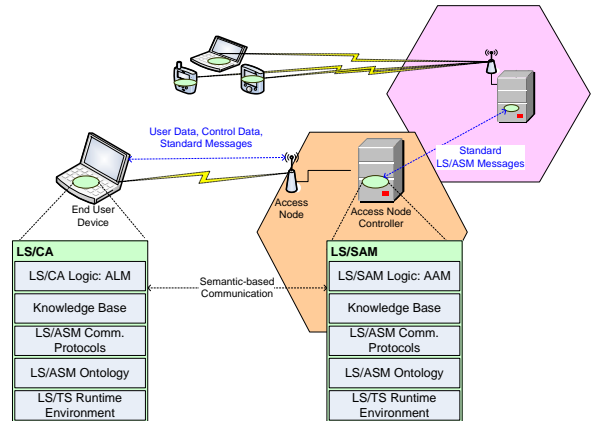


Fig. 2. The LS/ASM architecture.

protocols and a shared semantics-based ontology defining all LS/ASM needed concepts.

- The *Living Systems Connection Agent*, LS/CA¹, is a client component that can run on a variety of mobile end user devices (e.g., laptops, PDAs, smart phones) and provides mobile users with improved quality and reliability by optimizing service access through adaptive connection handover across multiple access technologies. By taking into account user preferences, application requirements, devices properties and dynamic network conditions, the LS/CA manages the end user device's connection to the network.
- The *Living Systems Service Access Manager*, LS/SAM, is a network component that can run on hardware located at the access nodes² or at a network management facility and dynamically manages and optimizes resource allocation using differentiated access technologies with adaptive problem recovery and load balancing methods. Proper actions (e.g. trigger vertical handover, reconfigure a device) are performed by the LS/SAM according to operators policies and well-proven distributed resource allocation algorithms.

These lightweight software components can flexibly complement and extend a number of existing service management architectures, and are able to run on resource-limited devices and support asynchronous communication with intermittent network connections. In addition, by dynamically coordinating their actions and behaviour, they enable adaptive communication service access by mediating between operator policies and end-users requirements and preferences.

This is achieved through a negotiation procedure that can be initiated either by a LS/CA calling one or several LS/SAMs for a proposal to set up a connection according to specific end user's requirements, or by a LS/SAM sending a connectivity offer to a LS/CA based upon current network conditions and

¹LS/CA is available as a standalone commercial product (see www.whitestein.com/pages/solutions/l_s_ca.html)

²Access nodes typically are send/receive stations that provide a link to an access network.

operator's policies. The connection characteristics on which negotiation is based can comprise bandwidth (average, minimum and maximum), maximum end-to-end delay, acceptable jitter, network type and cost schedule.

A. The LS/ASM Client Component

The LS/CA includes the *Adaptive Logic Module*, ALM, which provides adaptive service access by setting the networking parameters according to the outcome of the mediation process between the end user's requirements and the network provider's offering (as specified by the involved LS/SAM). The ALM outcomes and decisions are determined by a set of factors including:

- Quality requirements of the applications and services running on the device the LS/CA is embedded in.
- Physical end user device status, e.g., battery power level that can affect the transmission technology selection, and properties, e.g., only specific access technologies might be supported.
- Existing service provisioning conditions according to pre-defined subscription contracts/service level agreements.

The ALM proactively manages and processes this information according to policies which capture end user preferences, e.g., minimising connection costs, maximising battery life when on-the-move, etc. These policies are flexible in that they may be adapted automatically or changed by the user when needed/desired.

B. The LS/ASM Network Component

The LS/SAM includes the *Adaptive Access Module*, AAM, that proactively monitors traffic and resources in the access node the LS/SAM is controlling, triggers appropriate actions (e.g., vertical handover, load balancing, congestion recovery) according to the network status and current traffic conditions, processes incoming LS/CA calls for proposal and thereby elaborate offers as appropriate.

The AMM decisions and behaviour are guided by the operator's policies that express provider preferences with respect to a variety of aspects including, for instance, how to allocate traffic to balance out network utilization, how to treat specific users (i.e., connection) in case of congestion, how to adapt pricing schemes according to the user's subscription type. This requires dynamic monitoring and processing of information including:

- Traffic conditions and resources availability within the access node the LS/SAM is controlling.
- Traffic conditions and resources availability in other access nodes a given portion of traffic can be handed over to via dynamic peer-to-peer LS/SAMs coordination.
- Existing service provisioning conditions according to pre-defined subscription contracts/service level agreements.

C. Client-Network Mediation

The mediation process conducted between the LS/CA and LS/SAM components consists of a sequential interchange formulated as a contract-net protocol [8] negotiation with the

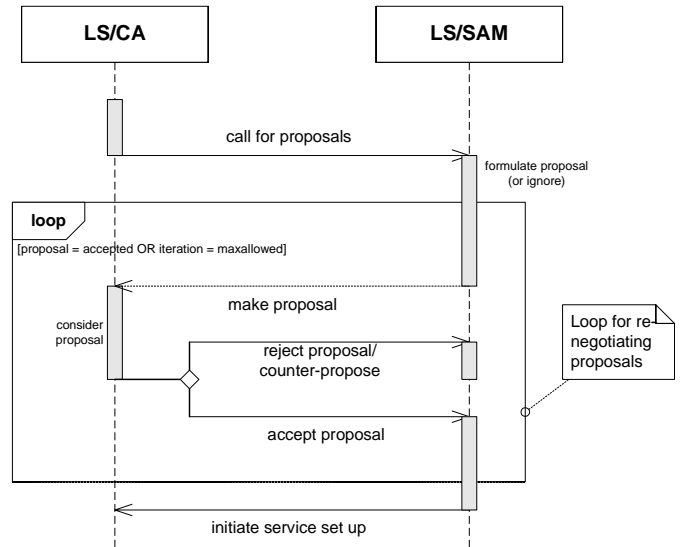


Fig. 3. Mediation process between the LS/ASM client and network components.

goal of determining the best connection parameters given the requirements of the end user, the offering of the network provider and the conditions of the transmission medium.

The requirements of the end user toward the provider are a combination of (i) the preferences of the end user formulated as user policies (e.g., minimising connection cost), (ii) the quality demands of the applications running on the end user device (e.g., a given application may require low end-to-end delay), (iii) the status of end user device resources (e.g., battery power, which can affect the selection of the transmission technology), (iv) the technologies supported by the end user device (e.g., only WLAN and UMTS network interfaces available), and (v) the conditions stated in the subscription contract (e.g., costs for using certain technologies).

The offering of the provider toward the end user is determined by considering (i) the properties of the provider network (e.g., diversity of network access technologies), (ii) the network status (e.g., distribution of traffic load, delay times), (iii) the capabilities of the network (e.g., mobility support, QoS control) and (iv) the provider policies, including business rules, that relate to the use of its infrastructure, pricing schemes, traffic prioritization mechanisms, etc.

Figure 3 illustrates the typical message exchange during a proposal setup sequence. The LS/CA sends a Call For Proposal (CFP) to one or several LS/SAMs requesting offers to set up a connection with specified constraints including quality requirements, or connection characteristics.

A simple example CFP is as follows:

CFP: (set up connection, (min. bandwidth: 100 Kbit/s, max. jitter: 50 ms))

In addition, specific time schedule information regarding the start time and end time of the connection might be included (e.g., start-time: 2006-09-01, 12:00 UCT, end-time: 2006-09-01, 16:00 UCT). In special cases, where the connection needs to be periodically established, the recurrence of this event can also be stated in the proposal.

The proposal offered by the involved LS/SAM is then

determined as a function of the supplied client constraints on what a proposal may contain, provider policies and network state, which may relate to the instantaneous state and/or historical state data, optionally including reservations of network services.

An example of a proposal is as follows:

Proposal: (set up connection, (network: UMTS, min. bandwidth: 100 Kbit/s, max. bandwidth: 120 Kbit/s, max. jitter: 40 ms, max. end-to-end delay: 200 ms))

This example proposal lists additional parameters than those mentioned in the original CFP. These can be taken into account by the receiving LS/CA, or ignored as preferred.

The originating LS/CA waits a predefined duration to receive incoming proposals and/or rejections. Once the deadline is reached, the LS/CA begins to assess received proposals by considering (i) the set of quality requirements stated in the original CFP, (ii) the received proposal (or the relevant parameters stated in the proposal), (iii) the user policies, and (iv) the status of the end user device. The output of the assessment function is a value indicating the viability of the proposal. If no proposals are acceptable, the CFP can be revised and resent to the same or different LS/SAMs. This forms the basis of the mediation process which may take place over several iterations. A basic protection algorithm is used to ensure that negotiation is convergent, thereby avoiding lengthy or endless iterations.

When, or if, a proposal is accepted the client device sends an accept-proposal message to the corresponding network provider. All other proposals that have been received are explicitly rejected by informing their source providers. The reason for rejection may be included in the message.

IV. REALIZING ASAM AS LS/ASM

The dynamic coordination of LS/ASM components enables mobile data connectivity and service management to be optimised transparently across multiple network access technologies. In particular, the ASAM vision is realized by means of a comprehensive set of mechanisms including:

- *Seamless handover* and *session continuity* that guarantees interruption-free service access across multiple technologies by allowing an LS/CA empowered device to maintain the same IP address for an entire session. This is achieved by making use of Mobile IP technology [15] and (alternatively) SESAM technology [6].
- *Secure communication*. Tight integration of the LS/CA with several 3rd party VPN clients allows an always secure connectivity. Furthermore, by integrating IPSec [13] and Mobile IP, the LS/CA ensures end-to-end encryption of all generated traffic (as an optional feature).
- *Connection adaptation*, which means automatic detection of available networks and selection of the preferred network adapter (access technology) based on service requirements and network conditions for improved reliability and QoS. This, as explained in the previous section, can trigger dynamic negotiation between the LS/CA and the LS/SAM components.
- *Context-aware customer support* through semantic service specifications, policy-driven decision making and

dynamic information retrieval. The LS/CA improves end-user experience by directly dealing and addressing low-level issues (e.g., failure recovery, connection adaptation), while taking into account user policies and boundary conditions, i.e., context-based information and coordination with LS/SAM components as needed.

- *Congestion recovery*: instantaneous and proactive detection, analysis and relief of congestion, which reduces call dropping and increases services resilience and availability. Within an access node, once no new network connection can be accepted or the total requested bandwidth exceeds the total available one, i.e., packets are dropped, an LS/SAM can decide upon specific strategies and existing service level agreements (if any) whether and how to drop or hand over part of the traffic to neighbour access nodes.
- *Load-balancing*: balance traffic load across WiFi and cellular networks while considering the QoS needs of running services, making the network more resilient to traffic peaks. This is achieved by dynamic coordination of LS/SAMs that can hand over a certain number of connections to neighbour access nodes according to several possible operator strategies. The use of distributed constraint satisfaction algorithms [19] enables to effectively balance out the load by taking into account all existing hard and soft constraints.

A. Benefits of LS/ASM

By means of the features described above the LS/ASM Suite creates value by bringing important benefits to both end users and operators.

LS/CA elements provide end users with the best connection available in wherever they may be located, e.g., an train, airport, business meeting, or at home. They achieve this by enabling a terminal to seamlessly select the access technology that will provide the best connection (e.g., that which offers the highest data rate), while automatically taking into account user requirements and provider policies.

By using proven distributed resource allocation algorithms for congestion recovery and load balancing, coordinating LS/SAM entities are able to optimize the deployment of network resources. Furthermore, resource optimization strategies are applied not only locally, but also take into account the status of the whole provisioning chain (through peer-to-peer LS/SAMs coordination mechanisms³). Moreover, historical data relating to the provisioning chain can be aggregated and used for off-line analysis to support network dimensioning and planning.

LS/ASM optimization techniques can also take into account different types of user subscriptions, by enabling service differentiation and premium services both per-session and per-subscription. This enables operators to adopt an effective convergence strategy taking better advantage of the unique benefits provided by each deployed access technology, while better serving customers with constantly growing demands.

³Discussion of peer-to-peer LS/SAM coordination, both intra- and inter-operator, is omitted from this paper due to space limitations.

In addition, the flexible nature of deployment using software agents allows straightforward support for fault tolerance through the integrated use of autonomic self-management mechanisms. In the first instance, if a negotiated connection fails because an LS/SAM becomes unavailable, it can be quickly replaced with an alternative connection established through an earlier, or on-demand, negotiation with alternative LS/SAMs. Secondly, both LS/CA and LS/SAM agents can, if necessary, be hot-swapped with a ready-to-run redundant backup agent that copies transaction controlled state and takes over if a failure occurs in the primary.

V. LS/ASM DEPLOYMENT SCENARIOS

Different combinations of the LS/ASM features enable a variety of deployment scenarios. In the following, three of the most significant ones are presented including a discussion of the distinctive characteristics in relation to relevant work.

A. Enforcing QoS

The notion of guaranteed data transmission quality with enforcement mechanisms, in particular for emerging QoS sensitive multimedia applications, e.g., voice or video over IP, is a key issue especially in converged networks [3]. While traffic prioritization is often not of paramount importance in core networks due to overprovisioning, QoS is an essential differentiator in limited-capacity wireless access networks for capacity and/or delay sensitive traffic such as voice or video over IP. While for cellular access technologies belonging to 2.5G, 3G and 3.5G, appropriate standards for QoS have been defined, few operators yet make widespread use of them. In addition, the WiFi world is supporting its technologies with specifications that directly account for QoS management.

In particular, when integrating different access network technologies, e.g., WiFi and UMTS, the quality of a connection may be degraded during vertical handover where (i) the connection needs to be re-established at the new access node, which is time consuming and during which no data can be transmitted, and (ii) if too many IP packets are lost, they must be retransmitted which can also be time consuming in the case of a large number of packets - again leading to service interruption.

Various approaches have been developed and proposed to address this problem. In [18], a reservation-based QoS model for integrated cellular and WiFi networks is defined and an adaptive mechanism to ensure end-to-end QoS is proposed. However, this model can only work by making the assumption that cellular/WiFi interworking is realized by relying upon a common and uniform reservation-based QoS architecture, which is not (yet) the case for most real network scenarios. Similarly, Song et al. [16] proposed an admission control mechanism for integrated voice and data services in cellular/WiFi networks. The main limitation of this approach though is that it does not account for video traffic.

To effectively provision QoS and optimize resource utilization for a variety of possible heterogeneous network scenarios, the LS/ASM Suite relies upon the dynamic combination of specific mechanisms both at the client side (i.e.,

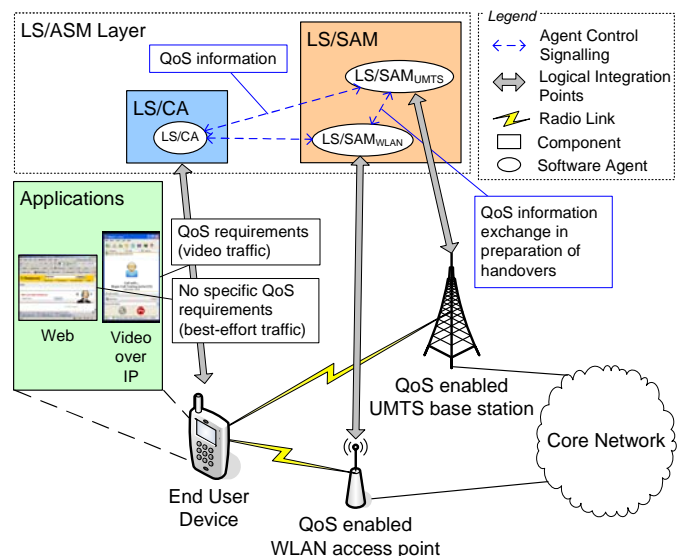


Fig. 4. Deployment model of the LS/ASM Suite for QoS enforcement.

seamless handover, session continuity and connection adaptation) and at the network side (i.e., congestion recovery and load-balancing) that are compliant with dominant industrial standards, e.g., mobile IP or SIP/IMS, when supported, or technology-independent, whenever possible.

Unlike legacy systems and hardware-based solutions, the LS/ASM software components accommodate high-level service and user needs and preferences (including QoS requirements) by implementing coordination mechanisms and resource allocation algorithms that hide low-level access technology dependent processes. This is achieved by deploying an agent-based middleware architecture that provides users with a common and higher level of abstraction, which makes low-level network access heterogeneity transparent.

On the client side, basic QoS in terms of service availability and continuity is enforced by the LS/CA through automatic and policy-driven vertical handover, i.e., all traffic is switched from one network interface, according to existing constraints and user policies. Moreover, by continuously monitoring network conditions and device status and properties, the LS/CA exerts QoS and context-aware resource management by selecting the most appropriate access technology to be used for the running applications/processes. In addition, when appropriate, as detailed in Section III-C, the LS/CA can also trigger negotiation with one or more LS/SAMs for different connectivity conditions.

On the network side, the key mechanisms deployed by the LS/SAM to enforce QoS provisioning are load-balancing and congestion recovery. Load-balancing can be triggered by LS/SAMs in order to redistribute traffic across several access nodes according to various criteria, including:

- Current utilization of resources at the access node, e.g., once the traffic overcomes a given threshold a certain portion of the supported connections might be handed over to neighbor LS/SAMs.
- QoS requirements of the running services, e.g., best-effort connections might be handed over to prioritize premium

services for which charging might be based on service reliability guarantees (e.g., $\geq 95\%$ non-disruption).

- Predictions of the network resources usage to minimize the probability of congesting an access node.

Analogously, whenever congestion occurs a specific part of the traffic at a given access node might be handed over to other LS/SAMs or selected existing connections (e.g., the non-premium ones) might even be dropped as appropriate. This enables relief of congestion and increases service resiliency and availability.

For example, assume a user that launches an IP-based TV program (e.g., a news channel) on a smart phone. During the launch of the selected application to render the video stream, the LS/CA determines the connectivity parameters (typically bandwidth and delay) for interruption-free high quality service provision. Because different access technologies offer different QoS assurances, the LS/CA might trigger vertical handover to a specific technology, e.g., UMTS, that better supports the QoS level needed for the video down-streaming. In addition, in the case of an UMTS connection, the LS/CA would set up a new Packet Data Protocol context requesting the UMTS QoS streaming class [1].

Figure 4 depicts the deployment model for this case. Each end user device is installed with an LS/CA component able to enforce QoS. The LS/CA must be aware of the different traffic categories available in each network access technology. During a vertical handover, the QoS class of the active network is mapped into an appropriate QoS class of the target network. There is one LS/SAM agent being deployed per access node, i.e., each LS/SAM agent is in charge of a specific access node and thus is up-to-date at all times regarding the status of that node. When planning load balancing and congestion recovery, the LS/SAM agent must be aware of the QoS classes supported by the different access technologies to minimize the risk of degraded service quality.

B. Integration with Push Services

Push technologies [11] are widely used in today's mobile communications market to send media content to users as soon as it becomes available. However, the majority of current existing solutions are neither able to determine the most suitable moment to send content nor which content quality to use to deliver it.

The LS/ASM Suite can be integrated with third party push service platforms to improve the media delivery process by providing information about the current status of the target user device and capability/reliability of the access network to be used to better reach such device. In this way, it is possible to more effectively choose when to push the content and at which quality it should be sent (according to the available access channels).

As a simple use case to illustrate the combined deployment of a generic push platform and the LS/ASM Suite, assume a mobile user connected to a cellular network (for instance UMTS) through which he/she is engaged in a video conference. As depicted in Figure 5 the LS/CA component is installed on the end user device. The LS/SAM component is

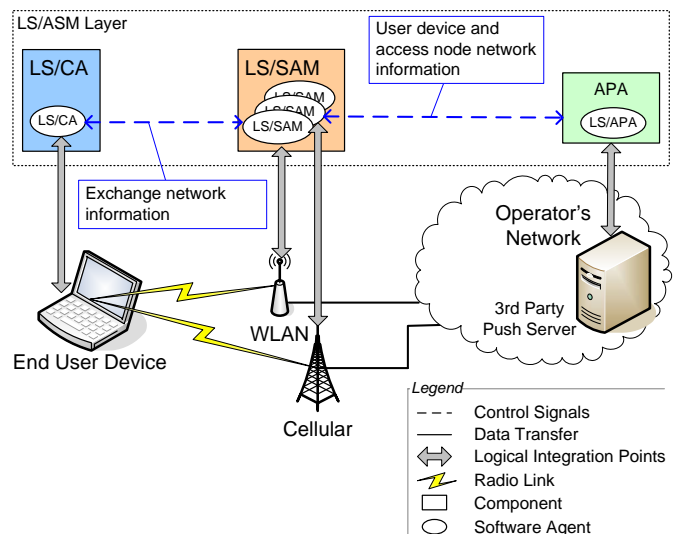


Fig. 5. Deployment model of the LS/ASM Suite for the push service scenario.

installed on a server that resides inside the operator's network - one LS/SAM component per each existing access node. In addition, an Adaptive Push Agent (APA) component is integrated with the push platform.

When passing a particular shopping outlet, with which the user has pre-registered, the push platform is signalled to transmit an advertisement to that user in either image or video format.

The APA contacts the LS/SAM controlling the access node to which the user is connected in order to retrieve appropriate information (e.g., capacity and security characteristics) about the deployed network connection. Based on this, the APA finds out that sending a video advertisement to the user would be disruptive to his/her already running video stream and thus also to the user's quality of experience. Therefore, the APA triggers the advertisement to be sent in image format with a text tag indicating that a video advertisement is also available if the user wishes to receive it in a later moment.

C. Integration with IMS/SIP

IP Multimedia Subsystem, IMS, initially developed by 3GPP and 3GPP2 as an IP core network architecture for cellular/wireless-based access to Internet services, is now evolving into a standard that provides a common framework to create and offer next generation converged network services [5]. IMS builds on the Session Initiation Protocol, SIP, that is mainly in responsible for delivering a session description to a user at its current location [14]. The key idea is to enable any kind of access (wireless or fixed) for any kind of media (including any combination of voice, text, image and/or video) supporting multiple devices and endpoints.

Because of the (at least initial) co-existence of IMS and non-IMS applications, the costs associated with moving to a full IMS-based network, and the inherent complexity of IMS (and its several standards, interfaces and protocols) most service providers and or operators are expected to migrate toward an IMS service framework iteratively.

of real-world scenarios, the adoption of the LS/SAM requires some additional work given the wide assortment of existing and upcoming service and network management architectures.

VII. ACKNOWLEDGMENTS

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