

An Autonomic Middleware Solution for Integrated Access Management

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Abstract. This paper introduces LS/ASAM, the Living Systems Adaptive Service Access Management Suite, an autonomic middleware solution that enables operators to effectively manage connectivity of nomadic end hosts across heterogeneous access networks, while optimizing the way network performance and resource availability are managed.

1 From Network Convergence to Service Convergence

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 enable Telecom end-users to access a growing mix of value-added services that must be available at any time, from any location and using any available technology. This poses significant challenges in many areas of network and service management, especially in resource-limited access networks, and demands a new kind of approach. A comprehensive policy-driven, autonomic solution, spanning provider infrastructure and end-user devices, which builds adaptive control functionality directly into the respective element. Being “autonomic” the solution components are able to dynamically detect, diagnose and repair faults, adapt their configuration and optimize their performance, while protecting and healing themselves according to changes in the network and operating environment.

2 An Autonomic Middleware Solution

The LS/ASM Suite is a comprehensive middleware solution that complements and extends many existing service management architectures in compliance with major industry standards¹, such as IMS/SIP, mobile IP. Autonomous software agents lie at the foundation of this solution. The central concept is that loosely-coupled distributed management functions and control methods can be well-modeled and implemented by making use of proactive software entities that are able to assist with the speed-up and automation of several tasks traditionally

¹ For more details see: M. Calisti, D. Greenwood, *Enabling Adaptive Service Access Management for Next Generation Multi-Service Networks*. ECUMN’07 Proceedings.

performed by human operators, configure themselves and dynamically optimize their operations according to the way their environment changes and in-line with specific policies. Effective delivery of next-generation integrated services is supported by dynamically combining end-users needs and service provisioning policies with network-facing management and control functionality by means of two main components.

The *Living Systems Connection Agent*, LS/CA, is a client component that can run on a variety of mobile devices (e.g., laptops, PDAs, smart phones). It provides mobile users with improved quality and reliability by optimizing service access through adaptive connection handover across multiple technologies and dynamic mediation of service delivery parameters. This by taking into account application requirements, specific conditions as defined by existing SLAs, devices properties and current network status in-line with high-level policies which flexibly capture user preferences.

The *Living Systems Service Access Manager*, LS/SAM, is a network component that can run on hardware located at an access nodes or at a network management facility. It proactively monitors and manages traffic conditions, dynamically coordinates its behavior with peer LS/SAMs to achieve global resource optimization, and mediates between operator policies and end-user requirements by interacting with LS/CAs. Specific actions, such as load balancing or congestion recovery, are triggered according to operators' policies and well-proven distributed resource allocation algorithms.

Dynamic coordination of these components, capable of running on resource-scarce devices and support asynchronous communication with intermittent network connections, is achieved by means of a negotiation procedure, which can be triggered either by the LS/CA or the LS/SAM, with the goal of determining the best connection parameters depending on specific application needs and current network conditions. In particular, mobile data connectivity and service management are optimised transparently across heterogeneous access networks by means of a comprehensive set of processes. This set includes:

- *Vertical handover and session continuity* to guarantee interruption-free service (maintaining the same IP address) access across multiple technologies.
- *Connection adaptation* to select the preferred network adapter based on service needs and network conditions for improved reliability and QoS.
- *Secure communication* via tight integration with several third party VPN clients to allow always secure connectivity.
- *Real-time detection, analysis and relief of congestion* to reduce call dropping and increase service resilience and availability.
- *QoS-aware balancing* of traffic load across WiFi and cellular networks to increase resiliency to traffic peaks.
- *Context-aware user support* through semantic service specification, policy-driven decision making and dynamic information retrieval.

These allow operators to reduce operational costs, better serve customers and adopt an effective convergence strategy taking better advantage of the unique benefits provided by each deployed access technology.