Designing Networks for the Delivery of Advanced Flexible Personal Services: the Daidalos approach

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Abstract – Next generation networks will integrate quality of service capabilities in mobile heterogeneous environments, under a common authentication, authorization, accounting, auditing and charging (A4C) framework, and provides a secure communication environment able to cope with technological changes, across multiple access technologies, both in unicast and broadcast scenarios.

This document discusses the initial approach of the Daidalos project, bringing together these diverse technologies under a common IP network concept. The Daidalos approach considers a multiplicity of interoperating providers, sharing identification and personalization mechanisms under multiple levels of trust relationships.

I. INTRODUCTION

Mobility has become a central aspect of the lives of European citizens - in business, education, and leisure. This trend has been followed by an increased usage (and diversity) of multimedia communications, as the increased success of cellular phones with embedded cameras illustrates. In order to keep up with the resulting new communications needs, it becomes necessary to rethink existing network paradigms. Future networks should be able to support multiple business models with quite extreme company strategies – from network operators, service providers, broadcast companies, or cellular operators. These companies will function on a mixed competition-cooperation environment, where individuality will be required to surpass competition, but cooperation will be essential to improve the network value.

Daidalos innovations will make real these trends even to telecommunication companies with different purposes and business models, allowing their smooth interoperation and providing an opportunity for new service developments. Furthermore, the resort to open technologies will support end-user centric service developments, such as peer-to-peer technologies.

Due to rapid technological and societal changes, there has been a bewildering proliferation of technologies and services for mobile users. This has created a complex communications environment for both users and network operators. For efficient interoperation, these novel network environments will need to integrate quality of service capabilities in mobile heterogeneous environments, under a common authentication, authorization, accounting, auditing and charging (A4C) framework, and provide a secure communication environment. The integration of all these technologies represents a major multi-disciplinary research effort undertaken in Daidalos.

This paper discusses the initial Daidalos [1] approach to these new networks, expanding approaches initially researched in the Moby Dick project [2-3]. The rest of the paper is organized as follows. Section II will present the overall Daidalos objectives and design orientations. Section III discusses the Daidalos architecture concepts, such as contracts, service providers, identities and administrative entities and federations. Section IV will then detail the major network entities envisioned in our network. Unfortunately, for conciseness, this paper will have to be restricted to high-level architectural blocks. Finally, section V will present our current conclusions and future steps.

II. THE DAIDALOS APPROACH

The Daidalos project aims to work towards an environment where mobility is fully established through scalable and seamless integration of a complementary range of heterogeneous technologies and concepts, and providing the framework of integrating multiple existing technological, service and business paradigms. Daidalos is also committed to use open interfaces, and technologies, according to a vision of a future user-centric fully-networked society. This environment will enable mobile users to enjoy a diverse range of personalized services – seamlessly supported by the underlying technology and transparently provided through pervasive interfaces. In Daidalos, information will reach the user through an “always best-connected” approach, taking in consideration network availability, user preferences and user/service contracts. Daidalos will develop and demonstrate an open architecture based on a common network protocol (IPv6), which in its
successive instantiations will increasingly approach the Daidalos vision, instantiated in two different design scenarios. Two major influences will guide the developments inside Daidalos.

a. Operator-influence and business orientation

The Daidalos project comprises operator-oriented business scenarios. The project researches on business-models oriented towards future communication operators needs, both mobile and broadcast-based. These operators may have very different scales: national operators, small-communities, application providers, etc, but will use the same basic technologies.

b. Scenario-based design

The Daidalos approach is being detailed through a scenario-based design concept. A scenario is a real-life, user-centric, description of communication-based activities, which we use in an iterative process to further refine the requirements for system and architecture design.

Two major scenarios are currently under consideration: the Daidalos Mobile University scenario and the Daidalos Automotive scenario. Together both scenarios are highly representative for broad variety of education, entertainment and business scenarios in the mobile world.

c. The Daidalos development process

The overall Daidalos design process follows the lines depicted in Fig. 1 Scenarios will be built respecting multiple requirements, fundamentally acquired from the final-user point of view. In parallel, diverse business models for operators and content/application providers are being developed. These two activities will input in the Overall Architecture Design, which will also receive technical information from the other technical activities in the project.

![Fig. 1 – Daidalos scenario-based design.](image-url)

The architecture then defines the overall design choices for the project, and passes this information to the technical activities, that will develop and implement the required components for the Daidalos architecture. All these components will be later delivered to an integration activity, which will instantiate proof-of-concept designs. With the feedback from these instantiations, new refinements will be promoted at the architecture level.

III. OVERALL DAIDALOS ARCHITECTURE

Given the constraints on design, the overall Daidalos architecture recognizes a set of conceptual entities and interrelations, which will be supported across multiple technology domains.

a. Technologies

Daidalos aims to provide an integrated architecture for multiple access technologies, incorporating wired networks (Ethernet, or EthernetOverXXX), wireless LANs (802.11b, and novel developments as the 802.11g and 802.11i groups on QoS and authentication) and hotspots, PANs (bluetooth) and ad-hoc areas, broadcast media (DVB, both satellite and terrestrial) and cellular technologies (FDD-CDMA, TD-CDMA, or other emerging technologies).

Daidalos will resort to Mobile IPv6 as a common transport layer, and its developments will be conceptually technology independent – with the exception of very well identified activities for improving the physical support of our network concepts. Daidalos will have in place adequate mechanisms to allow for access technology dependent optimizations.

In addition, Daidalos will rely on user-centric concepts, namely on user-profiles. These profiles will be associated with specific contractual relations, and adequate privacy management will be considered in order to exchange the adequate user information across multiple administrative domains and with content/application providers.

The networks will support services to customers under a Policy Based Management framework.

b. Major entities

The Daidalos architecture comprises a variety of different entities (Fig. 2). The key actor is the user, the person physically consuming a service. For that, the user subscribes to a service, with some entity. Actually the customer can have different identities to different operators, and different roles will be defined in each identity. Part of this subscription is the contract, that describes the rights and obligations of the consumer and provider – the subscriber will be the accountable legal entity taking the customer part in that contract. Examples of types of services can be: hosting an application, give access to a network, provide specific QoS, etc. and as such includes application providers, access
network providers, etc. When a user subscribes to a
service, that user will get some reference known as
the service identifier.

At the network level, Daidalos defines the access
network operator, the entity providing data
communication services. Multiple operators are
envisioned, with specialized markets (Access
operators, transport operators, broadcast
operators...). Note that any operator can use
whatever technology it considers more adequate:
for instance an access operator (such as an ISP) can
use a broadcast technology (such as cable). Any
operator has a service provision platform, or is
connected to a service platform operator, which will
allow application/content providers to access its
services. In particular, more complex operators, the
value-added service providers, will resort to these
service platform services in order to offer complex
personalized services to the user.

c. Design concepts

The roles/actors/entities introduced in the previous
section can be divided across three layers, based on
their different role in the architecture: Access
Network provider, Service Platform provider (“transport”), and Application/content provider,
providing multiple types of services, individually or
in aggregates. Daidalos support these facilities
using the federation concept [5]. Companies can
share variable degrees of trust and interoperation. In
the traditional mobile operator case, for instance,
access network operator capabilities are frequent.
Depending on the degree of federation, more
detailed data can be exchanged between multiple
“independent” service providers, at the service
provision and network levels, and at the customer
personalization levels. This exchange of
personalized information can occur both
horizontally (between similar providers) and
vertically (between operators with different roles).

In a federation, operators maintain business
relationships among each other which allow them
to share securely business-sensitive related data.
The Daidalos federation concept will allow mobile
operators jointly to establish a service infrastructure
possibly fine-grained with respect to personalized
customer profiles.

This latter point is also related to the degree of
privacy associated with the user. Given a contract
established with a service entity, the customer will
see its information protected from other entities.
Inside a “federation”, though, this information will
be more freely exchanged, in order to optimize the
service provided to the user.

Application/content providers will be able to
provide personalized services, taking in
consideration the information available from the
Service Platform, the profile of customer and
sensory input from the terminal. Providers will
offer end-user services through service
composition, using the services being provided by
multiple companies. For instance, the user can have
a contract with a video-server company, and this
company may establish all service platform and
access level contracts required for the transmission
of the video to the user – which will see himself
only as a costumer of the video-server, not of
the service platform operator(s).

d. Key interfaces

In the network framework depicted in the previous
paragraph, operators will have a set of facilities and
interfaces in their administration platforms (Fig. 3).

The operator will have a platform performing QoS
management and control, A4C functions, service
discovery and security enforcement, network
monitoring and management. Optimization and
personalization capabilities will be in place in this
(virtual) platform. This platform will be able to
interoperate with service providers, consumers, and
peering operators.

One set of interfaces will be dedicated to
interoperation with peer operators. Facilities for
information and monitoring, service invocation,
service negotiation, adaptation and security aspects
will be in place in these peering relationships.
A second set of interfaces will be dedicated to entities to which the operator is providing a service. A4C aspects and metering at this service level is required. Furthermore, service access points will exist. A counterpart set of interfaces will exist to entities which are providing a service to this operator. In this case an extra facility will be required, in order to define which type of technology will be used, namely if broadcast (e.g. DVB-T based broadcast with the mobility paradigm), multicast or unicast services will be requested to the layer below (named MultiBroad in fig. 3).

Naturally the information flowing across these interfaces and layers will depend on the specific federation details of the operators involved. In Daidalos, the abstract layer of value added service provision will be realised as a set of comprehensive pervasive services in response to the application requirements derived from the two Daidalos scenarios.

IV. THE DAIDALOS NETWORK ARCHITECTURE

The central interests of Daidalos are the multiple issues surrounding the next-generation operators. Fig. 4 depicts the current conceptual stage of a future operator architecture, incorporating access, service provisioning, and content-provider aspects.

a. Major blocks

Multiple technologies will be available for access, and an Access Router will interoperate the operator network with the “access technologies”. This Access Router will perform mobility management, QoS functions, security, paging, A4C control, network metering and management. It may further operate as a multimedia gateway, providing both SIP facilities and content adaptation to specific users/services. Alternative, a service proxy may be located here, with these functions relocated to a server in the core of the network.

The service platform has a A4C system, handling all contractual and personalization aspects of the user identity; a QoS Broker, for managing QoS aspects at the network level; a security manager, defining privacy and confidentiality levels for different communications, and interfacing with external certificate authorities; a home agent, for performing user identification in function of the address provided by the network at contract establishment time; and network management functions (paging –PA-, metering -CMS, control - PBNMS). Some of these functions are also supported at the access network level, for performance reasons. An independent Public Key Infrastructure will be also integrated in the network.

Service Providers (which can be third-party) can access the Service Platform on behalf of an end-user. The user profiles in the Service Platform make sure the Service Providers do not get access to information that the user is not willing to share.

The user terminal (Fig. 5) contains several functional blocks. Access authentication will be done through pana[4]-based services and an A4C client. Mobile IPv6 and heterogeneous mobility managers will control the terminal movement in the network, while QoS requests and A4C functions will be signalled to the network. Specific provision for SIP services exists, in order to interoperate with Multimedia Service Platforms.

Fig. 4 – Daidalos network architecture
**b. Interaction with the user terminal**

The user will initially identify himself to the network, using the PKI infrastructure, registering the terminal in the service provider A4C server. The registration process has to reflect the “home contract” related to the current identity of the user. After successful registration all entities (QoS Broker, security manager, etc.) involved in the service provisioning process have been provided which the required information derived from the possibly federated user profile in order to be capable to provide the service according to user contract.

When the registration is completed – a period when the terminal will be operating with local-link addresses – the terminal is registered in the network, and receives a specific home address. This home address will act as a network identifier, and will be used afterwards for the network to quickly determine under which service provider is the terminal operating. At this time, the Service Provision Platform also obtains all the information required to provide service to that terminal.

When moving, the terminal will be under the control of the Daidalos mobility management, which will select interface to be used at a given time based on both, customer and network preferences. Mobility itself will be performed by Mobile-IP with fast mobility extensions, such as those in [2, 6]. IPSec will be used for sustaining confidentiality, and context-transfer mechanisms for the keys will minimize mobility problems. In a next generation scenario, it will be often the case for the terminal to have also a SIP client (called SIP User Agent), in order to access multimedia services (such as voice and video) to other users and/or content providers.

The terminal will also have a QoS client, able to request specific levels of QoS from the operator for legacy applications. Other applications, like SIP User Agents, can have the QoS levels negotiated automatically by the operator based on their subscription and user profile.

**V. SUMMARY AND CURRENT STATE OF WORK**

This paper describes the initial work being pursued inside the Daidalos project. The paper shows the current refinement of an overall communications architecture: extending the Moby Dick architecture, Daidalos introduced in an Internet-centric manner pervasive personalized services and mobility enabled broadcast.

This architecture supports multiple types of services, and of service providers. It is based on IPv6-technologies, and addresses mobility, A4C, security and QoS issues. The architecture is access technology independent and specific support for broadcast media is being developed. In reality, broadcast media and broadcast services are separated in this architecture, and different combinations of these two different concepts can be supported.

The generic service provider/consumer implemented allows a flexible and optimizable architecture. The federation concept is being used not only to exchange variable details of user data, but also to implement a variable set of “operator” related information. Thus, although well defined interfaces exist at the service platform level, multiple service platforms can be integrated in several aspects, reducing implementation costs and providing for better service provision and network management.

Currently, the interactions between the different entities and protocols are being detailed. The project has already identified several aspects of existing protocols that are required to be improved in order to achieve this overall system integration.

**VI. ACKNOWLEDGEMENTS**

The work presented in this paper was partially funded by the EU project IST-2002-506997 “Daidalos” (Designing Advanced network Interfaces for the Delivery and Administration of Location independent, Optimised personal Services), and synthesizes the contributions of multiple project partners.

**VII. REFERENCES**