PUBLISHABLE EXECUTIVE SUMMARY

Project objective and organisation

The overall objective of MUSE is the research and development of a future, ***low cost***, ***multi-service access*** network that provides secure connectivity between end-user terminals and edge nodes in an open, ***multi-provider*** environment suited to the ubiquitous delivery of ***broadband*** services to ***every European*** citizen.

MUSE (MUlti-Service access Everywhere) contributes to the strategic objective "Broadband for All" of the 6th Framework Programme of the European commission. The expected impact and results of the project are a consensus about the future broadband access and edge network by major operators and vendors in Europe. Anticipated major results include pre-standardisation work aiming at a joint position in standards bodies, as well as proof of concept demonstrators and lab trials. This should lead to a new generation of Access equipment from European vendors, which is expected to be widely deployed across Europe, as operators upgrade their current networks.

The project started a ***second phase*** of two years in January 2006. During the first phase, MUSE defined and demonstrated a multi-service access architecture based on IP/Ethernet technology. The second phase aims to extend the architecture by adding more service capabilities, such as multimedia enablers and fixed mobile convergence support.

The ***consortium*** of MUSE Phase II consists of major European players in the field of broadband access, among them vendors (Alcatel-Lucent, Ericsson, Siemens, Thomson), operators (BT, FT R&D, T-Systems, Telecom Italia, Telefonica, TNO (for KPN), TeliaSonera, Portugal Telecom, Telecom Poland), research institutes (IMEC/IBBT, INRIA, NTUA, ACREO, BUTE, Lund TH, UC3 Madrid, TU Eindhoven, University of Essex, HHI), and a SME in engineering (Robotiker).

The project is ***organised in a matrix*** with five SPs (SubProjects) and four TFs (Task Forces). ***SPA*** is a special umbrella subproject that is in charge of the technical co-ordination of the task forces and the other subprojects. The technical directions by SPA are underpinned by techno-economic studies. SPA is also in charge of the overall standardisation strategy.

The other SPs are the vertical dimension of the matrix. They study detailed solutions at network element level and validate the concepts for four end-to-end deployment scenarios. There is ***SPB*** on ***Multimedia Broadband, SPC*** on ***Fixed mobile convergence, SPD*** on ***High speed distributed access***, and ***SPE*** on ***Node Consolidation***.

The TFs are the horizontal dimension of the organisation. They ensure communication and consensus in specific technical areas across the subprojects. The outputs of the task forces are common contributions to standardisation bodies, comparisons of different approaches, and common specifications. ***TF1*** focuses on ***Access architecture and platforms***, ***TF2*** on ***First mile solutions***, ***TF3*** on ***Residential gateways***, and ***TF4*** on ***Lab trials and testing***.

The way the matrix organisation operates is bidirectional, i.e. not only does it bring solutions originating in a technology-focused SP to a consensus across all SPs in the relevant TF, but also creates a framework for specifications in the TFs to guide developments in the SPs. Consequently the achievements described below are always the result of a strong interaction between TFs and SPs, as well as among different TFs.

Achievements

General access architectures

TF1 further developed the access network architecture by doing further work on auto-configuration and authentication, QoS and Policy control, and considering the concept of IP Sessions. The aim was to bring additional substantial contributions and defined proposals to the DSL Forum. As part of a technical co-ordination activity across the task forces, MUSE assigned responsibilities for different functions in the network architecture to its previously defined business roles.

In the same area, TF4 specified test requirements to evaluate compliance with MUSE specifications at the line interface between a subscriber and the network.

Multi-Media Rich Access

TF1 evaluated the distribution of higher layer intelligence into the access network closer to the subscriber. TF1 devised ways of embedding SBC functionality in the access node or residential gateway, in order to gain potential advantages in terms of network security, QoS control, and scalability. A concurrent techno-economic evaluation in SPA showed that the cost of distribution to an access node is similar to that of a centralised approach. However concerns about the operational costs are still being studied with a newly developed bottom-up cost model.

TF1 extended the QoE concept already defined for video and voice to other services such as high speed Internet access and gaming. This also resulted in proposed requirements for new monitoring functions in the residential gateway. Various contributions to the DSL Forum were made on these topics. In the context of QoE, TF4 further improved the test suite for perceived QoS and experimentally determined a mean opinion score for some characteristics of video services, such as zapping performance.

On the basis of work in TF1, SPB undertook the development of a service plane concept that allows the embedding of higher layer functionality in an access node in a generic way. It also elaborated a monitoring plane and knowledge plane concept to automatically measure and correlate the performance of services. An advanced video gateway was defined which allows the aggregation of streams from distributed video sources and high speed processing of high-layer functions. A packet-to-packet gateway is being extended to become a multi-service edge router.

SPD also deals with distributed access functions, but focuses more on self-organisation of such architectures and the related restoration mechanisms. SPD also simulated new algorithms for content distribution in the access.

Fixed Mobile Convergence

Use cases for fixed mobile convergence, which were defined by TF1 and TF3, considered nomadic services and session continuity in which at least one fixed access network provider is involved. TF1 and TF3 jointly defined an overall reference architecture for fixed mobile convergence. At network architectural level, TF1 elaborated authentication and auto-configuration steps for nomadic services and services that require session continuity. An important issue studied for QoS in the context of fixed mobile convergence was the policy appropriate to a user in a visited network. Session continuity can be realised at network layer by Mobile IP, or at application layer using SIP messages. If Mobile IP is used for session continuity, it was concluded that additional mechanisms are needed to achieve an acceptable hand-over time. The study on roaming is addressing the agreements required between peer business roles in a fixed and mobile provider environment. At the home network level, TF3 analysed the functionality needed on the residential gateway to support visiting users in a WLAN. SPA is validating different business cases for fixed mobile convergence. MUSE made contributions to ETSI TISPAN and the HGI on these topics.

Based on the architectural studies of TF1, SPC developed solutions for nomadic use cases. The Network and Service Management solution was optimised for FMC. A detailed architecture was proposed for network topology discovery and fault management for an Ethernet based access network. The team upgraded the Phase I demonstrator with the AAA and policy control functions that support the nomadic use cases. The evaluation of the lab trial started. A similar effort is planned next year to enable session continuity.

First Mile Solutions

TF2 made important contributions to the DSL Forum, ETSI TM6, and ITU-T on the improvement and convergence of VDSL2 and ADSL2, coexistence of remote and exchange based deployments, spectral management, line testing, DSL test requirements and accuracy of reported parameters.

Research in TF2 aims at drastically reducing operational costs through the use of technology that requires only one planned installation visit to flexibility points and remote electronics, while enabling 'zero touch' service provisioning. During the past year, an extensive analysis of use cases led to a set of requirements, issues and potential solutions that will be tackled in the next year.

SPC enhanced its Loop Qualification and Monitoring system based on feedback from extensive lab and field tests of the prototype of Phase I. It was integrated with a network and service management platform in order to achieve an efficient provisioning process and empower the network assurance and troubleshooting. The prototype was exhibited at BB Europe 2006.

SPE designed a XL PON system. Tests of the physical layer showed a world record 2.5 Gbit/s burst mode transmission over an optical attenuation equivalent to a 512-way split and 70 km of real fibre. The MAC protocol under development is an evolution of the FSAN GPON system. Other optical access technologies under study are a CWDM ring system, for which resilience was demonstrated, and a hybrid fibre radio solution, which is suited to feed WiMAX base stations.

TF4 updated the test suite of Phase I with new test requirements for VDSL2 and fibre access systems.

Residential Gateway

TF3 identified the new functions required for a multi-play residential gateway and captured them in a reference block diagram. It also specified new use cases emerging in multi-service deployment of residential gateways, including some for fixed mobile convergence. It analysed the enablers needed to realise these use cases. The studies included addressing, authentication methods, support of signalling protocols, QoS and admission control principles, as well as local and remote access control methods. TF3 compared different models to simultaneously configure and manage services in the RGW and home devices by multiple providers. The research led to a large number of contributions to the HGI. TF3 and TF4 co-operated on a set of test requirements for the residential gateway.

Acting on the directives of the TF3 framework, SPB specified an advanced multi-play residential gateway. A lab model was produced to demonstrate interworking between TR-69 and UPnP to manage devices in the home. The prototype was on display at BB Europe 2006. An OSGi based solution for the management of multiple services by multiple providers on a single residential gateway is being developed. While SPB is developing an industrial low cost prototype, SPD is realising a mock-up of a residential gateway following the TF3 specifications and based on a Linux platform. A first version was demonstrated during Infocom 2006.

Lab trials and testing

As already mentioned, TF4 is significantly extending the test suite of Phase I in step with the progress in various areas addressed by MUSE. After completion of test objectives in the present period, TF4 will release a document with test methods next year.

It was too early to evaluate the new concepts of Phase II this year. The subprojects still worked on the integration and testing of lab trials from Phase I, as planned. SPB evaluated its Phase I lab trial set-up in T-Systems and Telefonica I+D, both operating the IP forwarding architecture defined in Phase I. They were successfully interconnected via the MUPBED testbed and some regional networks and showed a multi-provider scenario of a video conference call via two packet-to-packet gateways. SPC started the upgrade of its multi-service Ethernet access platform in Delft and Kista. SPD realised an Asymmetric PON system operating at Gigabit speeds.

One cross SP lab trial was realised and another is well underway, both in co-operation with MUPBED. The SPB set-up in T-Systems was linked to the CWDM set-up of SPD/E in HHI, which was demonstrated during NOC 2006. Within the preparations for the second cross SP trial the lab sites of SPB in Berlin and of SPC in Kista were connected.

Figure 1: TR-69/UPnP demo of SPB and LQ&M tool of SPC on display at BB Europe.

Figure 2: CWDM demo of SPD/E at NOC 2006.

Summary and outlook

During the first year of MUSE Phase II, the project met its objectives by producing the necessary architectural extensions to support new services in a multi-service access network and support fixed mobile convergence. The project further developed the lab trial set-ups of Phase I and gave public demonstrations at Infocom, NOC, and BB Europe. The project disseminated its results via a significant number of co-signed contributions to standardisation bodies, publications and presentations at conferences, and at three MUSE "Season Schools".

During the fourth and final year of MUSE, the project will complete the consensus documents that specify the different aspects of a multi-service, multi-provider access architecture. MUSE will continue its effort to bring the concepts to standardisation bodies in order to achieve its low-cost and interoperability targets. The project will conclude Phase II with the evaluation of integrated lab trials.

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