INTEGRATING OPTICAL AND WIRELESS ACCESS NETWORKS FOR FLEXIBLE BROADBAND ACCESS DELIVERY – THE EURESCOM FREEHANDS PROJECT

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ABSTRACT

The paper gives detailed account of the EURESCOM P1015 FREEHANDS project that studied the possibilities for and potential of integrating broadband wireless drops with FSAN optical access networks and experimentally demonstrated the feasibility of the interconnection of such systems.

INTRODUCTION

Telecommunication network operators and service providers are striving to meet the increasing customer demand for broadband access, primarily for fast Internet access at present. Deploying broadband access is expensive and time consuming, therefore operators are interested in any solution that reduces both cost and deployment time.
EURESCOM project P1015 "Fibre and Radio Enhanced IntEgration in Heterogeneous Access Networks for Delivery of broadband Services" FREEHANDS was designed to support this process by investigating how to provide wireless access to a full services platform by integrating broadband wireless access (BWA) systems with Full Services Access Network (FSAN) type ATM based broadband optical access systems.
FSAN has defined a FTTx (FTTCab – Fibre to the cabinet, FTTH – Fibre to the home, etc.) network architecture based on ATM passive optical networks (ATM-PONs, APONs). The FSAN recommended drop technology is VDSL over copper pairs, where available. However, this does not preclude the use of other drop technologies and broadband radio represents an attractive option. Its use would allow the fast deployment of services where a wired access network is not readily available thus providing added flexibility. Furthermore, broadband radio has the advantage of low installation cost.
The integration of the two technologies is expected to result in an access network with media independent services. This would provide added flexibility to network operators in order that they may deploy the most suitable and economic technology in every area and reduce overall provisioning time.

CRITICAL ISSUES FOR THE INTEGRATION

In order to gain the maximum benefit from the integration of the two platforms all requirements, i.e. general high level, ATM and media specific shall be carefully reviewed to guarantee the interworking and the compatibility of the two media [1]. For example, the number of VP/VC supported should be coherent with the maximum number of terminal supported by the ONU in case of xDSL drop and in case of BWA drop. A detailed account of and discussion on the critical issues is provided in [2].

COMBINED LABORATORY AND FIELD TRIAL

The architecture we propose to integrate broadband wireless access (BWA) into an FSAN system is shown in Fig. 1.

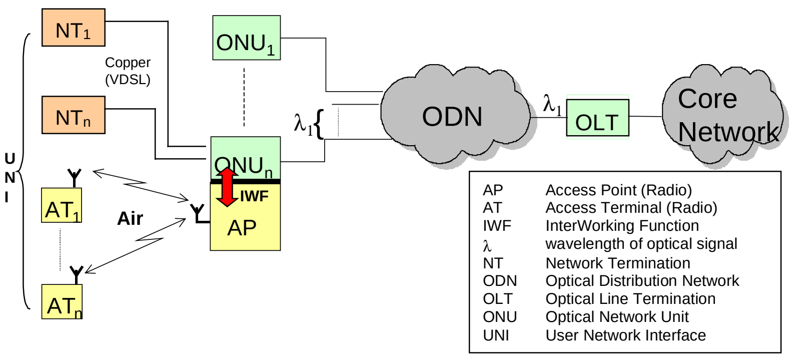

Fig. 1. BWA integration into FSAN access

We have validated the feasibility of interconnecting an FSAN APON system and an LMDS system at the ATM level through a combined laboratory and field trial. A commercially available LMDS system was used in the trial.
Fig. 2. shows the experimental platform used to test and demonstrate the feasibility of interconnection.

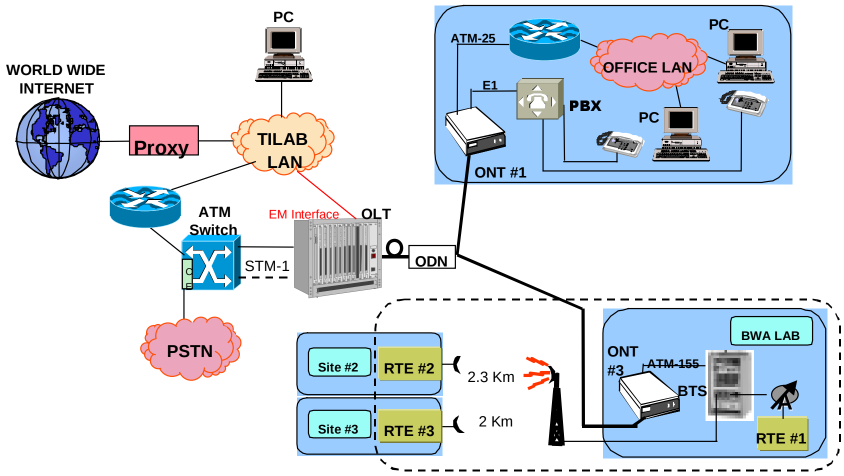

Fig. 2. The experimental platform used to test and demonstrate the feasibility of BWA FSAN interconnection

The trial was aimed to

- Verify the interoperability between the BWA and PON systems;
- Test throughput, latency and other performance parameters;
- Study the behaviour of real applications via a service trial;
- Compare QoS in the interconnected BWA FSAN system with QoS in a stand-alone FSAN system, and identify any degradation.

A promising alternative radio approach, hybrid fibre radio (HFR) was also investigated in the project to assess its performance and potential – using again a commercially available system [3,4].

TRIAL RESULTS

Our trial confirmed the reasonable interoperability of the two systems, including manageability and configurability – VPC and VCC configuration, E1 and IP configuration. Joint management of the radio and PON system was possible.
The performance of the interconnected BWA and FSAN system was found almost identical to the stand-alone radio and PON systems, except regarding latency.
The interconnected system was also tested with services. High speed Internet access, video streaming (750, 1050, 1500 and 1800 kbit/s MPEG-4 coded video streams were transmitted over 2 Mbit/s peak rate UBR ATM connection) and video conferencing (again 2 Mbit/s peak rate UBR connection) was used for the service trial. Only a slight difference in performance was found compared to the stand-alone FSAN system.

INTERCONNECTION VERSUS INTEGRATION

When implementing an access network architecture with radio drops we can distinguish between two different scenarios, two different levels of integration. The first scenario is a simple **interconnection** of existing FSAN systems with broadband point to multipoint radio systems. A second scenario is one in which the two systems are **integrated** below the ATM layer. The protocol reference models for FSAN radio interconnection and integration are shown in Fig. 3 and 4, respectively.
Integration below the ATM layer offers numerous advantages in comparison to the simple interconnection at the ATM level. These include:

- More efficient utilisation of system capacity, allocated dynamically on demand between wireless and wired connections;
- Better management of the QoS in the access;
- More efficient service provisioning and monitoring;
- SLAs can be specified and respected under a fully monitored and controlled entity.

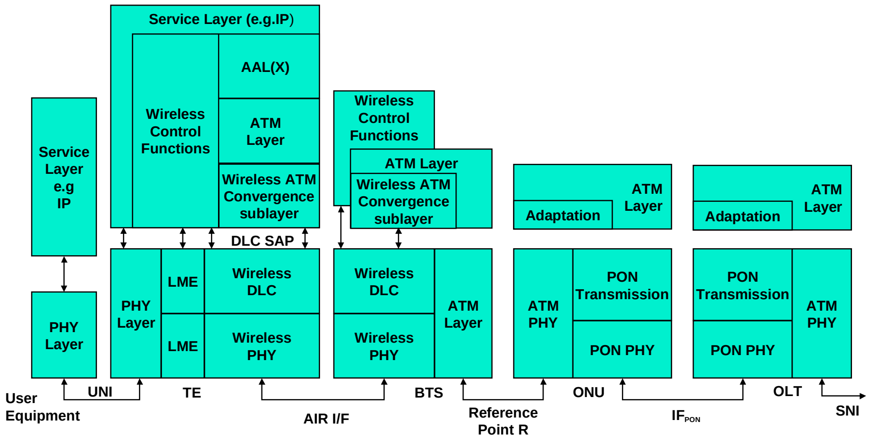

Fig. 3. Protocol reference model for FSAN APON and BWA interconnection at the ATM layer level

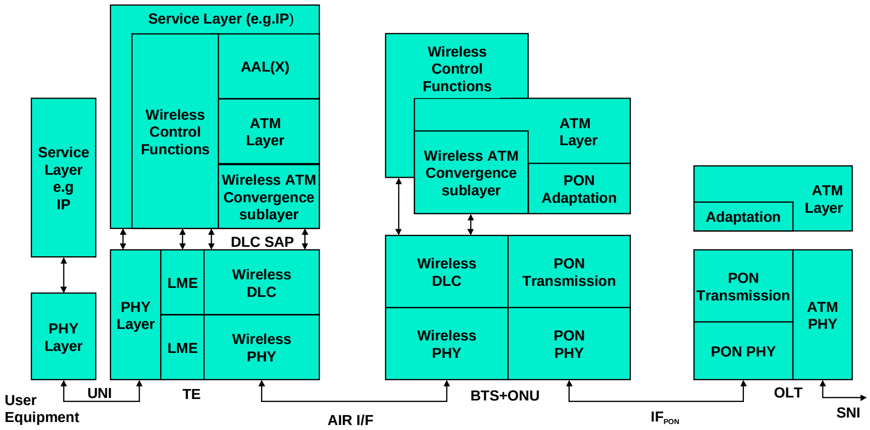

Fig. 4. Protocol reference model for FSAN APON and BWA integration below the ATM layer

The integration also offers:

- reduced complexity in the protocol stack and also in the equipment (as it is shown in Figure 3 and Figure 4);
- Simplified ATM connection management, and
- NNI to NNI connection enables the use of the 12 bits for the VPI field.

IMPACT OF INTEGRATION ON MANAGEMENT [5]

The integration of broadband wireless systems into the recommended FSAN management system requires a number of new, radio-specific parameters and functions to be supported. This is, however, only an implementation issue, and should not present any specific problem, as it is in principle the same as interconnecting wire-line systems.

The only issue that has been discovered is the use of ATM-based management interface to the Terminal Stations. Using a dedicated VP/VC interface between the Base Station and the Terminal Station will require a specific ATM path/channel set for each Terminal Station within the network that can easily amount to thousands of paths and is therefore not practical. We propose to resolve this issue by using a VP/VC between the Network Operations Centre and the Base Station, and then an embedded channel between the Base Station and the Terminal Station.

RADIO SPECIFIC PERFORMANCE MONITORING [6]

Collection of performance information should support the appropriate maintenance procedures, and also allow correlation of radio-specific ATM/IP/AAL performance information for OAM and SLA procedures. The radio specific performance monitoring functions should allow the detection of radio link performance, for example by means of received and transmitted power in a given period of time, and of MAC/DLC performance, for example detecting the number of packet data units (PDUs) discarded in a given period of time.

WIRELESS MANAGEMENT CONTROL CHANNEL (WMCC)

The Wireless Management Control Channel (WMCC) is a management information channel between the based station (BTS) and the terminal station (TS). The WMCC should be able to support the following functions:

- flows of F4/F5 functions, i.e. Continuity Check, Loopback, in case of ATM connection at the UNI interface in TS, as defined by ITU- Rec. I.610
- flow of IP specific function, if defined.

MULTICASTING

Project FREEHANDS has identified multicasting as a fundamental requirement, because multicast aware nodes (e.g. using IGMP) can save both on PON bandwidth and radio spectrum.

CONCLUSIONS

EURESCOM Project P1015 FREEHANDS has proved the feasibility of the interconnection, and potential integration of BWA and FSAN systems. Using a radio drop had only marginal impact on QoS and a wide range of services could be provided media independently.

The project has also demonstrated that a closer integration in which the FSAN APON and BWA systems are integrated below the ATM layer has a number of advantages compared to an interconnection scenario in which existing systems are simply connected at the ATM level.

An integrated architecture would provide the following advantages:

- Enhanced flexibility and fast access provisioning, service deployment in areas where a wired access network is not readily available or viable;
- Reduced deployment costs in areas of low user densities;
- Gradual introduction of radio carriers as demand for broadband connections grows. Furthermore, radio carriers can be dynamically allocated to the different users within an area, supporting a very efficient utilisation of resources.
- Re-use of existing secondary copper plant.

In summary the integration of a broadband wireless system with FSAN-APON systems gives a real benefit to network operators, since the flexibility and scalability allows deploying a broadband access network at a reduced cost.

The feasibility of interconnection, and the potential for integration was experimentally validated. Using a radio drop had only marginal impact on QoS and a wide range of services could be provided media independently.

To support the interconnection / integration we propose the following improvements:

- increase radio channel capacity;
- develop efficient ATM statistical multiplexing;
- standardise the air interface at the radio side;
- realise commercial FSAN solutions with interfaces directly supporting radio functionality;
- enable the fitting of radio equipment into the EURESCOM street cabinet.

Finally, the project made a number of proposals to the ETSI BRAN project based on its findings.

We feel that it is now the vendors turn to come to the market with such BWA systems that allow seamless interconnection or even full integration with FSAN access networks.

REFERENCES

[1] EURESCOM P1015 FREEHANDS Project Report “Integration of radio systems in the FSAN platform”, EDIN 0185-1015, http://www.eurescom.de

[2] EURESCOM P1015 FREEHANDS Technical Information “Requirements for FSAN-Radio Integration and Impacts on Cabinet Design”, EDIN 0186-1015, http://www.eurescom.de

[3] EURESCOM P1015 FREEHANDS Project Report “Broadband radio systems”, EDIN 0180-1015, http://www.eurescom.de

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[5] EURESCOM P1015 FREEHANDS Technical Information “Management and QoS issues in multi-technology access networks”, EDIN 0187-1015, http://www.eurescom.de

[6] EURESCOM P1015 FREEHANDS Technical Information “OAM specifications of broadband wireless access”, EDIN 0182-1015, http://www.eurescom.de