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1 INTRODUCTION

A liaison standardization activity within the PLUTO project is a technical dissemination activity achieved within the project that identifies, prepares and presents proposals in response to a call for technologies from the DVB standardization forum.

Furthermore, activities conducted in this standardization forum related to transmission diversity, which might influence PLUTO project developments are also considered to be informative liaison activities, as they have to be carefully followed by PLUTO partners.

It is in this context that one of the main objectives of the PLUTO project, in addition to research on broadcast transmission diversity, is to keep strong liaisons with this international standardisation body dealing with optimising transmission (i.e. DVB project) in collaboration with associate interest groups (e.g. COST 2100) and to actively contribute with proposals based on PLUTO project developments which might be useful to standardize.

Liaison activities are considered to be of great importance in order to have a strong scientific and technological impact, to open new prospects for IST and to contribute to help solving societal problems in the longer term. Liaisons with relevant EU projects and broadcast transmission researchers in Europe and worldwide are also of paramount importance and participation in concertation mechanisms and international conferences and workshops are being made.

The document is organized as follows: In section 2, work related to defining scenarios for transmission diversity is described; in section 3, work related to network discovery and handover within and between networks is described; in section 4, work related to applying transmit diversity schemes for DVB-T/H is described; in section 5, work related to solutions for the modelling of the radio propagation channel in a DVB-T/H network including diversity techniques and on-channel repeaters is described. Concluding remarks are given in Section 6.

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2 SCENARIOS FOR TRANSMISSION DIVERSITY

One of the objectives of PLUTO is to define scenarios that are suitable of demonstrating where transmit diversity is of benefit covering the following situations:

1. In a city or town where there is no direct line of sight from the broadcast transmitter
2. On a motorway where line of sight is obscured by bridges, hills, other cars, forests etc.
3. In a rural environment where line of sight transmission is obscured by hills, forests etc.
4. Indoor environment where line of sight transmission is obscured by walls and buildings.

The PLUTO project has produced, and submitted to the Commission, Deliverable D2.1 titled “Service Scenario and System Definition”. This deliverable considers first high level services from by characterizing the DVB platform, especially the DVB-H system, which is main target of the project. This follows by the taxonomy of broadcast services with respect to their content and suitability to different categories of consumers. Next the system services scenarios are considered for various diversity schemes to be investigated in the PLUTO project. The resulting comprehensive analysis of service categories for the PLUTO project is presented in this deliverable.

This deliverable has a strong impact in deciding which scenarios to analyse theoretically, test in the laboratory with an emulated radio channel and test in the field when reporting to the DVB project on transmit diversity.

3 NETWORK DISCOVERY AND HANDOVER

A further objective of the work will be to investigate how a service management system should be enhanced to enable handover of mobile broadcast multimedia services between technologies such as 3G and DVB and between transmitters. It is postulated for this project that the decision of a terminal to select a particular broadcast service over a particular access medium depends on not just current network connectivity but also on estimated robustness for a particular type of mobility and reception scenario. It is envisaged that network descriptors and end-to-end QoS agents will be required to access and report on low level quality of service data from end-user terminals.

The PLUTO project has produced, and submitted to the Commission, Deliverable D2.2 titled “Prototype Network Selection and Handover Algorithms”. This deliverable considers network discovery and handover for mobile broadcast. Network discovery means how the terminal finds a network in a specific location. Handover means how the terminal keeps delivery of content when changing location beyond the range of single transmitter. Handover and network discovery are critical for user satisfaction and service acceptance. Robust solutions to these problems are very much desired.

In the PLUTO project, a novel technique for network and service discovery in heterogeneous broadcast environment called Universal Network and Service Discovery (UNSD). It is an extension to the DVB-H ESG concept and can be applied both to mobile and stationary broadcast systems. Moreover, the UNSD is backward compatible with the original DVB-H ESG. The UNSD enables the unification of content, service and network description in a heterogeneous environment. It makes the discovery faster and easier as the UNSD allows acquiring full information about the entire broadcast network environment from a single instance of UNSD. New methods were proposed for utilizing location and positioning information system by overlaying coverage and access information of networks on GeoMap data. Finally algorithms (decision and manager) were designed for making best used of the heterogeneous environment and to enable fast handover between broadcast networks.

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4 TRANSMIT DIVERSITY SCHEMES FOR DVB-T/H

A further objective of the work is to discover if Transmit Diversity can improve non line of sight reception provided multiple signals are received with decorrelated fading, and that the receiver can effectively process the signals to its advantage. The measurable objectives of the Transmit Diversity part of this project are to:

1. Identify suitable Measurement metrics and diversity schemes. (M4.1)
2. Produce experimental monitor receiver equipments (M4.2)
3. Identify how diversity can be implemented and produce experimental diversity equipments. (M4.3)
4. Measure best-case performance under simulated conditions. (M3.1)
5. Confirm that receivers will process the diverse signals. (M3.2)
6. Evaluate performance of transmit and receive diversity working together (M7.3)
7. Evaluate performance in field environment and identify best ways to ensure uncorrelated fading achieved (M3.3)

The PLUTO project has produced, and submitted to the Commission, Deliverable D4.1 titled “Report on Measurement Metrics and Theoretical Diversity Modelling”. This deliverable presents and discusses results applying transmit diversity schemes for DVB-T. The main standard compliant diversity schemes are presented. These are delay diversity, cyclic delay diversity and phase diversity all of which enhance diversity in the frequency domain. Additionally schemes are presented which could be used to enhance time diversity, like Doppler diversity and discontinuous Doppler diversity. The performance of these diversity schemes is presented in Ricean and Rayleigh channel for various environments.

This work has been presented to the DVB-T2 technical module within DVB project, which has reacted to this contribution by requesting that the PLUTO projet prepare a response to the call for technologies on DVB-T2. An initial draft has been prepared and was presented at the DVB-T2 Eindhoven meeting on 21st / 22nd February 2007 [1].

The PLUTO project has produced, and submitted to the Commission, Deliverable D4.2 titled “Experimental Receiver Equipment”. This hardware deliverable provides a modified set top box receiver to be used for field measurements. This equipment will be useful for monitoring the performance of Transmit Diversity over long periods of time to ascertain the effects of the weather and seasons. The results of this work will be presented to the DVB-T2 technical module.

The PLUTO project has produced, and submitted to the Commission, Deliverable D3.1 titled “Simulation Lab Facility and test Report”. This deliverable provides a description of the design construction and measurement processes for the diversity broadcast experimental test equipment. The results of this work will be presented to the DVB-T2 technical module when it is completed.

The PLUTO project has produced, and submitted to the Commission, Deliverable D3.2 titled “Final Backwards Compatibility Report with results of testing”. This deliverable provides a description of the likely performance of Set Top Boxes, which might receive pre-echoes if Transmit Diversity is deployed. This situation occurs when a delayed signal from one of the transmitters is at a higher RF level than an un-delayed signal. The objective of these tests is to identify if existing Set Top Boxes currently being used can process these pre-echoes and if not to what extent it would be a problem. The results of this work may be of interest to the DVB-T2 technical module and can be presented to them at an appropriate time when it is completed.

The PLUTO project has produced, and submitted to the Commission, Deliverable D7.1 titled “Experimental Diversity DVB-H Receiver”. This deliverable provides the world’s first DVB-H diversity receiver, which if connected to a PC, can analyse and compare the performances of single and diversity receivers. These results canbe combined with the diversity transmission results to obtain overall MIMO system performance for DVB, which can be reported to DVB-T2.

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5 MODELLING OF THE RADIO PROPAGATION CHANNEL FOR DVB-T/H

Once the effects of these techniques have been evaluated, their impact on network design and cost of network rollout will be evaluated. Example networks will be designed using both the traditional broadcast model of few large high power transmitters and the cellular model of many small lower power transmitters with and without the diversity and repeaters. Networks will be designed for a variety of scenarios including extreme rural, mountainous and urban regions. Costs and complexity of each network design will be investigated and published in a reference document. The measurable objectives of this work will be:

1. Identify impact of new techniques and defined scenarios on radio planning tool requirements. (M6.1)
2. Develop new propagation models and incorporate within radio planning tool (M6.2)
3. Produce a prototype planning tool based on a modified Volcano Technology for use in future network design. (M6.2)
4. Measure effectiveness of transmit diversity in terms of diversity gain and publish in network design guidelines. (M6.3)
5. Measure effectiveness of mini on-channel repeaters compared to traditional repeaters measured in terms of network coverage and use of spectrum. (M6.3)
6. Produce comparison of modelled network costs with and without transmitters and repeaters. (M6.3)
7. Produce and publish network design guidelines. (M6.3)

The PLUTO project has produced, and submitted to the Commission, Deliverable D6.1 titled “Report on Impact on propagation models”. This deliverable presents solutions for the modelling of the radio propagation channel in a DVB-T/H network including diversity techniques and on-channel repeaters. This document provides also requirements for the trials (measurement campaigns) and the evaluation of the diversity performance. The results of the propagation channel prediction and how this impacts all radio network simulation results, like the cover area, the capacity and the quality of service (QoS) will be developed in close collaboration with COST 2100 interest group and presented to DVB-T2 technical module at the appropriate time.

6 CONCLUSIONS

Liaison activities are very important for the PLUTO project. Particular attention has been paid to liaison activities with standardization bodies such as DVB and many PLUTO partners participate in these standardization activities. Presentations have been made into the DVB-T2 technical module to introduce the overall PLUTO technical activities. In addition as PLUTO has developed transmit diversity techniques, special emphasis is being put preparing a contribution to the DVB-T2 Call for Technologies. Results and publications from other projects related to diversity have been followed although no relevant activity has been found in DVB-T standards compliant transmit diversity.

PLUTO intends to continue contributing to standardization bodies. The research activities done so far in the project and the very important liaisons established by PLUTO partners with DVB assure that transmit diversity for broadcasting and its impact on radio network planning may have an important impact on future standardization activities.

7 REFERENCES

1. John Cosmas, Jonathan Loo, Yue Zhang, Armin Damman, Ronald Raulefs “Input to Call for Technology for DVB-T2: Transmit Diversity Schemes” First Draft, Eindhoven, 21st February 2007.