SMART ANTENNA & RADIO FOR ACCESS AND BACKHAUL FOR ADVANCED NETWORK NODES

SPECIFIC TARGETED RESEARCH PROJECTS			
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ABSTRACT

This document defines the plan for actions and activities that will be taken to disseminate and use the knowledge and results obtained in the SARABAND project. In particular, this deliverable is an updated of the deliverable D8.2 and includes the dissemination activities performed during the second year of the project.

KEYWORD LIST

Dissemination, Use plan, Website, Dissemination Material

EXECUTIVE SUMMARY

This deliverable gathers the Dissemination and Use Plan for the SARABAND project. The dissemination and use plan describes the general approach for dissemination of knowledge gained during the course of the SARABAND project and the plans to use the results of research activities.

The SARABAND dissemination plan and the overview of the dissemination achievements within the first project year have been presented in deliverable D8.2 - Dissemination and Use Plan (version 1). The current deliverable is a follow-up of the deliverable D8.2 with an overview of the project's dissemination activities in the second year.

This document is structured as follows. The SARABAND approach to dissemination is explained in Section 2. An overview of the project publications in conferences, journals and meetings is given in Section 3 along with brief description about the interaction with other relevant European research projects and standardization bodies. An updated use plan regarding the project results is presented in Section 4.

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LIST OF ABBREVIATIONS

ATTM	Access, Terminals, Transmission and Multiplexing
BWA	Broadband Wireless Access
CAPEX	Capital Expenditure
CSPA	Circular Switched Parasitic Array
EC	European Commission
EU	European Union
FS	Fixed Service
FTTH	Fiber To The Home
HDI	High Density Interconnect
HSDPA	High Speed Downlink Packet Access
IC	Integrated Circuit
ICT	Information and Communication Technology
ISP	Internet service providers
M	Month
MAC	Medium Access Control
Mbps	Megabits per second
MEMS	Microelectromechanical systems
MIMO	Multiple-input Multiple-output
mm	Millimetre
MNO	Mobile Network Operators
MWS	Multimedia Wireless Systems
OPEX	Operating Expenditure
PCB	Printed Circuit Board
PHY	Physical Layer
PMP	Point-to-Multipoint
LTE	Long Term Evolution
RF	Radio Frequency
Rx	Receiver
SIP	System in Package
Tx	Transmitter
TRx	Transceiver
WiMAX	Worldwide Interoperability for Microwave Access
WP	Work package

1. Introduction

The demand of bandwidth in mobile communication is growing exponentially day-by-day, as the numbers of users have been increased drastically over the span of last five years. The next generation wireless communication systems therefore need to be of higher standards, so as to support various Broadband wireless services such as, video conferencing, mobile videophones, high-speed Internet access and so on. Then, as newer technologies and newer bandwidth-intensive applications are used, the need for a technology to transport the bandwidth from the point of access to the core of the network will rise swiftly. In this context, millimetre wave technology, especially in the Q-band, fits nicely into these new backhaul scenarios and can bring large capacity with high throughputs, fast deployment and discrete equipment. Actually, the SARABAND project aims at taking advantage of the Q-band frequency in a cost effective way to provide higher performing and integrated network nodes for wireless backhaul of future mobile radio and last mile access by developing smart antennas and front-end radio modules.

The SARABAND project will focus on the development of low profile high gain and programmable multi-beam Q-band antennas, and on the development of miniaturized radio module based on new substrate, new packaging and interconnection process in Q-band frequency. This approach will enable operators to capitalize on the massive bandwidth available in the EU regulated Q-band (40,5-43,5 GHz) for future wireless backhaul, as well as last mile access to bridge the digital divide in a most cost-efficient, easily deployable and energy efficient way.

The SARABAND project will address this issue by creating state of the art, smart, high gain & agile Q-band antennas with miniaturized Q-band radio head inside. To this end, SARABAND will handle the following concepts:

- The first SARABAND project concept is to leverage the EU regulated Q-band (40,5-43,5 GHz) to help overcome the digital divide for next generation mobile backhaul.
- The second concept of the SARABAND project is to exploit sub-wavelength Lens and Switched Parasitic Array technologies to design small form factor, programmable, high gain, multi-beam antennas, in order to achieve low cost production and performance "beyond state of the art".
- The third concept of the SARABAND project is to exploit new packaging and interconnection solutions with the latest process technology to provide Q-band radio head modules with low loss, high power and high reliability at a fraction of the price of any available radio today.
- The fourth concept of the SARABAND project is to integrate innovative miniaturized steerable antennas with advanced Q-band circuits to produce small, low cost novel network systems with outstanding performance and high-energy efficiency.

Thanks to SARABAND breakthroughs in hardware design (multi-beam, programmable and reconfigurable antennas) and network capabilities (very low spectral pollution due to multi-beam antenna and Q-band frequency), the products developed in the SARABAND partnership will bring a competitive alternative to actual technologies for two vast markets (commercial backhaul and residential access), while ensuring important cost savings, accelerate deployments, and boost subsequent indirect the economy.

SARABAND addresses a highly innovative approach to improve the global efficiency of wireless backhaul networks systems, which extends the current state-of-the-art. It is expected that important

scientific and technological research results will be obtained within SARABAND so that raising awareness among the public will strengthen the impact of the proposed technologies. Therefore, within SARABAND dissemination is an important activity. The project results will be disseminated to the target audience in several ways:

- Maintaining a project internet website for dissemination of results.
- Presentation of results to the scientific community and industrial community.
- Contributions to standardization, research forums and other fora.
- Press releases about objectives and achievements within SARABAND.
- Cooperation with other FP7 projects.
- Organization of workshops addressed to industrial community.
- Demonstration events, which show applicability and improvements of the SARABAND technology.

The dissemination and use plan followed by SARABAND consortium will be described in next sections. The dissemination plan gives an overview of the SARABAND dissemination means and describes how the exchange of results and knowledge among the partners, with related European projects, with the scientific community and with standardization bodies and other fora, will be handled. On the other hand, use plan provides a view of the expected results from research activities and how these research activities will be exploited.

2. SARABAND Dissemination Approach

2.1. Dissemination objectives

The aim of dissemination is to create the critical mass of interest necessary for the deployment, on the target scale, of the results of the project. The dissemination activity has the following objectives:

- To share the technical results of the project with the scientific community interested to the topics addressed by the SARABAND project, in order to promote the research and receive useful inputs from other scientists and International Communities.
- To improve the knowledge of SARABAND results in the industrial community as a basis to create new opportunities for building quality products and services.
- To attract potential customers and generate expectation towards the project results, in order to prepare its exploitation.
- To identify additional potential application fields, customers and business opportunities based on the reactions to the dissemination activity.

2.2. General approach to dissemination

For the SARABAND consortium the dissemination of information and results is an important part of all project activities. An efficient dissemination is necessary to establish fruitful discussions with various users and target groups. These discussions are an important basis to achieve a feedback from users and target groups, which is an added value for project work. Therefore the strategy in the SARABAND project is to establish a concurrent dissemination as an integral part of project work.

According to this strategy, dissemination activities have been planned right at the beginning of the project to ensure an effective and timely dissemination of the project results to potential users, both at the European level and world-wide, and to stimulate the exploitation of the SARABAND results by industry and standardization bodies. The relevant dissemination activities will be run in parallel to the more technical research activities and these activities will be extended step by step during the duration of SARABAND project.

To establish an efficient dissemination it is important to meet the needs of each individual target group. The main targets of the dissemination activity are industry, technical and scientific audience, target customers such as telecom operators, interested public and standardization bodies working on definition of Multimedia Wireless Systems (MWS) in the Q-band. Moreover, since the European Society as a whole will ultimately benefit from the results of the project (in terms of offering new services with high added value such as e-learning, e-health, etc), special measures have been planned to reach the wide-public.

Dissemination to industry, research institutions and standardization bodies, as well as to European citizen, has been, and will further be, carried out by a variety of means:

- Talks at relevant international conferences, events and forums (both presenting the technical achievements and introducing at a high level the project objectives and results).
- Publication of papers in proceedings of international conferences and events, as well as in international scientific journals.
- Organization of workshops on project-related topics, including "project workshops" addressed to external experts, professionals, and target customers.
- Management of a publicly available website that includes descriptions of the main project results.
- Press releases describing the advancement and main results of the project, so to reach and make the public aware of both the short-term and long-term impact of the project results.
- Preparation of promotional material to support the dissemination activity (newsletters, flyers, posters, etc).
- Liaison with other projects.
- Contribution to standardization bodies.

The description of the dissemination activities planned during the course of the project will be detailed in next section.

2.3. Dissemination strategy by individual SARABAND partners

Dissemination strategy by partner summarizes how each partner contributes to reaching the target audiences, their proposed strategies and a specific set of actions to be performed.

2.3.1. THALES Communication and Security (TC&S)

The participation of TC&S in dissemination activities is split up in two main directions:

The first one, dedicated to industrial activities into Thales Group and particularly Thales Communications and in relation with BLUWAN to promote SARABAND applications among Thales

Community and operators Community. This section of Thales contribution to dissemination is focused on sharing progress and results of SARABAND in:

- Thales C&S Intranet events and report.
- Thales Intranet Community.
- Technical Approach for new products inside Thales C&S.
- Cooperation with BLUWAN for Operators demonstration.
- Cooperation with BLUWAN to Congress

The second one, in refereed in section 3, and with the other participants, is a contribution to all the actions dedicated to dissemination activities. They will be focused on:

- Contribution to Public website.
- Contribution to papers or news on SARABAND progress and results.
- Contribution in events (Congress, Forum).
- Cooperation with other EU projects.
- Contribution in workshops related to SARABAND project.

2.3.2. Bluwan

Bluwan is aggressively promoting the SARABAND activities along with its backhaul system that was launched at Mobile World Congress in Barcelona earlier this year (February 2012).

- The SARABAND deliverables are promoted as part of our product roadmap to:
  - Our partners: Globecomm Systems (US, Africa), Giza Systems (Middle East), GDS Technologies (Africa), Somcable (Africa)
  - Operator Prospects: UK Broadband, MLL Telecoms, FT-Orange, Everything Everywhere, Vodafone Group, SuperOnline/Turkcell, Etisalat, Du, STC, Telkom ZA, MTN, Vodacom, Reliance
  - At exhibitions & events such as Mobile World Congress, LTE World Summit, Layer 123 Packet Microwave & Backhaul Forum, and Africacom, among others.
  - Industry Analyst Briefings: ABI Research, Exelixisnet, Maravedis, Strategy Analytics, Senza Fili Consulting, Heavy Reading, Rethink Wireless, Informa, etc.
  - In articles in relevant Telecommunications/Industry media: All Bluwan relevant articles are cross posted at: http://bit.ly/VmabxZ
- Contribution to dissemination material (public website, statements, papers, and articles) from the SARABAND forum.

2.3.3. ONERA

ONERA will contribute to the dissemination activities by:

- Giving feedback, opinion and advice regarding the layout and content of dissemination materials produced during the SARABAND project (public website, brochure, newsletters, etc).

- Providing support to the creation and production of dissemination material. For example, the support may consist of producing illustrations and part of text used in the website, brochures or other dissemination materials.
- Publishing technical results regarding to antenna technologies studied in the SARABAND project.
- Participating and attending to international workshops and conferences to disseminate the technical results.
- Participating to the workshop related to the SARABAND project.

2.3.4. Fraunhofer (FHR)

With respect to the dissemination strategy Fraunhofer FHR will focus its self-contained activities on the publication of scientific results achieved in the course of the development of a multi-beam Q-band antenna with wide angle electronic beam steering capability based on the circular switched parasitic array (CSPA) antenna approach as defined in WP4. Of course, in the introduction and conclusion sections of these publications reference to the intended application and the SARABAND project (including the SARABAND web-site) will be made. Additionally, Fraunhofer FHR is always willing to contribute with dedicated sections to publications initiated by other consortium partners.

2.3.5. THALES Research and Technology (TRT)

As a corporate and transverse laboratory, Thales Research and Technology will disseminate their results both outside and inside Thales, especially towards the microwave and RF communities. This will be done by the usual means: participation to conferences, workshops, publications, scientific exhibitions open to the scientific community and also through specific internal workshops and exhibitions organized inside Thales either for the Thales community (Techno-days, Journées de Palaiseau, "R and T" days) or customers.

2.3.6. Systrel SAS

Along the lifetime of SARABAND project, Systrel SAS will acquire new technological knowledge of interconnections and brazing or gluing of components for the applications in the field of the Q-band frequency. This knowledge will be disseminated inside Systrel SAS for training the staff on these new activities and new equipment; and on the other hand, the project results in Q-band modules will be spread among customers and other potential users in order to be recognized as manufacturer qualified for Q-band modules.

2.3.7. Universitat Politècnica de Valencia (UPVLC)

UPVLC will participate in all dissemination activities refereed in section 3, with special focus on sharing the research results of SARABAND with the scientific audience. Our challenge is also to address the general public. Namely, the dissemination activities will be focused on:

- Creation and maintenance of public website.
- Design and production of dissemination material.
- Contribution to the dissemination of scientific and technical results of the project through publications in the most relevant international conferences, journals and workshops. As WP7 member, UPVLC will also participate in trials and demonstrations of the wireless network platform developed by SARABAND project.

- Cooperation with other EU projects. When appropriate and in close collaboration with the SARABAND consortium UPVLC will exchange information and cooperate with other EU-projects.
- Organization of a workshop in topics related to SARABAND project.
- Close monitoring of the developments in the standard communities in order to present where and whenever appropriate the SARABAND approach, results and the SARABAND input to standards.
- Internal dissemination of SARABAND contents and results.

2.3.8. Fibernova (FIB)

The dissemination activities of FIB will be mainly focused on the results of the field trial demonstration task at the last year of the project and the interaction with potential users of the SARABAND technology. Namely, these activities will consist of:

- Dissemination of the project field-trial results. For that purpose a live "open house" like demonstration will be scheduled during one week of the field-trial being held at the UPVLC campus. The demonstration will be aimed to the potential users of the SARABAND technology, who will be invited to attend the event. Also, a day in which the open house is available for the general public will be considered.
- Inquiries and contact with the potential users of the SARABAND technology informing about the project technology and results.
- Contribution to the workshops organized during SARABAND project, specifically regarding the field-trial status and results.
- Attendance to conferences and workshops related to the SARABAND results.
- Internal dissemination of the project progress.

2.3.9. ORTEH

ORTEH will participate in all dissemination activities refereed in section 3 and initiated by other partners, with special focus on sharing the research results of SARABAND with the scientific audience. Namely, the dissemination activities will be focused on:

- Active contribution to the dissemination of scientific and technical results of the project through publications in the most relevant international conferences, journals and workshops.
- Cooperation with other EU projects. When appropriate and in close collaboration with the SARABAND consortium ORTEH will exchange information and cooperate with other EU-projects.
- Internal dissemination of SARABAND contents and results through the Project's www page and through direct communication with partners.

3. Description of Dissemination Activities

During the first year of SARABAND project dissemination activities were focused on the introduction at a high level of the project objectives and developed technologies to the potential user and expert groups. During this second year, papers explaining the technical progress of SARABAND project in terms of the development of antennas and RF modules at Q-band have been submitted to journals

and conferences. However, the strongest impact for the dissemination of results will be the demonstrator for the wireless network platform incorporating the building blocks developed at the SARABAND project. Therefore, the dissemination activities will increase during the last year of the project.

The dissemination activities performed in SARABAND project are detailed below.

3.1. Public Website

From the initial stage of the project, SARABAND public website has been established at www.sarabandfp7.eu. The SARABAND public website is intended to provide a vision of the project to the general public and to facilitate the spread of project outcomes to different stakeholder groups such as the European industry and the operators of fix and mobile communications. The public website is the core element of the external communication strategy of SARABAND project and the specific purpose of the site is to:

- Raise awareness about the project activities.
- Inform about the aims, the on-going research, and the achievements performed.
- Engage feedback from the community.
- Promote the exploitation of the results.

The website is a dynamic environment to which information will be added as it becomes available. During Year 2, UPVLC has been updating on a regular basis SARABAND website with news, content and documents related to the project activities during this period. In particular, the achievements obtained in each work package have been published. Moreover, SARABAND publications, public deliverables, interesting documents addressing topics related to the project, and newsletters have been uploaded to the website. Finally, the section "News and Events" contains some links to recent news and a list of upcoming events.

Within this task efforts have been devoted to the enhancement of the project visibility through the SARABAND website and through appropriate mailing-lists for distributing the news of the project (including the newsletter issues). Actually, UPVLC uses a free web tracker (www.statcounter.com) capable of providing real-time web statistics. A variety of statistics is available including access to the website, use of each webpage, information about the site visitors and technical details. This data is used by UPVLC for assessing the website visibility, identifying its most popular webpages, and optimizing its design for improved user experience. Two specific examples of the available statistics are described below:

- **Visitor counter**: Figure 1 depicts the visitor counter of the site. The number of visitors within Year 2 is amounted to 1729 compared to 1564 for the Year 1. Moreover, the number of first visitors has increased from 346 to 629. These figures indicate the increasing visibility of the project during the second year.
- **Visitor map**: Figure 2 illustrates the geographical distribution of the website visitors revealing that in addition to the expected visits from Europe there have been additional visits from America, Middle and Far East as well as from Oceania. Should be noted that compared with previous year, the website presence has spread all over the world, increasing the visitors in America and Asia.

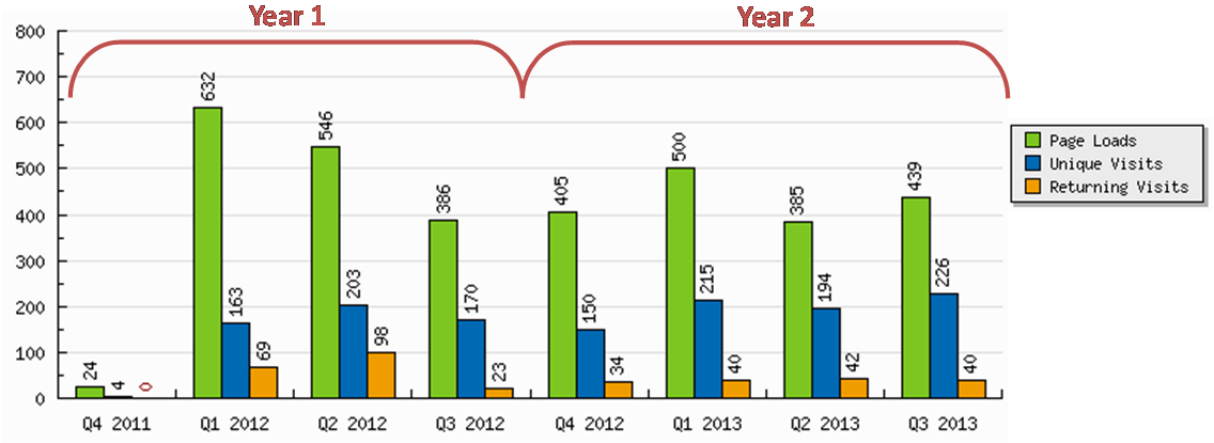


Figure 1. Number of visitors during Year 1 and 2

Figure 2. Recent visitor map of SARABAND website (from July to September, 2013)

3.2. Dissemination material: brochure, poster, newsletters

At the beginning of the project, a general purpose brochure was created to introduce SARABAND project and to provide a general description. The main intention of the brochure was to direct the interested people towards the SARABAND website, where more in-depth information can be found, and where the latest achievements and public deliverables of the project are available. During the second year, a new brochure has been created with the aim of presenting the technical progress obtained in the project (see Annex 1).

Posters are a well-recognized way to present both the partial and final results of a project. SARABAND will use posters to inform at national and international conferences or workshops about the aims and results of the project. During the second year, a poster with the latest achievements of the project has been created (see Annex 2).

The production of a newsletter was planned as part of the dissemination activity of SARABAND project. The newsletter is targeted to "interested, non-technical people" and provides a brief overview on the progress of the project. Up to now, the following issues have been edited:

- *Issue 1 – September 2012*
- *Issue 2 – April 2013*
- *Issue 3 – October 2013*

All SARABAND newsletters are available on the website.

3.3. Attendance at Conferences and other Events (seminars, forums, workshops)

During the first and second year, the SARABAND project and its results have been presented at scientific meetings, conferences, and forums. Next table shows the conferences or other events in which SARABAND consortium has participated.

Table 1. Past dissemination events attended by the consortium

Past Dissemination Events				
Event/Conference	Venue / Date	Description (Subject)	Nature of dissemination*	Partner involved
Mobile World Congress	Barcelona, Spain, February 28, 2012	World's largest exhibition and conference for the mobile industry	Exhibitor; Promotion of the SARABAND activities along with its backhaul system	BLUWAN
Mobile World Congress	Barcelona, Spain, February 28, 2012	World's largest exhibition and conference for the mobile industry	Distribution of SARABAND brochure; Inquiries to potential users	FIB
Transport Networks for Mobile Operators (TNMO)	Berlin, Germany April, 2012	TNMO is EMEA's leading specialist forum for mobile backhaul, RAN and core transport networking professionals.	Sponsor, Chair and Exhibitor; Panel participation, presentation and chaired Day 2 of this event	BLUWAN
LTE World Summit	Barcelona, Spain May 22-24, 2012	The conference is focused on LTE	Delegate; Promotion of SARABAND project	BLUWAN
European Conference on Network and Optical	Barcelona, Spain June 20-22,	The goal of the conference is to present high-quality results in the	Distribution of SARABAND brochure	UPVLC

Communications	2012	field of communication networks. EU Project Panel		
RF MST CLUSTER Meeting	Antalya, Turkei July 02, 2012	The conference presents Innovations on RF	SARABAND Presentation	
Layer 123 Packet Microwave & Backhaul Forum	London, UK October, 2012	The forum is focused on expanding the Role of Microwave in LTE Applying Microwave to Small Cell deployments	Sponsor and Exhibitor; Promotion of SARABAND project	BLUWAN
Workshop on multi-beams antennas	Palaiseau France, October 2012	Internal THALES workshop involving THALES Alenia Space and THALES Communication & Security.	SARABAND multi-beams lens antenna concepts and preliminary results presentation	TRT
Africacom	Capetown, South Africa Nov, 2012	AfricaCom is the most important fair for communications in Africa	Exhibitor; Promotion of SARABAND	BLUWAN
49th Journée de Palaiseau	Palaiseau, France, December 2012	Internal THALES conference	SARABAND lens antenna concepts and preliminary results presentation	TRT
Mobile World Congress	Barcelona, Spain, February 25-28, 2013	World's largest exhibition and conference for the mobile industry	Exhibitor; Promotion of the SARABAND activities along with its backhaul system	BLUWAN
Mobile World Congress	Barcelona, Spain, February 25-28, 2013	World's largest exhibition and conference for the mobile industry	Inquiries to potential users	FIB
Microwave & RF	Paris, France April 10-11, 2013	Le salon des radiofréquences, des hyperfréquences, du wireless et de la fibre optique	Technical presentation and organization of panel session on backhaul	BLUWAN
Antenna Workgroup meeting	Palaiseau, June 2013	Internal THALES meeting involving people from the antenna community.	SARABAND lens antenna concepts and preliminary results presentation	TRT
Small Cell Backhaul Summit	London, Uk June 4-6, 2013	The largest small cells event in the telecoms industry. The event attracted over 700	Technical presentation; Sponsor	BLUWAN

		visitors from around the world and over 40 exhibiting companies.		
RF MST Cluster Meeting	Potsdam, Germany July 1, 2013	The conference presents Innovations on RF	Technical presentation	TC&S
Future Network & Mobile Summit	Lisbon, Portugal July 3-5, 2013	It addressed the challenges of building the Future Internet Infrastructures, based on mobile, wireless and fixed broadband communications technologies.	Technical presentation	UPVLC
IEEE Antennas and Propagation Symposium	Orlando, US July 7-13, 2013	The goal of the conference is to present high-quality results in the field of antennas and propagation	Promotion of SARABAND project	ONERA
Conference on Antennas and Propagation in Wireless Communications	Torino, Italy September 9-13, 2013	The conference presents Innovations on antennas for wireless communications	Technical presentation	UPVLC
Layer 123 Packet Microwave & Backhaul Forum	Düsseldorf, Germany September 23-25, 2013	European largest forum for mobile Backhaul	Technical presentation; Participation in panel session; Sponsor	BLUWAN
Africacom	Capetown, South Africa Nov 12-14, 2013	AfricaCom is the most important fair for communications in Africa	Exhibitor	BLUWAN

*Note: Presentation of project, Brochure distribution, technical presentation, poster, publication, establish contact with target users, etc

For next year, some events have been identified by the consortium as opportunities to disseminate SARABAND project results and to perform a continuous liaison and clustering activities:

Table 2. Future dissemination events

Future Dissemination Events			
Event/Conference	Venue / Date	Description (Subject)	Nature of dissemination*
Mobile World Congress	Barcelona, Spain February 24-27, 2014	World's largest exhibition and conference for the mobile industry	Distribution of SARABAND brochure
European Conference	The Hague,	The goal of the conference is to	Technical

on Antennas and Propagation	The Netherlands April 6-11, 2014	present high-quality results in the field of antennas and propagation.	presentation
Future Network & Mobile Summit	Bologne, Italy July, 2014	Future Network and Mobile Summit addressed the challenges of building the Future Internet Infrastructures, based on mobile, wireless and fixed broadband communications technologies.	Presentation of SARABAND project results
IEEE Antennas and Propagation Symposium	Memphis, US July 6-12, 2014	The goal of the conference is to present high-quality results in the field of antennas and propagation	CSPA Antenna presentation; Paper and presentation of Fabry-Perot antenna
Journées Caractérisation Microondes et Matériaux (JCMM)	Nantes end March 2014	French National Conference on Microwave passives in alternance with actives (JNM)	SARABAND presentation focused on Antennas
European MicroWave Week (EuMW)	Rome, Italy October 5-10, 2014	The European Microwave Week focuses on the latest trends and developments in the field of design and application of microwaves, RF/mm-wave microelectronics and radar	Distribution of SARABAND brochure

3.4. Publications of Papers in Conferences and Journals

Through the duration of the project, SARABAND partners will disseminate the obtained results and knowledge to the relevant scientific communities. This will be done by contributing through papers and presentations to scientific meetings, conferences, workshops and journals in the field. Below is a list of the SARABAND publications during this period.

- S. Sanyal, "Backhaul elasticity for unlimited demand in a Het-Net world", *Globecomm Tech Forum*, New York, US, May 2012.
- F. Magne, "Le backhaul du LTE une chance pour les hyper", *Microwave & RF*, Paris, France, April 2013.
- S. Sanyal, "Next generation backhaul strategies for the pragmatic deployment of small cells", *Small Cell Backhaul Summit*, London, UK, June 2013.
- R. Vilar, O. Bosshard, F. Magne, A. LeFevre, J. Marti, "Wireless Backhaul Architecture for Small Cells Deployment exploiting Q-band Frequencies", *Future Network and Mobile Summit*, Lisbon, Portugal, July 2013.
- R. Vilar, J. Marti, O. Bosshard, F. Magne, A. LeFevre, "Point to Multipoint Backhaul Architecture for 3G/4G Networks and Small Cell Deployment", *Topical Conference on Antennas and Propagation in Wireless Communications (APWC)*, Torino, Italy, September 2013.

- A. Cauvin, "Using field-proven Gigabit Point-to-Multipoint to deliver in a Het-Net environment – operator case studies", *Layer 123 Packet Microwave & Mobile Backhaul*, Düsseldorf, Germany, September 2013.
- R. Vilar, R. Czarny, M. Sypek, M. Makowski, C. Martel, T. Crépin, F. Boust, R. Joseph, K. Herbertz, T. Bertuch, A. LeFevre, F. Magne, J. Marti, "Smart Antennas and Front-End Modules in Q-band for Backhaul Networks", submitted to *Microwave Journal*, 2013.
- R. Vilar, R. Czarny, M. Sypek, M. Makowski, C. Martel, T. Crépin, F. Boust, R. Joseph, K. Herbertz, T. Bertuch, J. Marti, "Q-band millimetre wave antennas: an enabling technology for multi-gigabit wireless backhaul", submitted to IEEE Microwave Magazine, 2013.
- R. Vilar, A. LeFevre, F. Magne, J. Marti, "Elastic millimeter wave backhaul architecture for small cells and heterogeneous environments: the SARABAND project", submitted to IEEE Communications Magazine, 2013.

Find below a tentative list of publications for Year 3:

- *Paper about CSPA Antenna,* IEEE Transactions on Antennas and Propagation or IEEE Antennas and Wireless Propagation Letters.
- *Paper about Fabry-Perot antennas,* IEEE Transaction on Antennas and Propagation or IEEE Antenna and Wireless Propagation Letters.
- *Paper about Sub-wavelength structured lens antennas,* IEEE Antenna and Wireless Propagation letters or Electronics Letters.
- *Paper explaining the use cases for SARABAND solution,* EURASIP Journal on Wireless Communications and Networking (EURASIP JWCN).
- *Paper presenting the benefits of using SARABAND technology,* International Innovation Journal.
- *Paper publishing the results of the SARABAND demonstrator,* IEEE Wireless Communications or IEEE J. on Selected Areas in Communications.
- *Paper presenting all the technological achievements obtained in the SARABAND project,* IEEE Transaction on Wireless Communications.

Apart from publication of papers in conferences and journals, several partners are now considering the publication of several patents focused on the technology developed in SARABAND project. These patents are detailed below and Table 3 summarizes the list of patents in the frame of SARABAND.

- A patent entitled "Multi-beam System for simultaneous multi-link" has been sent to the INPI (French National institute for industrial Property) by BLUWAN. This patent is focused on the radio and backhaul system capability with multi-beam provider or feeder.
- TC&S and BLUWAN are planning to support a common patent focused on the definition of the SIP (System In Package). The patent will describe the integration of Q-Band functions (transmitter, receiver and transceiver), including antenna connections, into a closed structure, ready for use.
- Fraunhofer FHR is planning to file a patent focusing on the novel configuration and types of parasitically coupled antenna elements. These are the core components of the CSPA antenna

and have been developed specifically to make the CSPA concept work at frequencies as high as Q-band.

- TRT is planning to file a patent focusing on multi-beam formation within a limited field of view. The proposed approach uses a passive distributor component that splits a collimated beam into the required number of beams in the desired directions.

Table 3. List of patents in the frame of SARABAND

Patent	Status	Owner
Network system	Already patent	BLUWAN
RF diffractive lens antenna	Already patent	TC&S
Chip-sets (Up- and Down-converter)	Already patent	BLUWAN
Multi-beam System	Sent to INPI	BLUWAN
Q-band RF functions (Transmitter, Receiver, Transceiver)	Considering	Bluwan or Bluwan/TC&S
CSPA Antenna	Considering	FHR
Multi-beam lens antenna	Considering	TRT

3.5. Workshops

Towards the end of the project, when the prototypes and the field-trial will be ready, two workshops to be organized by SARABAND project are planned. The goal of these workshops is to inform other parties (including telecom operators, and academia) about the project results and to get direct feedback from the target users. Moreover, these workshops will ensure that the services offered through SARABAND stay updated, and address the needs of the various stakeholders involved.

The first workshop planned for M34 is addressed to Telecom Operators and will be focused on the demonstration of the wireless network platform incorporating the building blocks developed at WP3 and WP4 and integrated at WP6. This workshop will allow us to demonstrate the new enhancement for wireless backhaul provided by SARABAND.

The second workshop planned for M36 is addressed to international audience and will be focused on the presentation of all technical and field trial results obtained in the SARABAND project with the aim of attract interested parties. This workshop will possibly be co-located with a major event, in order to maximize exposure and attendance.

All these events will be organized in following months.

3.6. Press releases

At the beginning of the project, a press release about the project was launched and distributed among certain general press magazines and other media. Additionally, SARABAND activities related to the backhaul system launched by BLUWAN at Mobile World Congress 2012 in Barcelona appeared in relevant Telecommunications/Industry media. These articles were posted at SARABAND website (News section).

During second year, SARABAND project has appeared in several Spanish media such as newspapers, magazines, Internet blogs, forums, etc. Some examples are given in Figure 3.

Figure 3. Example of the headlines appeared in media about SARABAND project

Moreover, the launch of the second generation of Bluwan's point to multipoint millimetre wave backhaul system that will introduce some Q-band equipment improvement arisen from SARABAND appeared in the media (See News section of SARABAND website).

Further press releases may be issued, accompanying major public achievements of the project, like public workshops and demonstration events.

3.7. Liaison with other projects and clustering

Dissemination from SARABAND will also actively seek links and interaction with other projects and fora with objectives related to SARABAND objectives. The goal is not only the exchange of information, but also the creation of any possible synergies on the development of the technical work. This activity will be conducted through events such as conferences, workshops, and concertation meetings, which will be a key vehicle for these links.

In particular, SARABAND partners have participated or are participating in projects with objectives linked to SARABAND objectives, among which the project **MIDIMU HD (Mixed Microwave and Digital Multilayer PCB for High Density Applications)** and **CONRAHD MINOS** can be highlighted. The first project aims at the development of a new technology making possible the design and manufacture of high density mixed microwave and digital printed circuit boards made of multilayer dielectric material, whereas the second one deals with the development of Q-band chip-sets including macro functions (up converter, down converter). These projects provide the basis for the design and implementation of enabling techniques for SARABAND.

Other relevant projects that fall within the scope of the SARABAND project are:

- **FLEXWIN: Flexible microsystem technology for micro- and millimetre-wave antenna arrays with intelligent pixels.** This project proposes a significant advance towards smart RF microsystems by combining: 1.) an RF MEMS switch process monolithically integrated with a Si/SiGe BiCMOS process, 2.) highly reconfigurable mm-wave building blocks, able to be used over a broad frequency range and for different applications, 3.) a new RF-system design

paradigm built around the concepts of reusability, multifunctionality and reconfigurability and 4.) environmental sensing and control built into multifunctional RF ICs with digital control.

- **iPHOS: Integrated photonic transceivers at sub-terahertz wave range for ultra-wideband wireless communications.** This project targets the development of compact and low power transceivers that enable wireless data transfer at sub-terahertz carrier frequencies and their application to future high data-rate short-distance communication links. The interest of the topic relies in the fact that advances in semiconductor technology, favourable spectrum policy and demand for gigabit throughput capabilities have created an opportunity for millimetre wave radio technology above 100GHz.
- **MEMSPACK: Zero- and first-level packaging of RF-MEMS.** This project tackles the packaging issue of RF-MEMS. The project's objective is to (further) develop and to characterize generic wafer-level (or 0-level) and 1-level packaging solutions for housing a large variety of RF-MEMS. The project will address all relevant issues of the development chain, i.e., the design of the package (including RF design, thermomechanical design, design for reliability), the packaging technology (e.g., 0-level "chip capping" technology, 0-level "thin film capping", 1-level packaging technology), the package characterization (RF, temperature stability, hermeticity) and the package evaluation (impact of the package on the device performance, towards meeting industrial specifications).
- **DRAGON: Design Methods for Radio Architectures Going Nanoscale.** The main objective of the DRAGON project was to research and use new design methodologies and architectural innovations, based on reconfigurability and state-of-the-art digital CMOS technology, in order to break the barriers imposed by the lack of scaling properties of analog components. Contacts have been taken with the DRAWON project coordinator.
- **E3NETWORK: Energy Efficient E-band Transceiver for Backhaul of the Future Networks.** This project targets the design of an energy-efficient and high-capacity transceiver for the backhaul infrastructure of future networks. While SARABAND concentrates on technologies for backhaul in the Q-band, E3NETWORK develops a transceiver working at the E-band.

  A meeting between UPVLC and the E3NETWORK coordinator (CEIT – IK4) took place during the Future Network Mobile Summit 2013.
- **COWIN**. COWIN is a support action launched under the 7th Framework Program to strengthen the European competitiveness in miniaturised smart systems. This initiative is dedicated to the commercial exploitation of advanced technologies developed in the framework of European collaborative research projects. COWIN's mission is to facilitate the take-up of advanced technologies worthy of investments, in order to capture innovation, win new markets and make a profit.

  COWIN is supporting SARABAND in the elaboration of the SARABAND business case. To this end, several conference calls have been settled and SARABAND has participated in some webinars dealing with the business case preparation and IPR issues and exploitation of results organised by COWIN partners.

Additionally, as a part of the interaction with other projects, clustering plays a key role in promoting synergies and cross-fertilization among projects. Following this line, SARABAND project joined **RF MST Cluster**. Indeed, SARABAND has participated in last RF MST Cluster Meetings, which took place on 2 July 2012 in Antalya, Turkey, and on 1 July 2013 in Potsdam, Germany. SARABAND, FLEXWIN, iPHOS, among others, participated in this workshop.

Besides contacts with other projects and clusters, SARABAND has also established contacts with operators, service providers, microwave industry and other institutions or forum dealing with the definition of future mobile networks such as the Small Cell Forum and the NGMN (Next Generation Mobile Network) Alliance. These contacts have taken place in the following events:

- Mobile World Congress: Contacts with potential users were established.
- Microwave & RF: A panel session on backhaul with the participation of Alcatel-Lucent, RF Micro Devices, and CNRS LAAX was chaired by Mr. Magne (BLUWAN).
- Small Cell Backhaul Summit: This event was co-located with Small Cells World Summit and supported by the Small Cell Forum. Contacts with industry analysts such as Maravedis, Senza Fili Consulting were taken. In addition, a presentation focused on next generation backhaul strategies for supporting small cells was given.
- Layer 123 Packet Microwave & Mobile Backhaul: This industry event was designed to further support operators as they make key strategic design and procurement decisions to build out Next-Gen mobile backhaul infrastructure. The event was supported by NGMN and operators, services providers, and industry analysts took an active role. SARABAND participated in the panel discussion about "LTE Backhaul – Experiences from the Field" and gave a presentation focused on operator case studies.

3.8. Dissemination at standardization bodies

SARABAND project will follow carefully all relevant EU norms and international standards and will contribute to their further development. In particular, it is the goal of SARABAND to contribute to the standards dealing with Q-band and the definition and development of broadband wireless access networks.

SARABAND has identified several standardization bodies which develop standards and recommended practices to support the development and deployment of broadband wireless networks, and specifications for point to point and multipoint radio systems, covering all equipment aspects. The standards concerning SARABAND activity are the following: the IEEE 802.16, ETSI HiperACCESS, and EN 301 997. Namely, the EN 301 997 applies to Multimedia Wireless Systems in the Q-band and specifies the minimum requirements for equipment and systems parameters, including antenna parameters which are developed more accurately in the EN 301 21503 which pertains to antennas in Q-band.

Given the nature of SARABAND project, which develops new antenna and RF radio module technology in Q-band, the standards EN 301 997 and EN 301 215-03 fits perfectly into our target.

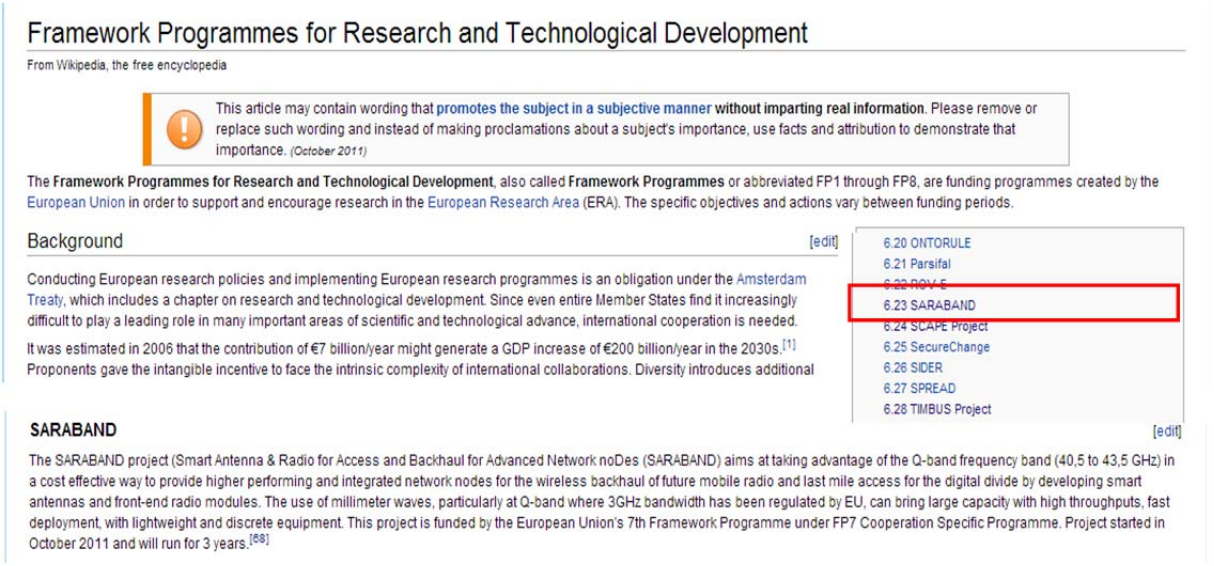
During year 2, EN 301 997 and EN 301 215-03 have been analyzed in depth. The conclusion is that some updates of the 2 norms should be proposed to ETSI group. Indeed the norms are now more than 10 years old and technology evolutions would slightly modify the norms in term of parameters precision, test and certification issues. In order to foster Multimedia Wireless Systems (MWS) development in good conditions it is valuable to update the norms. Therefore, SARABAND proposes to write "up-date" paragraphs named "UD x" to be inserted in the relevant chapters within the 2 norms. The result of this contribution would be to issue an EN 301 997-03 and an EN 301 215 3.1.

More information concerning SARABAND dissemination activities at standardization bodies can be found in deliverable D8.4 – Preliminary Standardization Activities Report.

3.9. Web 2.0 activities

In addition to the dissemination efforts listed above, SARABAND will also address the dissemination task from a Web 2.0 viewpoint. The main purpose of using various social media channels is to increase the visibility of the activities and results obtained during the project.

Concerning this task, SARABAND project has been included in the Framework Programmes Wikipedia page, as shown in Figure 4.


Framework Programmes for Research and Technological Development

From Wikipedia, the free encyclopedia

This article may contain wording that promotes the subject in a subjective manner without imparting real information. Please remove or replace such wording and instead of making proclamations about a subject's importance, use facts and attribution to demonstrate that importance. (October 2011)

The Framework Programmes for Research and Technological Development, also called Framework Programmes or abbreviated FP1 through FP8, are funding programmes created by the European Union in order to support and encourage research in the European Research Area (ERA). The specific objectives and actions vary between funding periods.

Background [edit]

Conducting European research policies and implementing European research programmes is an obligation under the Amsterdam Treaty, which includes a chapter on research and technological development. Since even entire Member States find it increasingly difficult to play a leading role in many important areas of scientific and technological advance, international cooperation is needed.

It was estimated in 2006 that the contribution of €7 billion/year might generate a GDP increase of €200 billion/year in the 2030s.[1] Proponents gave the intangible incentive to face the intrinsic complexity of international collaborations. Diversity introduces additional

6.20 ONTORULE
6.21 Parsifal
6.22 ROV-E
6.23 SARABAND
6.24 SCAPE Project
6.25 SecureChange
6.26 SIDER
6.27 SPREAD
6.28 TIMBUS Project

SARABAND [edit]

The SARABAND project (Smart Antenna & Radio for Access and Backhaul for Advanced Network noDes (SARABAND) aims at taking advantage of the Q-band frequency band (40,5 to 43,5 GHz) in a cost effective way to provide higher performing and integrated network nodes for the wireless backhaul of future mobile radio and last mile access for the digital divide by developing smart antennas and front-end radio modules. The use of millimeter waves, particularly at Q-band where 3GHz bandwidth has been regulated by EU, can bring large capacity with high throughputs, fast deployment, with lightweight and discrete equipment. This project is funded by the European Union's 7th Framework Programme under FP7 Cooperation Specific Programme. Project started in October 2011 and will run for 3 years.[68]

Figure 4. SARABAND project in the Framework Programmes for Research and Technological Development Wikipedia page

Other channels have been identified as potential points of Web 2.0 activities. These channels are listed below.

- Social Media Channels: LinkedIn has been identified as the first target channel due to its more professional context. Some posts related to SARABAND achievements have been published.
- Media Focused channels such as Slideshare and Youtube. SARABAND project has uploaded to Slideshare presentations related to the project objectives and achievements.
- Webinar (telecoms.com): Next Generation Backhaul Strategies for Heterogeneous Networks. http://webinars.telecoms.com/webinar/next-generation-backhaul/

  Shayan Sanyal, CCO at point to multipoint millimetre wave backhaul specialists Bluwan, and Peter Jennings, CTO at MLL Telecom, shared their experience in addressing small cell backhaul requirements. They elaborated on how they are innovating to help mobile network operators evolve and meet the unique demands of the public access HetNet.

4. SARABAND Use Plan

In this chapter, an updated use plan for the SARABAND project is presented.

4.1. General approach to use

This use plan will take several forms depending on the type of exploitation actor, distinction being done between industrial or scientific/academic actors.

The use plans of industrial partners of the SARABAND project will be focused on the development of products, based on the expected results from research activities. Namely, thanks to the research activities developed in SARABAND, industrial partners will acquire new technological knowledge in the field of Q-band, which will be speed up the deployment of new services, resulting in new usage scenarios and new customers. Companies will ensure this by transferring results from the research departments directly to development, products, and marketing ones.

The exploitation goals of research organizations and academic partners are different, yet complementary, to those industrial partners. Technical developments will be integrated quickly into the training and education and will be exploited in future national and international research projects. Moreover, research organizations and universities will play a key role for the dissemination of expected results from the SARABAND project to promote the development of spin-off products for additional markets by other companies.

4.2. Market needs

Demand for bandwidth is growing exponentially as consumers use their mobile devices and therefore 3G+/4G networks for more bandwidth-intensive applications. WiFi is becoming increasingly important to offload 3G and 4G networks. Also, in the SME and corporate market, the bandwidth demands are increasing constantly. Then, as newer technologies and newer bandwidth-intensive applications are used, the need for a technology to transport the bandwidth from the point of access to the core of the network will rise swiftly. Up to now, most of those needs have been met by leased and point-to-point microwave links. However, these solutions will not be able to meet the needs of the next generation of mobile networks in a practical manner. Therefore, Mobile Network Operators (MNOs) need to find ways to meet that demand in a cost effective manner. What is needed is an adaptable and flexible heterogeneous network solution with elastic capacity allocation that can backhaul 3G/4G macro cells, micro cells, small cells, relay sites, WiFi and SMEs within the same solution.

A point to multipoint (PMP) backhaul can efficiently manage scarce spectrum resources as it can dynamically allocate capacity amongst *n* endpoints. However, traditional PMP operating in the 10 or 28 GHz bands offer some potential CAPEX/OPEX (Capital Expenditure/Operating Expenditure) efficiencies, but unfortunately, do not have the required capacity to meet future market needs in terms of bandwidth. In that context, a PMP backhaul in bands such as the millimetre wave, especially in the Q-band, is very promising for high data rate mobile applications because of its wide frequency spectrum, compact and light equipment and ease of interference-free system configurations. In PMP, the hub itself only needs one antenna to connect with all of those in a given area; this means a significant decrease in CAPEX but an even more dramatic cut in OPEX, since the number of antennas (and therefore site rental charges) lessens and the tower is less encumbered. In addition, available wide-band PMP systems leveraging millimetre wave frequencies can aggregate traffic to better using high capacity backhaul fiber, essentially extending its reach. Then, PMP millimetre wave technology has been proposed as a promising solution that can deliver 150-200 Mbps in a cost-effective way. Actually, the SARABAND project joins together the millimetre wave technology in the Q-band and PMP transmissions to provide higher performing and integrated network nodes for the wireless backhaul of future mobile radio and last mile access by developing smart antennas and front-end

radio modules. Therefore, the products developed in the SARABAND partnership will bring a competitive alternative to actual technologies for two vast markets (commercial backhaul and residential access). It will ensure important cost savings, accelerate deployments, and boost subsequent indirect the economy.

On the other hand, wireless PMP backhaul equipment market is expected to reach US$1 billion by 2018 (From Maravedis 'PMP Wireless Backhaul Market from an All-IP Perspective' Report from 11/2011). Beyond 2013, the rise of LTE deployments, in combination with small cells growth, will drive the growth of PMP's market adoption. Moreover, most PMP vendors are paying special attention to the emerging small cells requirements and are tapping into this huge potential market. Key small cells features are small size, lightweight products, deployed outdoors and able to withstand harsh weather conditions and environments. The small cells, Outdoor Metro Pico/Femto, could easily be supported from PMP products, adding extra capacity to the cell site and the aggregation node. Therefore, the products developed by the SARABAND project are expected to have a potential impact in this new market.

Additionally, the SARABAND project results can be also suitable for transport and security market. With the introduction of new applications such as video survey of buildings, streets or specific great event, urban roads traffic management (roads, rail, airport, ...), train routing and control, passengers info, etc, the demand for capacity has increased. In this context, the SARABAND products can offer high speed data transport, interoperability and confidentiality.

More information about market analysis, competitive environment, target markets, and the value proposition of SARABAND project can be found in deliverable D8.5 - Preliminary exploitation plan.

4.3. Expected results and use plan

The SARABAND project challenge is to exploit the Q-band frequency (40,5 to 43,5 GHz) by developing smart antennas component and front-end radio modules to provide new capabilities for enhanced wireless backhaul network system. High throughput capacity, spectrum efficiency and reconfigurable network will be achieved by, on one hand, low-profile high-gain and programmable multi-beam antennas, and on the other hand, by a very high performance miniaturized radio modules in millimetre waves. These advanced technologies and architectures will offer advanced performances for future wireless backhaul network with cost-effective deployment and manufacturing process.

Therefore, the use plan is focused on the following results, expected from the SARABAND project:

- **Q-band low-profile high-gain antennas**. Two approaches have been analyzed: Fabry-Perot antennas and lens antennas for medium-gain (20 dBi) and high-gain (>30 dBi) applications, respectively.
- **Programmable multi-beam Q-band antennas**. Circular Switched Parasitic Array (CSPA) antennas as agile antennas with a large field of view, and multi-beam lens antennas for limited field of view have been analyzed.
- **Miniaturized radio module** based on new substrate, new packaging and interconnection process in Q-band frequency.

4.3.1. Low-profile High-gain antennas in Q-band

Characterization of the results

In lens antennas, a quasi-point source (the feeder) generates a spherical wave which is collected and collimated by a dielectric lens. This results into a plane wave generation at the antenna output that could provide diffraction-limited gain. Current lens antenna technology can be either bulky for refractive design or less efficient when it comes to low-profile solution (such as Fresnel lens). To overcome such limitations while keeping a lower profile efficient design, an innovative lens design based on "quasi-optical" RF components has been proposed and investigated. In particular, the idea is the transposition of an optical approach, in terms of wavefront control and component design, to the RF domain. This approach, using of sub-wavelength structures and hybrid lens design, allows efficient and flat high numerical aperture lens to be synthesized in order to control and reshape the wavefront emitted by the Q-band antenna feeder, hence allowing for low-profile and high-gain antenna.

In the frame of the SARABAND project, medium- to high-gain Fabry-Perot antennas will be developed. The antennas will use a planar technology based on leaky wave radiation and will have the capability to generate a pencil beam in the broadside direction for point to point communication links. This antenna concept is an alternative to the standard patch array, as it can be a very thin and low-cost radiating structure. Moreover, compared to the standard patch array, the Fabry-Perot antenna can use efficiently a large part of the radiating aperture with a simple source. This simplifies greatly the feeding network, resulting in a reduction of losses.

Contribution to use plan from TRT (High-gain Lens antenna)

TRT is planning to exploit the work and the experience gained through SARABAND project in the following ways:

- Publication of the scientific results in conferences or in international journals.
- Dissemination of SARABAND results through specific internal workshops, workgroup and exhibitions organized inside Thales for Thales staff or for its customers.
- Use of the knowledge and know-how gained through the project to adapt and extend the investigated concepts to other frequency bands and other applications.
- Investigate further away the concepts through the implementation of PhD.

Contribution to use plan from ONERA (Fabry-Perot Antenna)

ONERA is planning to exploit the work and experience gained in the SARABAND project in the following ways:

- By publishing the results in scientific magazines, journals and conferences.
- By patenting novel ideas and giving the industry licenses for commercial exploitation.
- By exploiting the knowledge of the developed technology in other research programmes (satellite communication for instance).

Contribution to use plan from BLUWAN

The high-gain antenna will be integrated in the TH (Transmission hub) radio for 2 applications:

- Long range high directive backhaul for a fibre point of presence to stand off relays (like the configuration of the demonstrator). The network indeed should have this capability to match any kind of configuration.
- High capacity secured microwave link. It would use 2 TH facing each other's. There is a need for that application within the mm-wave solutions. Indeed, E-band microwave links are less competitive (limited range availability with rain and difficulties to easily point and maintain bearing and elevation, less compact equipment). As far as W-band is concerned, the range is very limited due to O^2 absorption. Bluwan thus intends to introduce a microwave link into its catalogue in mid-2014.

4.3.2. Programmable multi-beam antennas in Q-band

Characterization of the result

In the course of the SARABAND project a novel programmable multi-beam Q-band antenna with electronic beam forming and beam scanning capability will be developed. The antenna will be a switched parasitic array antenna with large a field of view for use in the link between the repeater and the subscribers. The concept is based on an array with passive antenna elements that can be controlled electronically. The main objective is to explore the capability of an agile antenna with a large field of view that adapts dynamically to the changing environment in a capillary network and forms the antenna radiation pattern to provide optimum system performance and high data rate. The main advantages of this approach compared to standard technology are the agile electronic circumferential beam scanning capabilities without the use of any non-linear components in the direct RF signal path. The beam steering is achieved by parasitically coupled elements. Additional, no expensive components like integrated phase-shifters or RF switches are needed.

Apart from agile antennas, the SARABAND project also includes the investigation of other beam scanning or switching antenna designs such as lens antennas in order to benefit from its high gain capabilities within a reduced field of view. The considered designs will provide multi-beam formation in order to allow directive links to individual or grouped subscribers within a limited field of view.

Contribution to use plan from FHR (CSPA antenna)

Fraunhofer FHR is planning to exploit its achievements in the following ways:

- Scientific results exploited by publication.
- Novel ideas will be patented.
- Licenses will be given to industry partners allowing them to use the technology developed by FHR.
- Theoretical and technological insights will be used in future projects.

Contribution to use plan from TRT (Multi-beam antenna)

TRT is planning to exploit the work and the experience gained through SARABAND project in the following ways:

- Publication of the scientific results in conferences or in international journals.

- Dissemination of SARABAND results through specific internal workshops, workgroup and exhibitions organized inside Thales for Thales staff or for its customers.
- Use of the knowledge and knowhow gained through the project to adapt and extend the investigated concepts to other frequency bands and other applications.
- Patent the multi-beam lens idea and concept.

Contribution to use plan from BLUWAN

The multi-beam lens antenna based on the passive distributor will be used to facilitate certain configurations where gain is needed and/or to avoid energy distribution where not needed. An industrial design program must be conceived to provide the fabricant of the distributor with some kind of "dfx file" to quickly get the right product for the deployment.

4.3.3. Miniaturized radio modules in Q-band

Characterization of the result

One of the more challenging issue faced by SARABAND has been to successfully miniaturize the front-end radio modules, involving a state-of-the-art process technology and a novel RF and system design. Thanks to the use of SIP (System in Package) integration and GaAs-based MMIC chip-sets developed by BLUWAN compact modules have been obtained. Actually, prototypes of the new SIP modules of the transmitter (Tx) and the transceiver (TRx) are now available; the receiver (Rx) will be manufactured in October. These prototypes are under test for validation.

The second year of the SARABAND project was mainly dedicated to the definition of the manufacturing rules and the evolution of PCB and mechanics under plate to match the industrial rules for middle scale production. This step was of major importance for the development of the SIP concept. The success of this task was greatly associated with the mastered of the chip-sets and the connector assembly with the goal of avoiding long-time adaptation of RF characteristics. The main challenge was the bonding on the TRx SIP of the power amplifier, and the up- and down-conversion functions with the filter and the circulator. Flatness and length repeatability of the bonding was a key success. The second great progress in this year was the good adaptation of the antenna interconnection. Thanks to these achievements, three independent radio modules are implemented.

Contribution to use plan from TC&S

TC&S will use the development of SARABAND for miniaturization and improvement of new equipment. 3 Axis of improvements/development are identified:

- Macro-components: SIP development proves that chip-sets, filters, isolator/circulator, and the antenna interconnection can be integrated, leading to a compact antenna structure capable of operating at high or very high frequency. SARABAND progress is the milestone of multifunction association on a same chip-set.
- Multi-beam antenna: The multi-beam concept is also an enabling approach for the development of high-speed small scale networks dedicated to secure communication with multidirectional access. High-rate and secured communication is, of course, one of the business of TC&S; that's why the Q-band solution is a great opportunity.

- High-rate communications: The great contribution of SARABAND is to provide a global solution for very high-frequency applications. The project offers a great panel of RF functions, antenna and network management "on the shelf" for TC&S.

Contribution to use plan from BLUWAN

The SARABAND terminal will be industrialized by Bluwan; it comprises the SIP transceiver and the lens sub-λ short focal antenna middle gain (30.5dbi). This product fits perfectly in two applications:

- small cells LTE feeder for 4G deployments.
- hot-spot backhaul (micro WiMAX or micro LTE) to provide fix access at 100 Mbps peak and 20 Mbps average like fibre.

This product will be on the catalogue mid 2014.

More information concerning SARABAND exploitation plan can be found in deliverable D8.5 – Preliminary Exploitation Plan.

5. Conclusion

This deliverable details the SARABAND dissemination activities in the second project year as a follow up of deliverable D8.2.

This deliverable provides the dissemination plan for the SARABAND project established the first year of the project and describes the dissemination strategy to be followed by each partner.

Moreover, a summary of the dissemination activities performed during the first and second year of the project are given. During Year 1 dissemination activities were focused on the introduction at a high level of the project objectives whereas this year these activities have been more focused on the publication of the technical progress of SARABAND project in terms of the development of antennas and RF modules at Q-band.

Other activities performed in the frame of this WP such as the press releases, interactions with other projects and industry, contacts with standardization activities, etc are also detailed.

Finally, an updated use plan of the expected results is described.

ANNEX 1. Brochure

SARABAND OBJECTIVES

The overall objective of the SARABAND project is to push the boundaries of RF technology by developing high performance, smart, multi-beam, programmable and reconfigurable antennas containing (in terms of size in comparison with existing Q-band technology) miniaturized Q-band (40,5 - 43,5 GHz) radio technology to enable an energy efficient and high performance future wireless backhaul, as well as last mile access to bridge the digital divide.

S&T SARABAND SUMMARY PROJECT OBJECTIVES

Low profile (flat and thin), high gain antennas in Q-band.

Q-band Multi-Beam Antennas with up to four beams of different beamwidth and programmable directions.

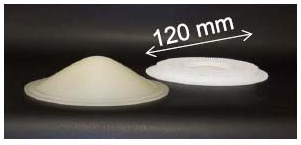
Q-band high power radio front-end with MMICS (Monolithic Microwave Integrated Circuit) on a smart (miniaturized) technology SIP (System in Package), thermal management and power efficiency with suitable packaging and interconnections process.

Integration of antennas with radio heads to achieve a cost effective and compact Beam Forming Solution for mobile backhaul with installation constraints (low cost and power efficiency).

Low-profile High-gain Antennas

Sub-wavelength lens antenna

Innovative lens design based on sub-wavelength structure and hybrid lens has been investigated. This design reduces the lens thickness by a 4.5-factor compared to the bulk configuration while allowing both efficiency and gain enhancement.



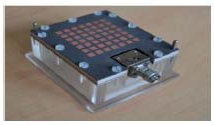
Comparison between bulk hyperbolic lens and fabricated structured lens (for Q-band operation)

Fabry-Perot antenna

For Q-band operation, the proposed Fabry-Perot (FP) antenna uses an air-filled cavity with periodic patches printed on a thick dielectric substrate.

FP antenna prototype at Q-band:

- 15-dB gain
- Bandwidth: 2.5 GHz
- The use of multiple sources inside the cavity is being investigated to increase the antenna gain



Multi-beam Antennas

Multi-beam lens antenna

The proposed multi-beam lens antenna uses a passive distributor component that splits a collimated beam into the required number of beams in the desired directions.

Multi-beam lens antenna prototype at Q-band:

- 5 beams with 20-dB gain
- Size < 150 mm
- Angular coverage of ±30°
- Bandwidth: 1 GHz (centered in each Q-band)

Circular Switched Parasitic Array antenna

Circular Switched Parasitic Array (CSPA) antenna is proposed as a solution for the agile Q-band antenna with a large field of view. A first fixed-beam demonstrator of the CSPA antenna has been manufactured.

CSPA antenna prototype at Q-band:

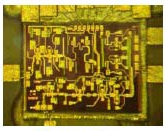
- 16-dB gain
- Beamwidth: 6°/60° (E/H plane)
- Horizontal angular coverage of 270°
- Bandwidth: 1 GHz (41,5 – 42,5 GHz)

Radio Frequency Modules

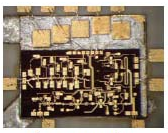
Front-end radio modules use advanced MMIC with GaAs foundry and benefit from SIP technology integration to reduce the printed circuit board footprint.

Novel chip-sets for up- and down-conversion have been developed:

- 33-dB gain for the down-converter
- 18-dBm power target for the up-converter
- 2,5-dB noise factor

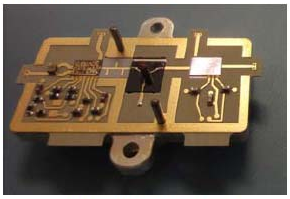


Up-converter



Down-converter

Specific SIPs including the mentioned chip-sets, filters, isolator/circulator, and the antenna interconnection for each RF module (transmitter, receiver, and transceiver) were designed and manufactured.



Transceiver SIP: 42 x 25 mm

ANNEX 2. Poster

SARABAND

SMART ANTENNA & RADIO FOR ACCESS AND BACKHAUL FOR ADVANCED NETWORK NODES

The objective of the SARABAND project is to push the boundaries of RF technology by developing high performance, smart, multi-beam, programmable and reconfigurable antennas containing miniaturized Q-band (40.5 – 43.5 GHz) radio technology to enable an energy efficient and high performance future wireless backhaul, as well as last mile access to bridge the digital divide.

SARABAND OBJECTIVES

- Develop low-profile (flat and thin), high-gain antennas in Q-band
- Implement Q-band high power radio front-end with MMICS on a smart (miniaturized) technology SIP (System in Package), thermal management and power efficiency with suitable packaging and interconnections process
- Develop Q-band multi-beam antennas with up to four beams of different beamwidth and programmable directions
- Integration of antennas with radio heads to achieve a cost effective and compact beam forming solution for mobile backhaul with installation constraints (low cost and power efficiency)

Q-BAND TECHNOLOGY DEVELOPED IN SARABAND

Low-profile High-gain Q-band Antennas

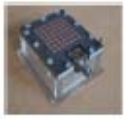
The objective is to provide high-gain (>35 dBi) and medium-gain (20 dBi) antennas, which will enhance throughput between the transmission hub and the remote site. Two approaches have been analyzed: lens and Fabry-Perot antennas.

High-gain lens antenna

- Sub-wavelength structure and hybrid lens design
- Both efficiency and gain enhancement
- Lens thickness is reduced by a factor 4.5 compared to the bulk configuration
- Measured gain: > 31 dBi
- Measured BW_{-10dB} of 2.4 GHz

Fabry-Perot antenna

- Low profile, light weight, and low cost antenna
- Computed BW_{-3dB} of 2.5 GHz
- Maximum gain (23.7 dBi) with a 60 mm × 60 mm PRS excited with 16 sources.



Programmable Multi-beam Q-band Antennas

The objective is to enhance coverage, reduce interference and save energy for selective sectorial links in the Q-band. Two approaches have been analyzed: Circular Switched Parasitic Array (CSPA) antenna for large field of view and multi-beam lens for limited field of view.

CSPA antenna

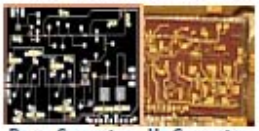
- The design is based on a printed microstrip CSPA
- Antenna gain: 16 dBi
- Antenna BW: 4.87 %
- Beamwidth of 6°/60° (E/H plane) to cover an area of 270°

Multi-beam lens antenna

- Use of a passive distributor component for splitting the collimated beam into the required number of beams
- Prototype: 5 beams with 20-dB gain
- Angular coverage: ±30

Q-Band Radio Frequency Modules

Front-end radio modules use advanced MMIC with GaAs foundry and benefit from System in Package (SIP) technology integration to reduce the printed circuit board footprint. Novel chip-sets for up- and down-conversion with better gain and noise figures have been developed by BLUWAN. Specific SIPs including the mentioned chip-sets, filters, isolator/circulator, and the antenna interconnection for each RF module (transmitter, receiver, and transceiver) were designed and manufactured.



Down Converter Up Converter

Transceiver SIP: 42 x 25 mm

Transceiver RF Module 100 x 100 mm

SARABAND CONSORTIUM

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