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# SUMMARY

This document presents the activities and output of the Workshop on Low-Cost Broadband Access and Infrastructure, part of the Work Package 3 (WP3), which was held in Kampala, Uganda, on May 4-5, 2009. During this 1.5-day long session, the 27 participants shared ideas about the future of broadband in emerging markets. All of the materials discussed and presented in Kampala are available on line on the project website: http://www.digitalworldforum.eu/workshops/20-future/62-wp3-ws-overview. The main findings that emerged from the workshop can be summarized as follows:

- In terms of access technology, the landscape seems to be stabilizing on a global scale, with LTE comforting its position as the top next-generation mobile broadband system, while WiMAX is repositioning on emerging markets. IMT-Advanced systems appear to be valid candidates for future deployments in emerging markets, making leapfrogging 3G to 4G a legitimate option for telecommunications operators.

- With regard to infrastructure, a combination of solutions is privileged, with a preference for fibre wherever possible, with microwave as a second choice and satellite an option for the remotest areas. Infrastructure sharing is an economic requirement, whether it is at backbone, core network, backhaul, or site levels.

- Appropriate regulatory and taxation policies are required to boost broadband deployment and adoption. Such policies can strongly support the development of infrastructure sharing, and the take-off of local content creation.

- Energy costs can be significantly cut by reducing the consumption of certain equipments and promoting infrastructure sharing. The diversification of energy sources can also be undertaken to make up for unreliable grid power and drive down certain costs.

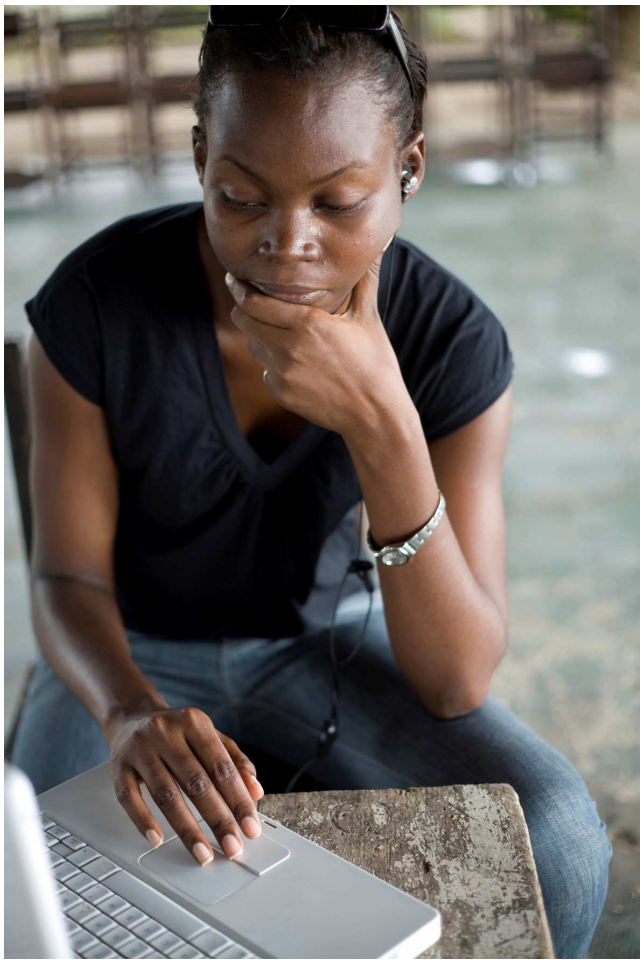
- Restrictions on international bandwidth still act as a brake on broadband usages and should thus be alleviated.

- African countries ought to join forces on the international scene, so as to build and promote internationally their own requirements for broadband standards and handsets configurations.

The project team will build on the discussions and presentations that took place in Kampala to construct a technological roadmap; the document will aim at defining relevant initiatives to be undertaken in the near to medium future.

# 1. INTRODUCTION

This document summarizes the activities and output of the Workshop on Low-Cost Broadband Access and Infrastructure, which was held in Kampala, Uganda, on May 4-5, 2009.



## 2. BACKGROUND

WP3, dedicated to low-cost broadband access and infrastructure, proposes to take a pragmatic approach to the "last mile" issue, by assessing each key technological solution in the light of a typology of local contextual factors. The WP3 focuses on wireless, non-satellite-based solutions, in order to stay in line with a stringent low-cost approach.

While Africa as a whole is characterized by a very low penetration rate of fixed networks (e.g. 0.7% in Senegal, 3% in Cameroon), a significant and rising part of the population owns a mobile phone: 25% on average. Both the rurality of the population and its insolvency is acting as a brake upon prospective deployment of fixed infrastructures taking into account the huge investments necessary to install wired solutions. A growing set of alternative wireless technologies have emerged or are emerging and could be used to serve the local loop: WiFi, WiMAX, CDMA, HSPA, LTE… These technologies raise hope for ambitious broadband access roll-outs through contained capital expenditure; so that a consensus has emerged that mobile broadband will take the mass market in Africa[1].

However, in first analysis[2], none of the candidate technologies is likely to be in a position to fit all situations. Moreover, the infrastructure and access domain is particularly active, with permanent technological developments and vigorous competition between technologies themselves and stakeholders behind them.

The purpose of WP3 is to provide a thorough technical evaluation of existing or emerging wireless technologies, to identify main roadblocks and key research challenges, and to define appropriate initiatives to be undertaken at EU level in the next few years, so that broadband Internet can be deployed on a large scale in Africa and Latin America.

The work package has been phased into 3 main tasks:

- Production of a state-of-the-art study with the aim of thoroughly analyzing the relevant technologies through lab tests (D3.1)[2].
- Organization of an international workshop in Africa, on wireless access and infrastructure (D3.2).
- Construction of a technological roadmap based on inputs gathered in stages 1 and 2, with a view to defining key appropriate EU initiatives (D3.3).

The international workshop has thus been conceived as a pivotal event, aiming at gathering manufacturers, service providers, carriers and academics, with the following three goals:

- Identify the most suitable technologies for the specific needs of developing countries.
- Analyze the factors driving down the cost of alternate broadband access technologies and thereby making them more widely accessible.
- Provide inputs for future R&D programs to improve existing technologies or promote new ones and further reduce costs, i.e. contribute to the construction of the technological roadmap.

# 3. METHODOLOGY

Given the technical orientation of WP3, the workshop aimed at gathering a limited number of people (20-30) with a high level of knowledge on broadband issues, typically decision-makers from industry and academia, in order to ensure an involvement of each participant and a rich output.

The first main task consisted in determining the venue and date of the seminar. It was decided that the workshop would take place just before IST Africa 2009 (i.e. May 4-5, 2009), in the same venue, in order to simplify a combined participation in the two events for the guests. Synergies between the two events were sought and favoured: the IST newsletter mentioned early in 2009 the existence of the workshop, which was subsequently integrated as an option in the registration process in order to widen the potential pool of participants. Reciprocally, all workshop participants were strongly encouraged to register via the IST portal, i.e. to register for the two events simultaneously.

Given the location of the workshop, Makerere University came as a natural choice for co-organizing the event, as it both brought guarantees in terms of scientific excellence and enabled to increase the involvement of local stakeholders.

All potential participants were invited to contribute upstream of the event in two different ways, reflecting the two distinct categories of participants: on the one hand, guests invited in their official capacity had to fill in a comprehensive questionnaire prior to the event; on the other hand, a very limited number of "open participants" were admitted on the basis of the excellence of their contributions in response to a call for papers issued in December 2008 (http://www.digitalworldforum.eu/workshops/66-workshop-on-broadband-access-a-infrastructure-call-for-paper).

The call for papers was first published on the Digital World Forum website, and then relayed within the DWF ecosystem, including the France Télécom – Orange Group corporate website (orange.com). It was also distributed physically during the EuroAfrica ICT meeting which took place on March 25-26, 2009, in Brussels. Contributors were invited to submit papers on the following issues:

- disruptive approaches, in the technological field or in that of business/usage models;
- identification of missing links in the existing or emerging technological chain;
- frequency management: analysis of the license allocation policies in Africa or other emerging markets;
- regulatory policies: analysis of compared impacts of regulatory policies on broadband penetration rates;
- identification and analysis of cost reduction factors for broadband access technologies;
- Technological elements of the ecosystem: related technologies, notably of the energy field, likely to contribute to cost reduction.

# 4. AGENDA

While the workshop was originally intended to spread over 2 days, its duration was eventually reduced to 1.5 day, so as to enable participants to take part in the visit to Makerere set-up by IST Africa's organization committee.

The workshop was divided into 4 phases.

The first phase was dedicated to the presentation of general issues at stake, with an introductory keynote address. The address was made by Prof. Ashok Jhunjhunwala, from IIT Madras, on the theme of affordable broadband for developing countries, from an Indian perspective. The presentation made a tremendous impression on the audience, as a comparative approach was adopted, the Indian example being taken as paving the way for future similar developments in Africa.

This introductory material was used to fuel a brainstorming session which was conducted around two topics: broadband services and policy/regulation. Participants' creativity was notably spurred by discussions about the Indian experience. All of the ideas generated were synthesized and formalized by the WP3 project team in the evening of day 1.

The first part of the 2$^{nd}$ day was devoted to a presentation of selected papers, as a complement to thoughts on R&D evolution presented and discussed on day 1. 9 papers were eventually submitted, 4 of which being rejected, after analysis by Philippe Mendribil, broadband specialist with Sofrecom (France Télécom – Orange Group), and Idris Rai, Deputy Dean of Makerere's ICT Department. In addition, a presentation of the Wireless World Research Forum (WWRF)'s research agenda for Africa was made by Prof. Ashok Jhunjhunwala, founding member of WWRF; indeed strong synergies between WP3 and WWRF are anticipated, as the development of broadband in Africa is high on WWRF's research agenda.

The final part of the workshop consisted in a synthesis and presentation of key collective findings, intended to make up the framework of the technological roadmap. These findings are elaborately presented in part 6.

# 5. PARTICIPANTS

Around 70 people, fully conversant with the broadband domain, most of whom are decision-makers from the industry, were invited. 27 persons effectively took part in the event, in line with the original target of 20-30 participants. A wide variety of backgrounds was represented (academia, research institutes, operators, regulators, manufacturers), making the level of interactivity during brainstorming phases very satisfactory, with challenging viewpoints brought by some participants. While most participants came from Africa, other regions of the world were represented: of course EU, but also China and India.

It is to be noted that some of the invited organizations that were not in a position to participate in the workshop, for practical reasons, made very valuable contributions in the form of filled-in questionnaires. So although they did not have the opportunity to express their views directly during the workshop, their thoughts were taken into account and integrated into the consolidated presentation of questionnaires which was made in the first part of the workshop.

# 6. FINDINGS

The questionnaires and contributions that were received, as well as the open discussions during the workshop itself, aimed at identifying future trends and promising research directions in the field of broadband for emerging markets. These findings are described below.

## Access technologies

Both the questionnaires and the open discussions reflected some uncertainty as to which technology is the most appropriate to offer low-cost broadband access in the near future (3-5 years). The choice of the right technology depends on various factors, such as available frequencies, the market scale of the technology, its performances relatively to coverage and traffic needs.

However, the technological landscape seems to be stabilizing on a global scale, with 3GPP technologies clearly leading the way, and WiMAX repositioning on emerging markets. Within the 3GPPP/3GPP2 standards family itself, 3GPP2 systems such as EV-DO and UMB have been losing ground, comforting LTE in its position as the top next-generation mobile broadband system[3].

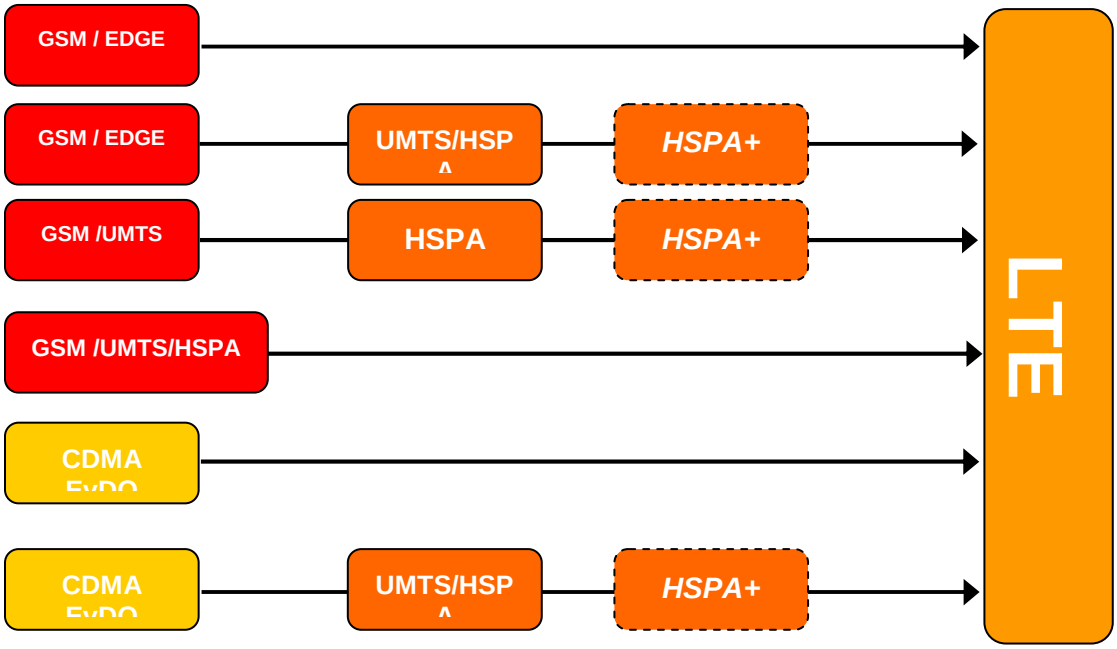



**Fig.1: Access technologies: evolutions under way – 3GPP/3GPP2**

*source: Ph. Mendribil*[4]

Both WiMAX (evolution to 802.16m) and LTE (LTE-Advanced) are candidate for ITU IMT-Advanced (4G) which will allow enhanced peak data rates to support advanced services and applications: 100 Mbit/s for high mobility and 1 Gbit/s for low mobility (http://www.itu.int/ITU-R/index.asp?category=information&rlink=imt-advanced&lang=en).

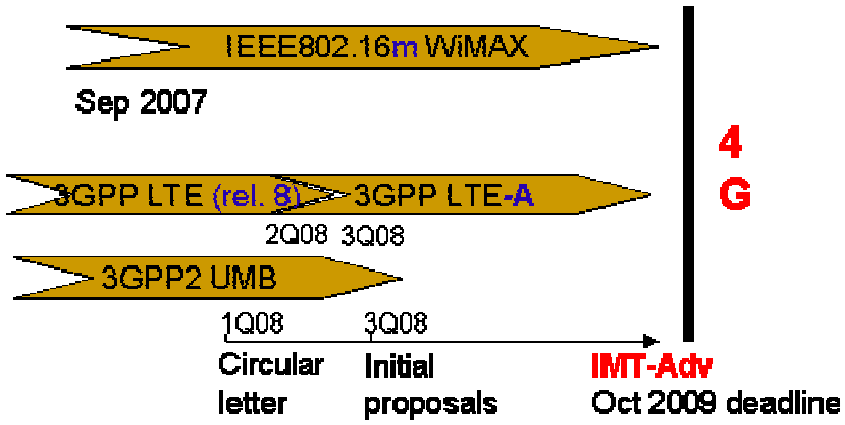



**Fig.2: Access technologies: evolutions under way – 3GPP/3GPP2 and IEEE standards**

*Source: A.Jhunjhunwala*[5]

In first analysis, IMT-Advanced systems may seem to be inappropriate for emerging markets. Indeed, they are supposed to support high-end services, such as high quality multimedia applications, to have worldwide roaming capability, and to be widely compatible with fixed networks: these requirements seem irrelevant for users with no Internet access at all presently.

However – and this is one of the main findings of the workshop – that level of performance is required if real affordability has to be reached. The Indian experience shows that, for a $5 monthly ARPU, wireless technology needs to support 500 to 800 broadband subscribers / operator / cell, which implies a capacity of 10 bps/Hz/cell. Such a capacity (7-10 bps/Hz/cell) is only offered by WiMAX 802.16m and LTE-A[5&6]. Consequently, it makes business sense for telecommunications operators to leapfrog 3G to 4G in emerging markets, which causes some analysts to predict higher growth rates for LTE/WiMAX in emerging markets than in developed ones[7].

## Infrastructure

There was a discussion among participants whether digital microwave or optical fibre should be favoured for backhauling, some arguing that only optical fibre will provide the capacity required to bridge the digital divide. On the whole, a combination of solutions is privileged, with a preference for fibre wherever possible, with microwave as a second choice and satellite an option for the remotest areas. The question of whether satellite and its recent evolutions (Ka band usage) will boost its competitiveness was addressed; satellite is mainly considered a valid backhauling option, though some advocate its relevance as an access technology down to end-users[8].

The need to promote infrastructure sharing was strongly voiced by participants. As high speed access schemes imply the roll-out of nearly twice the number of radio access network nodes as compared to GSM networks, it is unrealistic to hope to provide wireless broadband services at affordable prices while keeping the same

techno-economic model. Radio Access Network (RAN) sharing by competing operators, currently promoted in Europe, enables to reduce both cost of infrastructure deployment and power consumption of broadband mobile networks[9]. As shown in figure 3, the two network operators NetOp1 and NetOp2 can share part of their infrastructure to reduce their Total Cost of Ownership (TCO). Savings can apply to base station (BS) cell sites, BS towers, BS power, etc. Infrastructure can also be shared at backbone, core network and backhaul levels.

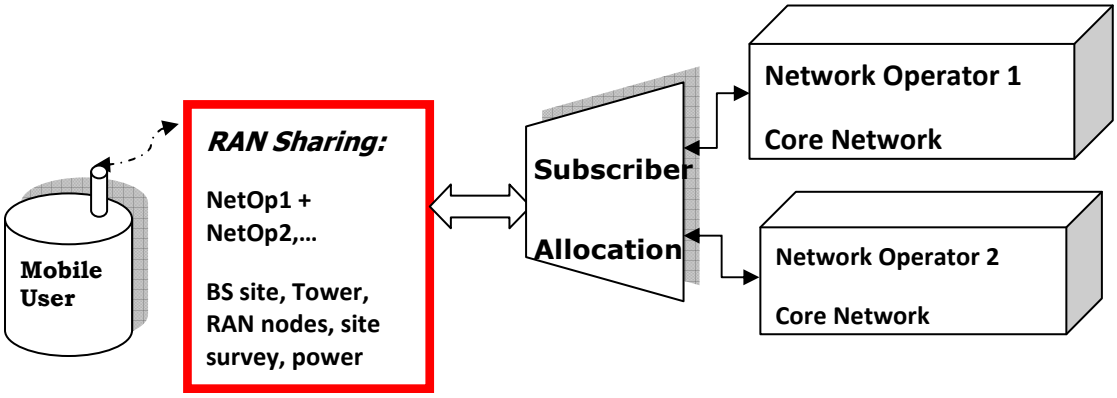



**Fig.3: Radio Access Network sharing concept**

*Source: F. Mekuria[9]*

The role of regulatory bodies in promoting infrastructure sharing is considered critical. Governments and Universal Service Funds should support the building-up of shared infrastructure in hinterlands. For instance, when allocating spectrum, regulators could sell the licences for lower fees or no fees, while being more demanding in terms of coverage (geographical redistribution).

## Regulation

There was a consensus among participants and contributors on the fact that the role or regulators should be strengthened and that market forces cannot solve all problems in all areas. Appropriate regulatory and taxation policies are thus required to boost broadband deployment and adoption.

In most countries, regulatory bodies have not yet taken the necessary steps for the allocation of frequencies and, even when regulations are in place, the necessary control tools seem to be missing. With the proliferation of new technologies and the increasing demand for telecommunications services, the spectrum demand keeps growing. Therefore spectrum should be allocated efficiently and economically, under transparent conditions, in the light of ITU guidelines.

As mentioned in the "Infrastructure" part, a licence may not be necessarily associated with fees but with certain obligations. The Brazilian case was pointed out as exemplary: in this country, the regulator reduced the cost of new frequency licensing for new entrants but required 2G coverage in 100% of the municipalities and 3G coverage in 60% of them (within 3 years). The basic principle of such an approach is

that service providers are allowed to exploit the lucrative market in the main cities and required to fulfil certain social obligations too. It is to be noted that the approach implies a significant level of social inequality within the country, as it relies on a form of cross subsidization between wealthy users and poorer ones.

Monopoly situations on certain national backbones have also been identified as significant regulatory challenges. In some countries, only the public and incumbent operator has the right to deploy optical fibre networks on a national scale, so that newcomers are obliged to hire capacity and operate under unsustainable conditions; some argue that they should thus be given permission to build a national backbone for their own purposes. Of course, such a recommendation conflicts with the widely advocated move to infrastructure sharing, so that the preferred situation will be one with a shared national backbone with attractive conditions for stakeholders.

With regards to content creation and usage, regulatory bodies can also play a positive role by creating a favourable environment. To encourage the development of local contents and the local adaptation of existing contents, a transparent policy is necessary. Market forces are deemed insufficient to enable the building-up of content ecosystems in emerging markets. In particular, clearly-defined and consistent policies are required to ensure interoperability of data services, such as SMS-based services.

## Energy

The challenge of energy is key in emerging countries. Two approaches were suggested in this respect by contributors, during the workshop itself and/or via the questionnaires.

The first approach consists in multiplying and diversifying energy sources. Indeed a typical problem is that of unreliable grid power connection. In most typical cases, the duration of available power can vary between 2 hours to 16 hours per day (source: Nokia Siemens Networks). The available grid power can be used to both feed the site and back-up batteries; the handover between grid power and batteries will then be automatically managed by a site controller. Another option to make up for insufficient grid power consists in resorting to renewable energy solutions (wind and/or solar); such solutions are already widely available in the market.

Another way to address the energy issue consists in optimizing energy consumption. Shared infrastructures can heavily contribute to the reduction of energy expenditure: in rural Africa, it is a usual scene to see three nearby BS towers, powered by three diesel generators[9]; such waste of resources can easily be avoided by mutualising facilities. Moreover it is possible to drive down energy costs by reducing the consumption of certain equipments. Air conditioning could be used more restrictedly, primarily for the cooling of batteries[5]. Promising R&D work has also been undertaken to improve energy efficiency, both at the base station level, with the development of low-power BS, and at the core network level, with energy-aware routing protocols which will favour links where a lot of energy is available.

## Other issues

Other problems hindering the take-off of broadband in Africa were pointed out during the workshop.

International connectivity is generally thought of as a bottleneck for broadband usages in Africa, even though international capacity is expected to grow significantly in the years to come, with the construction of new optical arteries or the extension of existing ones.

Enhancement of base station technology is an interesting research field. Not only will next generation base stations be energy-efficient, as previously mentioned, but they will also be software-upgradable, both to new standards and future spectrum. The objective is to perform upgrades with minimum changes in hardware, so as to keep costs down.

For broadband to be widely adopted, it must clearly serve development goals: users need to see an early positive impact in their lives and practical problems. Thus the development of local contents and the local adaptation of existing ones should be strongly encouraged, primarily by means of appropriate regulatory and fiscal policies. Providers of local contents can be private companies, typically with services aimed at serving basic needs (school coaching, health, livelihood), as well as end-users in a user-generated contents (UGC) approach. Such contents should be available on current, narrowband, technologies (GPRS/EDGE), and then progressively enhanced as broadband is being rolled-out. One important point, which requires R&D work, is that human language technologies (text to speech and speech to text) will play a critical role in the creation and diffusion of local contents, as some languages are hardly writeable.

Finally, the group came up with a recommendation of a more political nature. As in Africa R&D functions in a difficult context (scarcity of resources, obsolete equipments, difficult access to scientific literature…), local labs need to get ready to make a better use of EU support for R&D: work together, find partners, promote their projects, identify R&D programs meeting African specific needs… Partnerships between universities and private companies should also be promoted, and Universal Services Funds ought to be incited to invest in R&D in addition to infrastructure. More importantly, emulating India, Africa could participate actively in international standardization efforts, and build its own requirements for broadband standards and handsets configurations, taking into account such parameters as topology, population density and affordability. In other words, African stakeholders need to act as much as possible in a pan African way.

# 7. CONCLUSION: NEXT STEPS & PREVIEW OF THE TECHNOLOGICAL ROADMAP

Based on the contributions received and the discussions and presentations that took place during the Kampala workshop, a technological roadmap will be constructed, with a view to defining relevant initiatives to be undertaken in the next few years, so that broadband Internet can be deployed on a large scale in Africa and Latin America.

More specifically, the document will elaborate on a number of recommendations and research directions to be explored in the near to medium future. Five subjects will be addressed:

- Infrastructure sharing: the analysis will be conducted on the various network levels, i.e. backbone, backhauling, access network, facilities and equipments, including CPEs (customer-premises equipments).

- International connectivity: recommendations will be made to save on international bandwidth, encompassing considerations on local content creation and caching strategies.

- Regulation: different regulatory and tax policy configurations will be investigated, with best practices analyzed.

- Access technologies: promising research directions will be explored in the light of the so-called "digital dividend" (massive amount of spectrum due to be freed up in the switchover from analogue to digital terrestrial TV).

- Energy efficiency: recent developments will be investigated with an emphasis on next generation low-power base stations.

A condensed version of the document will be made available for discussion and amendments within the project ecosystem, through the project discussion forum (http://forum.digitalworldforum.eu/group/lowcostbroadbandaccessandinfrastrucure), at the beginning of August, for a delivery to the Commission planned August 31.

# REFERENCES

[1] Pyramid Research, *Broadband in Africa: Wireless to dominate Data as well as Voice*, Webinar Africa, 25th September 2008: http://www.pyr.com/downloads.htm?id=11

[2] Digital World Forum / WP3, *State-of-the art analysis of the broadband access and infrastructure domain*, November 2008: http://www.digitalworldforum.eu/upload-document/doc_download/52-dwfd31october08fullpdf

[3] Informa Telecoms & Media, *Future Mobile Broadband: HSPA & EV-DO to LTE Networks, Devices & Services - 3rd edition*, April 2009: http://shop.informatm.com/marlin/30000001001/MARKT_EFFORT/marketingid/20001744820

[4] Mendribil Ph., *Technologies for Broadband Wireless*, 4th May 2009: http://www.digitalworldforum.eu/upload-document/doc_download/63-review-of-the-different-technologies-available-or-under-preparation

[5] Jhunjhunwala A., *Affordable Broadband for Developing Countries: An Indian Perspective*, 4th May 2009: http://www.digitalworldforum.eu/upload-document/doc_download/62-general-issues-to-get-cheaper-broadband-in-developing-countries-an-indian-perspective

[6] Broadband Wireless Consortium of India, *India Broadband Wireless Technology Requirements*, November 2007: http://www.cewit.org.in/docs/cewit_publctns/india_market_requirements.pdf

[7] Pyramid Research, *LTE's Five-Year Global Forecast: Poised to Grow Faster than 3G*, Global Telecom Insider / Vol. 1, No 1, May 2009: http://www.pyramidresearch.com/store/ins_gl_090513.htm?sc=TL_IGL1.1

[8] Leurquin C. & Bove A., *Research Directions for low cost satellite communications: Building blocks for bridging the Digital Divide in Rural and Developing Countries*, 4th May 2009: http://www.digitalworldforum.eu/upload-document/doc_download/78-research-directions-for-low-cost-satellite-communications

[9] Mekuria F., *Mobile Broadband Technology & Services: Sustainability Factors*, 4th May 2009: http://www.digitalworldforum.eu/upload-document/doc_download/76-mobile-broadband-technology-a-services-sustainability-factors-