D3.1 STATE-OF-THE-ART ANALYSIS OF THE BROADBAND ACCESS AND INFRASTRUCTURE DOMAIN

Executive Summary

1. Scope and objectives

In this document, we present a study on the capacity and architecture of the different systems that can be deployed in emerging countries. We namely consider WiMAX, HSDPA, CDMA 1x EVDO, EDGE and WiFi. As several technological implementations are possible (bandwidth size equal to 1.25/5/7/10 MHZ, frequency of 450/900/2000/2600/3500 MHz), and several environments are to be studied (urban/rural) with a possible usage of an outdoor CPE, we perform a study on the coverage and throughput in different configurations and come out with general conclusions concerning the comparative capacity, coverage and architecture of the studied systems.

2. Structure of the document

This document is organized as follows:

 In the first section, we perform an analysis based on link budget to assess the throughput of HSDPA, CDMA 2000 1xEVDO and WiMAX. The main results are in terms of maximal cell range and corresponding throughput versus distance to the base station.

 The methodology (and results) presented in the previous section are then used to evaluate the capacities of the candidate systems in three cases: when the cells are coverage-limited, when reusing existing GSM sites, or when deploying a new, capacity-limited network. We also study the capacity of WiFi mesh networks for different possible implementations (maximal number of hops, wired backhaul).

 A comparative study about the support of voice over IP in the different systems is then conducted.

 The final part of the document compares the architectures of the candidate systems; this comparison is necessary to compare the CAPEX and OPEX needed when deploying the network.

3. Main findings

The conclusions drawn from this study are as follows:

 Coverage analysis

As expected, the coverage is extremely related to the frequency. The coverage of EV-DO 450 is thus the largest, far ahead of HSDPA 900 that, in turn, has a larger coverage than HSDPA 2000. On the other hand, having an outdoor CPE with a gain of 6 dB will increase significantly the coverage of all systems, but will increase also the costs. Outdoor CPE are thus to be used only when there are

some far isolated users or when we have channels on high frequencies (e.g. WiMAX at 3,5Ghz).

 Capacity analysis

When the cells are deployed based only on coverage criteria, systems like EVDO or HSDPA at 2Ghz will have very large cells and will not be able to serve a large number of subscribers. A joint capacity-coverage dimensioning is thus necessary. We consider two case studies. The first is when the telecommunications operator has an already deployed GSM network and wants to reuse the existing sites to offer the internet service. We thus give the capacity of the resulting network for the different systems. The other case is when the operator has a target penetration for its service and wants to know the best inter-site distance for each technology. For WiFi mesh, the capacity is studied for a given offered traffic and we find the best configuration to attain the target QoS.

 Architecture comparison

For 3GPP/3GPP2 systems (EDGE, HSPA, CDMA 2000), there is no major difference for network Packet Switch (PS) architecture. The access network composed of Base Stations and Base Station Controllers and the core network composed of a GGSN, SGSN and HLR (MSC and PDSN for CDMA 2000). The migration from GPRS to Edge or from EDGE to HSPA (or from CDMA 2000 EVDO Rev 0 to Rev A) does not need an hardware upgrade of the PS core network if PS core network capacity still sufficient after migration (since data rate in the access network will increase). For WiMAX, it provides a very simple all IP architecture with few elements in the core network (only an AAA server with embedded DHCP function) reducing needed OPEX. It has to be noted that architecture evolution is toward reducing the number of nodes in the network (e.g. RNC in Node B for HSPA). As of WiFi mesh, the architecture is also very simple but standardization process is not finished and many proprietary solutions are implemented.

 Voice over IP support

For HSPA+, WiMAX and CDMA 2000 Rev A, QoS mechanisms and radio performances will allow deploying a VoIP service offering a high quality call. However for HSPA+, since no product will be available before 2009, VoIP quality should be assessed when available. For HSPA, 2008 product does not implement all features needed to deploy a VoIP service with QoS. For EDGE, it will be not possible to offer a VoIP service since mouth to ear delay is too high in bad radio conditions.

4. Takeaways

On the whole, there appears to be **no "killer" technology**, though **CDMA 2000 1x EVDO is very promising**; however standardization issues might jeopardize it. In any case, a **trade-off between coverage and capacity** is a constant necessity. For a given country/region, technological choices should thus primarily derive from marketing targets.

More specifically, the following results can be considered of particular interest:

 The **coverage is extremely related to the frequency**, making cells in CDMA 2000 1x EVDO very large.
 Using an **outdoor CPE** is useful only for **far isolated users** or when the frequency is very high (e.g. WiMAX 3500).
 When reusing existing sites, **1x EVDO and HSDPA 900 support large capacities**.
 For a target traffic intensity, an **optimal cell range** can be found for each technology that minimizes the costs while guaranteeing the target QoS.
 WiFi mesh networks offer a **good QoS** when the gateways are linked to the Internet by a **good wired connection**.
 3GPP/3GPP2 systems (EDGE, HSPA, CDMA 2000) have the **same network PS architecture**. The core network can thus be reused when upgrading between these systems.
 WiMAX has the **simplest all IP architecture**, while the WiFi Mesh all IP architecture is still in standardization.
 All systems, except EDGE, **support (or will support) Voice over IP** with a good QoS.