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SUSTAINABLE VILLAGES FOR DEVELOPMENT: PROMOTING DIGITAL INCLUSION

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ABSTRACT

Despite all the advances in Information and Communications Technology (ICT), digital divide is still part of the lives of many citizens - It is estimated that, by the end of 2016, 53% of the world's population will still not have access to the Internet. The problem is further aggravated in developing countries. Reduced and/or non-existent access to ICT solutions (coupled with poor education and health systems) has a negative impact on the human development index [Ngwenyama et al., 2006]. It is therefore imperative that opportunities for cooperation be identified between key societal entities (i.e., academia, industry and government), focusing on the provision of communication infrastructures and services targeting digital divide.

One way to reduce the negative effects of digital divide is to employ ICT for development (ICT4D). The ICT4D approach combines the use of low-cost, easy-to-deploy and easy-to-maintain equipment and user-friendly applications, with the following main objectives: i) *digital inclusion* of citizens located in underserved regions, providing access to technology and communication infrastructures; and ii) *improvement of the quality of life* of these isolated and poor communities (e.g., rural), providing different services that use ICT4D infrastructure, such as in health (e.g., in-situ malaria diagnosis [Devezas et al., 2014]); access to services (e.g., offline access to the Internet [Oliveira et al., 2014]); education (e.g., literacy and access to reading [Almeida et al., 2014]). Contrary to what is observed in developed countries, where access to technology and communication infrastructures is rather common, in underserved regions of developing countries ICTs are non-existent. In addition, these regions are spread over a large geographical area. These characteristics introduce numerous challenges regarding the deployment of communication networks and the provision of services that we normally have access to in large and developed urban centres: connectivity is intermittent, latency is high, the number of equipment is limited, and end-to-end paths between communicating parties may (or not) exist.

Considering the need to promote digital inclusion and the characteristics of these communities, Figure 1 (a) illustrates our concept of Sustainable Villages for Development (SV4D), aiming at improving the quality of life of citizens in remote regions through access to infrastructure, connectivity and services once unavailable or accessible only in urban centres. Figure 1 (b) shows the SV4D architecture, where its communication infrastructure can meet the needs of underserved communities through the different aforementioned services.

Our SV4D solution focuses on the *provision of broadband access to isolated communities*, considering the existence or not of communication infrastructure. The low population density and the distance from the large urban centres make these communities unattractive when it comes to investments for deploying optical fibre and/or cell towers. This contributes to digital

divide. With that in mind, our solution extends the state of the art regarding connectivity in remote regions, adapting them to the characteristics of existing technologies in the target communities, and reducing their complexity concerning utilization and maintenance, making them self-configuring, resilient and robust (i.e., solar powered, remote management).

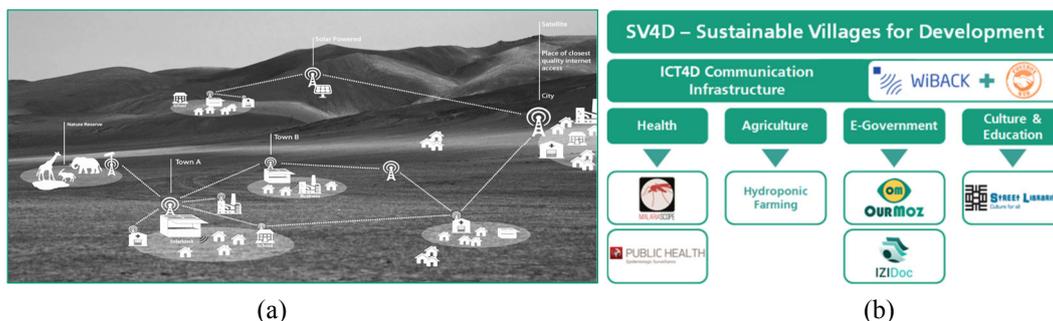<div align="center">(a)   (b)</div>

Fig. 1 - (a) Example of sustainable villages for development, (b) SV4D architecture

Another aspect addressed in our solution relates to the proposed *software framework* that considers the concept of Delay/Disruption Tolerant Networks (DTN [Burleigh et al., 2007]). Such a framework targets a solution for Android devices that addresses inherent characteristics of the target communities (e.g., intermittent connectivity and lack of end-to-end paths), exploring the Store-Carry-Forward paradigm that "simulates" the notion of permanent connectivity. This allows users to produce and exchange data (i.e., emails, documents, e-books, diagnosis) among their mobile devices until the information reaches the intended destination (i.e., citizen, government agencies, schools, doctors).

Finally, our SV4D proposal is *flexible and interoperable*, allowing its integration into existing mobile networks owned by commercial operators. This feature makes it possible to avoid costly investments in infrastructure (i.e., optical fibre, towers) since the SV4D communication infrastructure extends the capillarity of the cellular network, and is also able to serve the citizens of these remote communities.

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