VillageNet: Next generation networks for rural areas

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VillageNet

A holistic concept for rural area connectivity:

- Harnessing software-defined radios using white space frequencies for better coverage
- Employing a traffic localization system to minimize gateway traffic
- Providing a low-cost implementation of localized free-to-air cell phone coverage


Internet Usage Analysis

Traffic monitoring and social surveys in Macha, Zambia and Dwesa, South Africa revealed:

- Mostly web-based traffic with Facebook accounting for the majority of requests.
- 3162 Youtube hits in two weeks (15% of requests to top video, 87% abandoned)
- The majority of chat/VoIP and social networking occurs within the village.
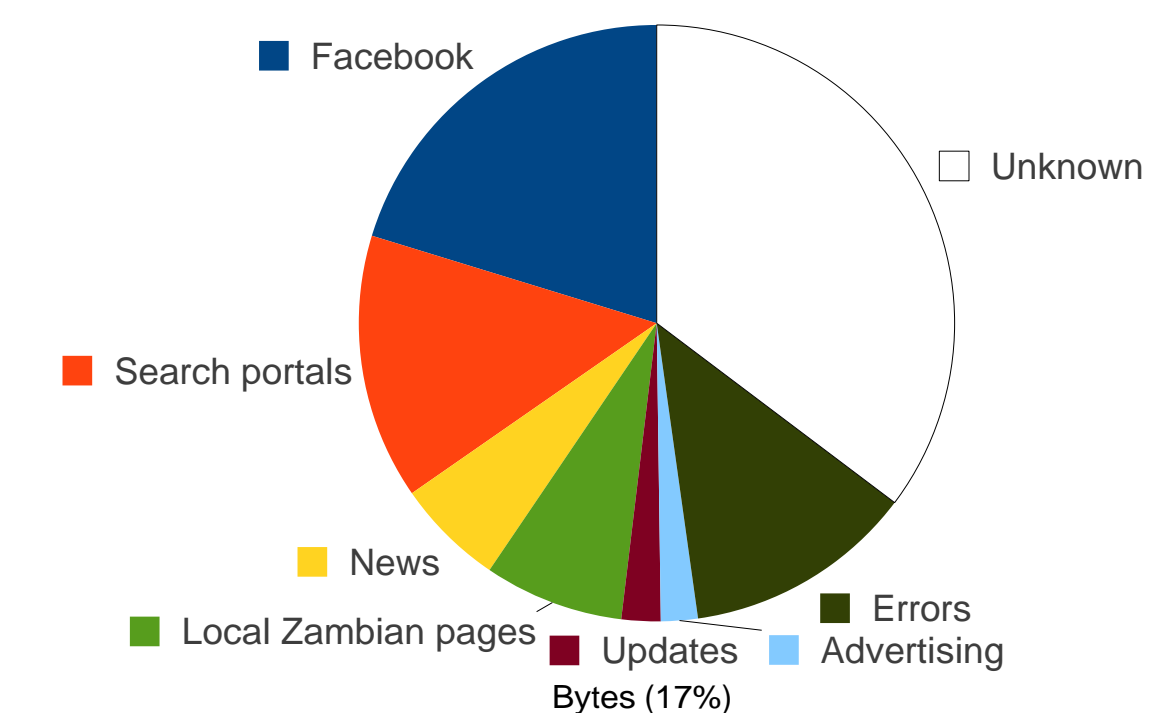

VillageLink

VillageLink is our solution for wireless backhaul connectivity in rural areas where long distance links are required and line-of-sight is not always possible. These links make use of "white spaces", which are unused frequencies between 50 MHz and 700MHz normally reserved for TV. TV frequencies are ideal for rural areas as they have good propagation and foliage penetration properties. Spectrum analysis of TV frequencies in urban and rural areas in South Africa reveal that, on average, 97% of the allocated spectrum is unused in rural areas, whereas 50% is unused in urban areas.
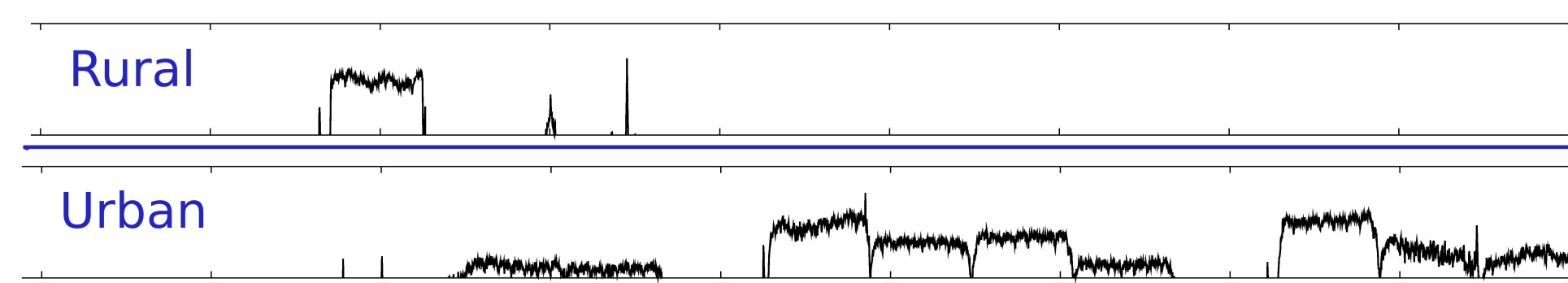
In order to make use of this available spectrum, a novel adaptive probing system is used to find the best performing frequency to use in this wide frequency band. The principle, known as channel sounding, is similar to what would be used to discover the acoustic properties of a concert hall, such as the level of attenuation or echo at each frequency.

VillageShare

VillageShare is a mechanism to ensure that content destined for local users does not traverse the satellite gateway multiple times, as is currently the case with widely used Skype and Facebook applications. Static content, such as images and music, is shared using a localized Facebook application. Dynamic content, such as voice and instant messaging, is automatically re-routed using data mining and machine learning techniques.
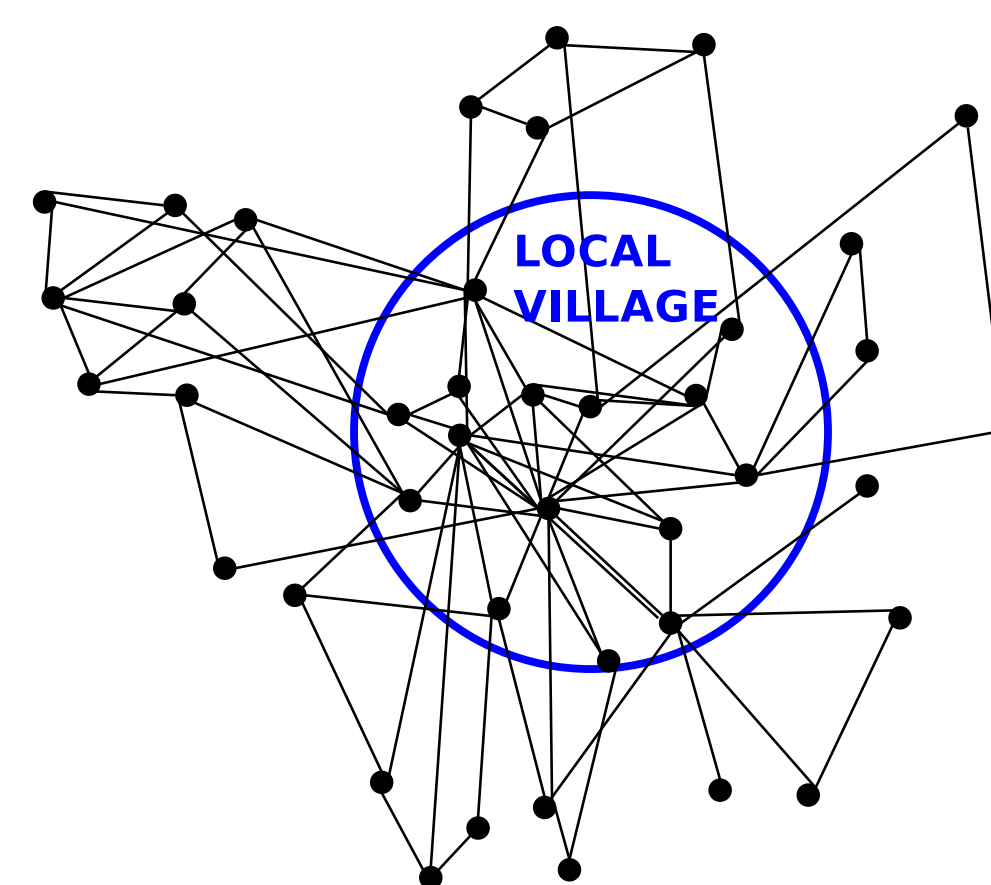
To identify the start of a local real-time flow, we obtain network-wide flow signatures and sequence match upstream and downstream flows. This helps us to find cases where traffic source and final destination is in the same village.

VillageCell

Cell phone ownership is high even in the most remote areas; however, big telecoms are reluctant to provide network coverage due to low population densities and low income in rural areas.
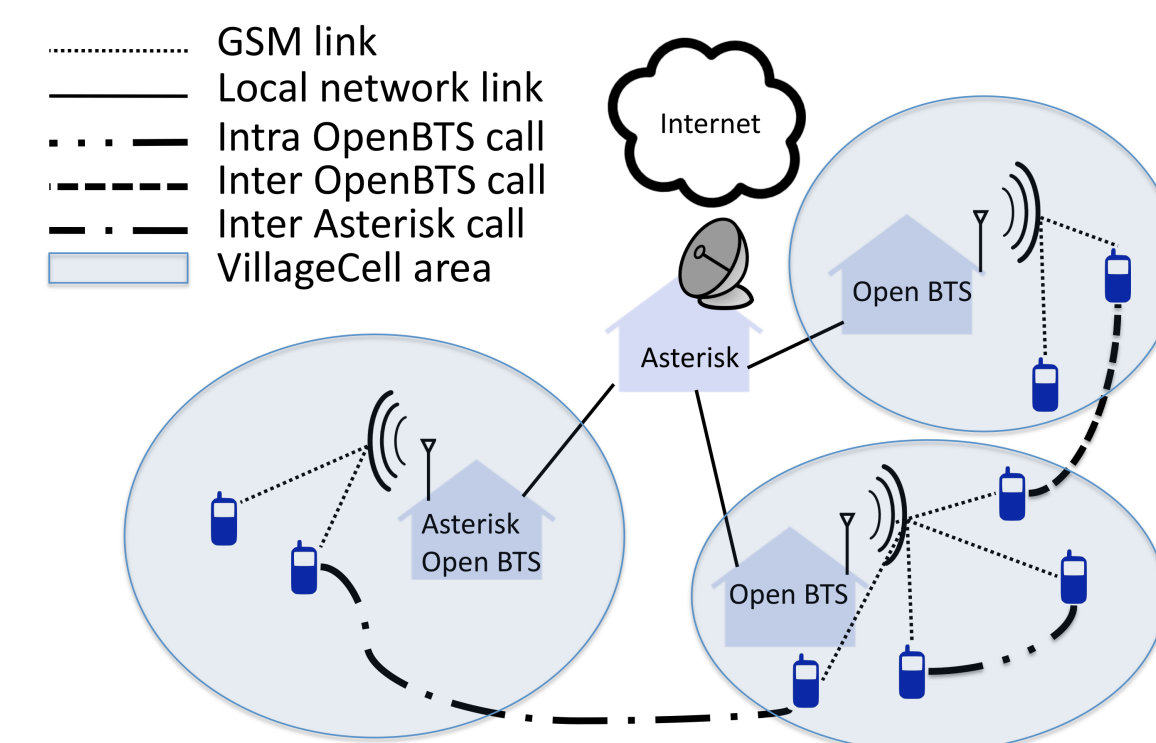
VillageCell is a low-cost alternative to high-end cell systems. It relies on SDRs and open source software for GSM communication (OpenBTS) and call management (Asterisk). It provides:

- Low-cost, low-power, easy to deploy cell phone infrastructure
- Free calls within the local network and standard telephony connections to the outside (through GSM - VoIP translation)
- Rural area-specific applications based on free local SMS messages: e.g. RemoteMath app that allows rural school children to obtain real-time help from experts with math homework