A Hybrid Approach for Rural Broaband Access Networks

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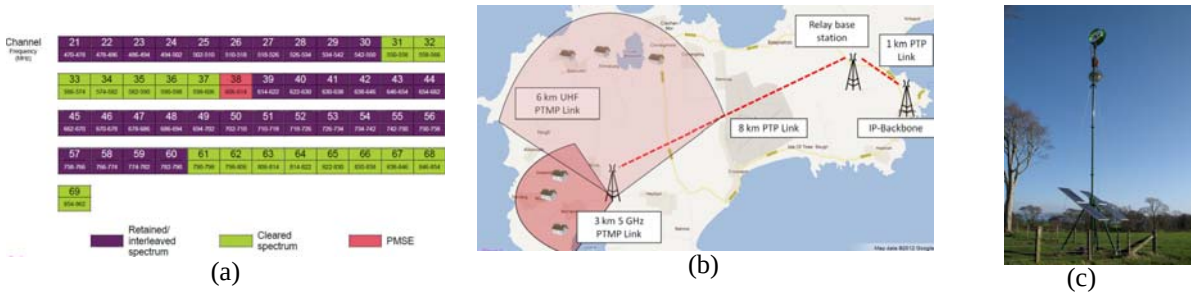
Abstract - Recent regulatory developments by the US's Federal Communications Commission and the UK's Office of Communications (Ofcom) have opened up new opportunities for wireless systems to utilize unoccupied TV 'White Space' (TVWS) channels now available after analog switchover for secondary use as shown in Fig. 1a. TV-band spectrum has favourable radio propagation characteristics that allow signals to travel relatively long distances over hilly terrain or in built-up urban areas. This, coupled with the fact that the regulations currently being drawn up by the FCC and Ofcom are widely expected to allow licence-exempt access to TVWS spectrum, make TVWS attractive for applications such as: i) rural broadband; ii) high-definition CCTV transmissions in towns and cities; iii) data off-loading for already-congested cellular networks; iv) machine-to-machine (M2M) communications; etc.

In this article, we present a wireless broadband access testbed running in the Scottish Highlands and Islands which is based on a relay network of low-power base stations. Base stations are powered by a combination of renewable sources creating a low cost and scalable solution suitable for community ownership. The use of the 5 GHz bands allows the network to offer large data rates and the testing of ultra high frequency "white space" bands provides wider coverage whilst reducing the number of base stations or required transmission power. We argue that the reliance on renewable power and the intelligent use of frequency bands makes this approach an economic green radio technology which can address the problem of rural broadband access.



(a) (b) (c)

Figure 1 (a) 470-862MHz TV spectrum, (b) Example of a network connecting remote communities and (c) Renewable base station

Green base station trials have been running in Scotland over the last 24 months, including a 10 m high hybrid wind and solar powered base station on the Isle of Tiree as shown in Fig. 1b, and a 6 m high hybrid wind and solar powered base station as shown in Fig. 1c recently installed on the Isle of Tiree. On the Isle of Bute a renewable powered "WindFi" base station has been operating over 24 months with different radio payloads to assess the performance of the renewable power system. Outdoor tests on Bute using "white space" test-kit based on a modified WiFi radio with a 5 MHz bandwidth (operating in an 8 MHz channel) have demonstrated Transmission Control Protocol (TCP) throughput up to 3 Mbit/s in a 5 MHz channel for a 4.8 km non-LOS link in a UHF channel at 2 W EIRP, and higher than 10 Mbit/s for 2 km connections. Further trials are now ongoing under the auspices of a UK Government Technology Strategy Board Grant in collaboration with British Telecom PLC, BBC, Steepest Ascent Ltd, Netpropagate Ltd and Berg Design Ltd which commenced in April 2011 and will run until September 2012.

Conclusion- This article has discussed how a combination of green radio techniques enables the provision of a low-cost rural broadband solution through a network infrastructure of renewable base stations. Low-power and low-cost WiFi based radio equipment allows renewable energy "WindFi" base stations to be operated by renewable sources, reducing operating costs, fuel use, and eliminating the requirement of access to the electricity grid. Additionally, "WindFi" base stations are capable of transmitting via an overlay using TV "white space" frequency bands.