Wireless Mesh Networks for Interconnection of Remote Sites to Fixed Broadband Networks*

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Abstract. The paper describes a technology transfer project that intends to evaluate the usefulness and feasibility of wireless mesh networks (WMNs) in meteorological monitoring applications. We try to identify application and usage scenarios for WMNs. We investigate whether and how the used hardware and software components are appropriate for the intended application scenarios and whether the application requirements such as bandwidth, delay, reliability, recovery times etc. can be met. Potential weaknesses and bottlenecks will also be identified. We performed a preliminary latency test over 11.4 km.

We investigate whether wireless mesh networks (WMNs) are appropriate for connecting sensor networks or other devices deployed in remote areas, where no fixed network access is available, to a fixed broadband network. To support a variety of application scenarios, the WMN must meet reliability requirements and bandwidth in the 10 Mbps range over distances of several 10 km, e.g., by using directional radio transmission. We intend to develop, deploy, and evaluate a WMN based on IEEE 802.11a/h (5 GHz). WMNs would allow SWITCH, the provider of the Swiss national research and education network, to extend the geographic coverage of their fiber network and to offer broadband services to further locations that are not close to the fiber network.

Experiments with real-world deployments have proven the usability of directional antennas for wireless radio networks to connect nodes at long distances (e.g., Heraklion MESH, WiLDNet CATER, and Quail Ridge Reserve WMN). Actual measurement results of far-distance 5 GHz (802.11a/h) links applying directional antennas are rare. The advantage of 5 GHz links is expected in lower interference with existing networks.

We intend to run experiments with different network scenarios. We need to evaluate the attainable signal quality, bandwidth, and delay for a single long distance hop (Fig. 1(a)). Afterwards, relaying the transmission by intermediate mesh nodes has to be evaluated. Moreover, we will measure the QoS characteristics including reliability using redundant paths via multiple intermediate hops (Fig. 1(b)). Finally, performance tests in case of link breaks (recovery times) will be performed. Our goal is to build a reliable and redundant connection between the meteorological testing station of MeteoSwiss at Payerne and the access point to the SWITCH backbone in Neuchâtel over multiple mesh nodes deployed in the region of lake Neuchâtel.

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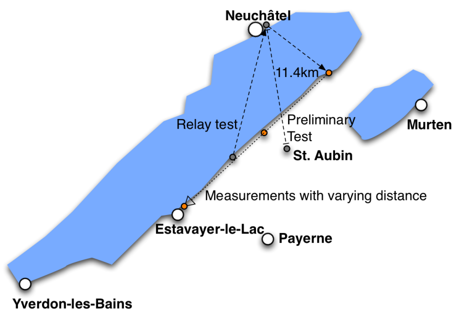
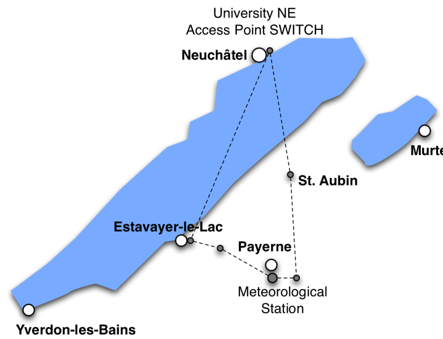


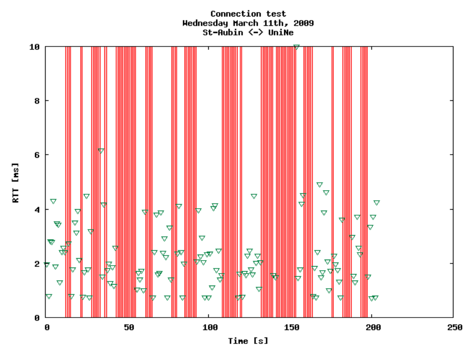
(a) Preliminary, distance and relay tests



(b) Meteorological station ↔ SWITCH

(c) Neuchâtel

(d) St. Aubin



(e) Measurement results

Fig. 1. Test scenarios and results of preliminary measurements Neuchâtel ↔ St. Aubin

Preliminary measurements have been performed between a mesh node mounted on the roof of the University of Neuchâtel and another temporary node on the other lake side (distance of 11.4km). The nodes and the measurement results are shown in Fig. 1(c) - 1(e). Our first measurements performed using ICMP echo packets show good round trip times (0.8 - 5ms). Periodically, there are some time periods with packet loss (39% of the totally sent packets with vertical lines). Strong winds during the measurements caused periodic movement of the antenna top (5m above ground). By tensioning the antenna to ground with ropes, the movement can be eliminated in future measurements. Moreover, no adaptations have been made to 802.11a/h parameters in the first measurements. Fine-tuning the parameters for the long-distance links may further reduce the packet loss. Two other problems occurred. First, the correct alignment of the antennas without tools is very difficult. Binoculars, a clinometer and an amplitude compass will be used in future measurements. Second, the dedicated 100m Ethernet cable (mesh node on the roof of University of Neuchâtel ↔ border router of SWITCH in basement) and the lightning protector resulted in packet loss due to high attenuation and collisions. The packet loss has been eliminated by reducing the cable distance to the next active network component through an additional VLAN on the building network instead of the dedicated physical connection.