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Wireless Mesh Networks

Connecting Remote Sites

Text **Thomas Staub**

Today, many sensors deployed in the environment do not have direct access to high bandwidth corporate or public networks. Wireless Mesh Networks can solve this problem by providing a flexible and secure access network. Their feasibility has been explored in a recent technology transfer project.

The coverage of high capacity networks will probably never extend to all areas of Switzerland. The deployment of fixed networks can be expensive, and topography can limit the coverage and availability of cellular networks. There are, however, several applications, such as meteorological or environmental monitoring, where sensors require broadband network access at remote locations. Usually, such network access is then provided by the costly extension of either wired or cellular networks. Wireless Mesh Networks (WMNs) are a candidate technology for providing cost-efficient connection of remote sites to corporate or public networks.

The technology transfer project entitled «Wireless Mesh Networks for Interconnection of Remote Sites to Fixed Broadband Networks (Feasibility Study)» evaluated the feasibility and serviceability of WMNs as an alternative to the broadband interconnection of high-bandwidth sensors to a fixed network backbone. The Swiss Commission for Technology and Innovation and the industry partners of MeteoSwiss, SWITCH, and PC Engines funded the project.

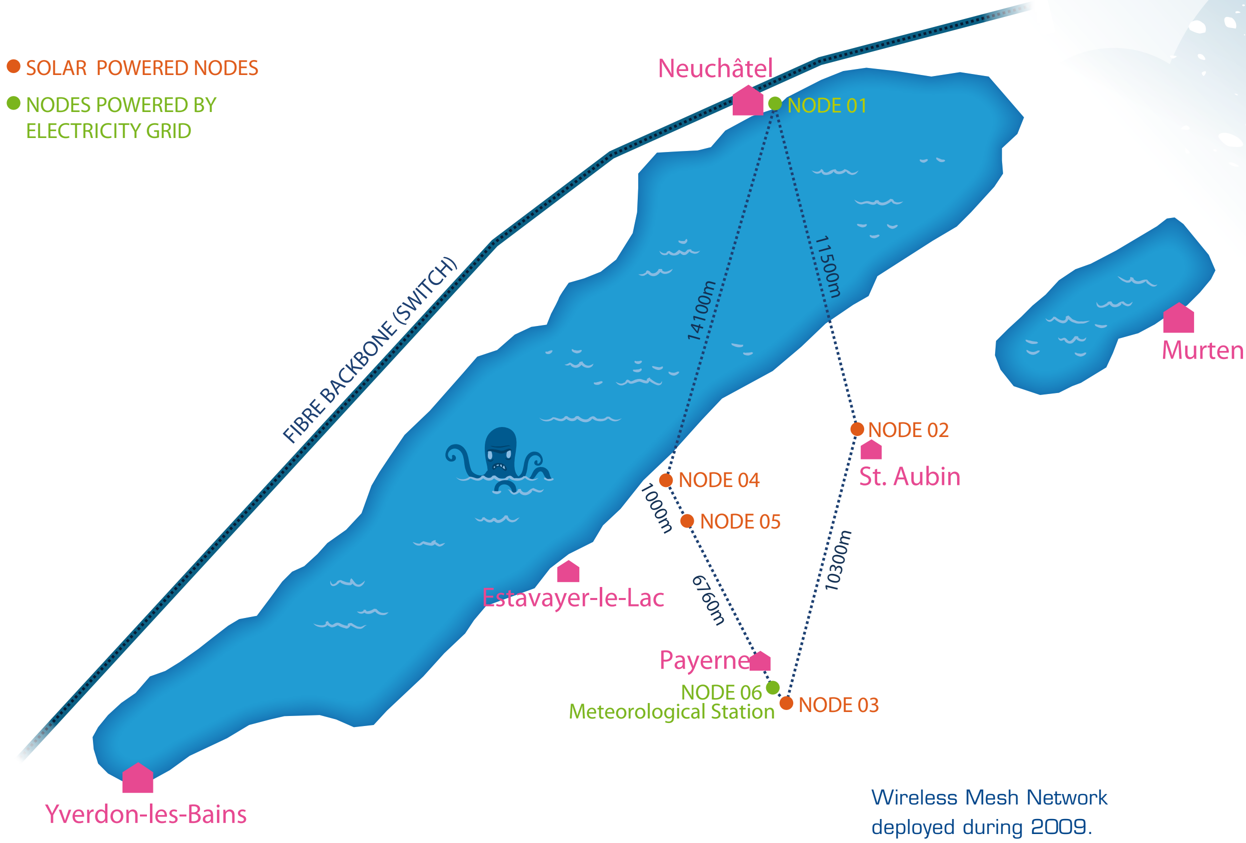
In a showcase example, an IP camera located at the MeteoSwiss Aerological Station in Payerne was connected via WMN to the SWITCH*lan* fibre backbone at the University of Neuchâtel, approximately 20km away. The WMN consisted of six nodes and formed two redundant paths so as to increase network robustness and resilience. The four intermediate nodes were solar-powered. The nodes communicated over IEEE 802.11h (5GHz) in line with the regulations issued by the Federal Office of Communications. The equipment used included mesh nodes, directional antennas, solar panels and batteries, telescopic masts and guying materials, and different tools and utilities.

The mesh nodes were running an embedded Linux distribution with a Linux 2.6 kernel. The distribution is a development of the University of Bern and is called ADAM (Administration and Deployment of Ad-hoc Mesh networks). It provides all the required functionality for operating the WMN.

We recommend the following best practice for similar field studies structured in the three phases of network planning, pre-deployment, and deployment.
Several aspects of network planning have to be considered for successful WMN deployment. Elevated node sites are needed for free line-of-sight connections. Accurate electronic maps can help in determining candidate node locations. Changes in vegetation and buildings since the maps were first compiled make on-site reconnaissance indispensable in order to ensure that the node sites are actually useable. Possibilities for fixing the antennas can be evaluated, the accessibility of the sites can be checked and taken into account for the final selection of the sites, and the consent of the landowners can be obtained.
In the pre-deployment phase, the appropriate equipment and tools have to be determined, ordered, and prepared for deployment, e.g. the nodes must be assembled and loaded with the operating software, and the solar-powered equipment must be dimensioned to cope with all potential weather conditions. An outdoor pre-deployment test at a nearby location is then recommended for establishing any missing or defective materials and tools at an early stage of the project.

During the deployment, different mechanical aspects have to be taken into account. As directional antennas can be employed to cover long distances, one crucial aspect is their correct alignment, which poses considerable challenges. Our best practice involves setting up and fixing the antennas with the correct intermediate angle and

Solar-powered mesh node with directional antennas.



Wireless Mesh Network deployed during 2009.

correct elevation in the laboratory and then aligning the antenna with an amplitude compass and a mast level on-site. Another issue is the stable mounting of the antennas; the ground may have to be stabilized to prevent the sinking-in of the tripods and subsequent antenna misalignment. Moreover, guying the masts may be necessary in order to prevent movement of the antennas. If antennas are mounted on a building, appropriate lightning protection is required.

To sum up, the project showed that WMNs are an interesting alternative for interconnecting remote sites with corporate and public networks. Our showcase example provided a network service for transmitting weather data (430 kbps over 20km) with an acceptable network availability (>97%). Further potential exists for using the full bandwidth provided by the IEEE 802.11h links and for increasing the network availability obtained through further self-healing and resilience mechanisms and multi-path communication. Due to their moderate costs, their operation in a licence-free spectrum and the use of low cost off-the-shelf equipment, WMNs can be used in various other application scenarios, such as for connecting sensor fields. Although the WMN in this study has not yet matched the trustworthiness of wired networks and will probably never reach their bandwidth, the potential of the technology has been successfully proven. WMNs are a viable alternative for connecting remote sites to fixed broadband networks in many scenarios.

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Final Report of the Technology Transfer Project entitled «Wireless Mesh Networks for Interconnection of Remote Sites to Fixed Broadband Networks (Feasibility Study)»
http://bit.ly/cti-mesh

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