A⁴-Mesh: Connecting Remote Sites

Developments in A⁴-Mesh have turned wireless mesh networks into a valuable technology for Swiss institutions of higher education. Large numbers of research projects in different areas, like climate research and geology, will profit from an easily deployable outdoor wireless network that also supports mechanisms for authentication, authorization, accounting and auditing (A⁴) functionalities.

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Equipment for the deployed A⁴-Mesh network for environmental research in the Valais region.

Wireless mesh networks (WMNs) are a candidate technology for the easy and cost-efficient connection of remote sites to public or corporate networks. So far, WMNs have enjoyed only limited deployment and have been used mainly in community networks to provide cheap Internet access, in industrial settings for control and monitoring, and in military applications to permit mobile communications within field units. However, in the near future several new applications – mainly in the area of higher education and healthcare – are likely to make WMNs an everyday reality.

A⁴-Mesh: technological novelty

A⁴-Mesh has generated tailored technologies for extending coverage and providing redundancy for campus networks, as well as for connecting up remote sites for research experiments. In particular, A⁴-Mesh technology has made it possible to develop and integrate innovative A⁴ mechanisms:

a) broadband network access, plus integration into the authentication and authorization infrastructure (AAI) for Swiss higher education, based on SWITCHaai mechanisms,

b) an accounting system adjusted for federated WMNs using SWITCHaai. The accounting mechanism keeps track of a user's traffic consumption on every mesh node forwarding the user's traffic to the Internet so as to be able to fairly share out the costs among the organizations using the wireless network infrastructure concurrently,

c) a reduction in network maintenance costs through auditing functions which can trigger recovery mechanisms for successful operation even under inconsistent and erroneous states.

A⁴-Mesh: an interdisciplinary approach

The A⁴-Mesh project has been carried out as part of the «AAA/SWITCH-e-Infrastructure for e-Science» programme. It is an interdisciplinary collaboration between SWITCH and two networking research groups, UniBE IAM and UniNe IIUN, plus several potential WMN users, namely the environmental researchers from UniBE GIUB and the IT services from UniBE IT and UniNE SITEL. The project has profited tremendously from the synthesis of different disciplines. On one hand, it has generated tailored technologies for the increased coverage of campus networks and, on the other, it has created new opportunities for environmental research. The initial goal of the project to develop a fully functional wireless mesh network supporting the A4 functionality, has resulted so far in the successful deployment of two indoor test beds and two outdoor networks. Among these, the deployment pilot network for environmental research in the Valais region deserves a closer look. The deployed A⁴-Mesh network supports the transdisciplinary MontanAqua project for national research programme NRP 61, which is aimed at developing strategies for sustainable and integral water management in dry valleys in the Alps. The Crans Montana Sierre region has been chosen as a study area which is already affected by water shortage.

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MontanAqua pilot network

In 2010, as a part of the MontanAqua project, an extensive hydro-meteorological monitoring network was set up for estimating and modeling water availability under present and future conditions. This network comprises twelve automatic weather stations, seventeen rain gauges, six soil moisture plots, one hill-slope lysimeter, a high resolution webcam and six runoff gauges. All these devices produce a large amount of data, which needs to be transferred from the different field sites to the Institute of Geography at Uni-BE, preferably in near real time. It would be very convenient to be able to access measurement devices directly from the university, ensuring data transfer at frequent intervals as well as giving the option of remote control, both of which reduce the risk of data loss. A⁴-Mesh technology fulfills these requirements, since this technology allows the university's campus network to be extended to virtually every measuring site. In 2011, a wireless communica-

tion network using A⁴-Mesh technologies was deployed in the Crans Montana Sierre region to connect the hydrological sensors to the university network. This network consists of seven nodes that collaborate and propagate the data between each other. Two additional nodes are planned for spring 2012.

These developments of four innovative A⁴-mechanisms for authentication, authorization, accounting and auditing have proved the value of A⁴-Mesh technology for Swiss institutions of higher education.

The Les Roches Gruyère private university in Bluche kindly provides facilities for entrance to the SWITCHlan backbone and vice versa, which we refer to as the gateway node. The first link from the gateway node is directed to a relay station in Vercorin, on the opposite hill slope, where the MontanAqua webcam is located. The second link from the gateway node connects to nodes in Cry d'Er, which in turn interlink with all the other nodes, except a node which is, due to constraints of the mountain environment, only connected to the in Vercorin located node. A line of sight propagation between neighbouring stations permits a wireless link even up to 10 km using directional antennas that internally have two antennas, one of which is vertically and one horizontally polarized.

The A⁴-Mesh is a WLAN-based network using IEEE 802.11n technology, which builds on previous 802.11 standards by adding multiple-input multiple output (MIMO) to improve the network throughput between neighbouring stations. In this way, the deployed network has been configured to achieve the best possible throughput. Additionally, as a means of improving lifetime and reducing the maintenance cost of WMNs, most of the mesh nodes come with a self-contained power supply based on a solar panel and a battery.

The deployment of the A⁴-Mesh pilot network in the Crans Montana Sierre region has brought many benefits to researchers wishing to access remote sites at any time. One of these is doubtless the combination of almost real-time data collection, ease of access and convenience – aspects that are necessary for performing qualitative research experiments. A⁴-Mesh has eventually achieved the very first, basic step towards developing a fully functional wireless mesh network, which is furthermore integrated in the authentication and infrastructure, in our case the one for Swiss higher education.

→ https://a4-mesh.unibe.ch

Installation of an infield mesh node for environmental research in the Valais region.

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