Community Home Gateways for P2P Clouds

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***Abstract* — P2P based clouds built with low-end devices and voluntarily contributed resources have been proposed by several authors. While some work was published on architectures and decentralized P2P-based mechanisms for such clouds, yet no complete system has been presented which implements such cloud systems without important limitations. We present the community home gateway, a computer system attached to a wireless community network router, able to host platform and application services. Different to current home gateways and other low-end systems, the community home gateway offers resource virtualization, and can thus be used as cloud resource. The community home gateway removes the lack of a system open for service contributions and therefore constitutes an important step towards building P2P clouds with low-end devices. While we present the community home gateway as being part of a P2P community cloud, the applications scenarios of the system that can be imagined go beyond community networks.**

Index Terms – P2P services, home gateways, community networks.

I. INTRODUCTION

A cloud built with geographically distributed low-end devices and voluntarily contributed resources has been proposed by several authors. In [1] a decentralized P2P Cloud is proposed, which brings together resources of peers without any central monitoring and coordination component. The Clouds@Home project [2] proposes a cloud infrastructure built with contributions of end-user devices voluntarily shared by the participants. The Nanodatacenters project [3] proposes ISP-controlled home gateways to provide computing and storage services and adopts a managed peer-to-peer model to form a distributed data center infrastructure.

It can be seen that today's home gateways, found on the premises of the customers of telecommunication operators, offer much more than their initial functionality to establish the connection of the user's home computers to the Internet through DSL. Nowadays, the functionality of home gateways is being extended in different directions, so that this equipment is embodied in various physical device personalities and form factors. Some home gateways are more oriented to network service provision (e.g. broadband Internet connectivity, firewall, VPN connectivity, IP telephony, IPTV audio/video streaming, wireless LAN) and are offered by the telecom operators as DSL router home gateways. Other types of these devices focus on the function around media distribution, also called set-top-boxes (STB), offering a user interface through the TV to control media streaming applications. Following this trend, more complex application services, which the user currently runs on computers connected to the home gateway, might in the future be incorporated in the home gateways. This will lead to important energy savings for services needing a 24x7 operation, since the user's home computer will not need to run these services any more.

The trend towards an extended home gateway device for service and application hosting is also clearly stated in the documents of the Home Gateway Initiative (HGI)[1], an alliance of telecom operators, home gateway manufacturers and vendors, with several on-going works on next-generation home gateways.

An important limitation of the service provision by the HGI envisioned home gateway devices is that the ISPs consider them as closed systems, where the services that can be deployed (or contracted) are controlled by the telecommunication operator, such as also foreseen in [3]. This approach will slow down the speed for achieving P2P clouds with these devices, since these home gateways are not open to install additional components, e.g. external cloud services, beyond those foreseen by the configuration options defined by the telecom operator.

Different to the commercial network provision, wireless community networks are an emergent model of an infrastructure that aims to satisfy the demand of a local community for Internet access and ICT services. Most community networks originated in rural areas which commercial telecom operators left behind when deploying the broadband access infrastructure for the urban areas. Community networks have become rather successful and widespread, with network sizes ranging from 500 to more than 20,000 nodes such as FunkFeuer[2], AWMN[3], Guifi.net[4], Freifunk[5] in Europe, among many others.

The community network user typically has a router installed outdoors on the roof of the building in order to be able to connect over a wireless link to the community network. These routers are often off-the-shelf cheap low-end

[1] http://www.homegatewayinitiative.org/
[2] http://www.funkfeuer.at/
[3] http://www.awmn.net/
[4] http://guifi.net/
[5] http://www.freifunk.net/

devices, providing just networking services. For the provision of services, the router is connected over a wired LAN with a home computer (e.g. a PC or laptop), where the services are hosted, and via a wireless link with the community network.

In this demonstration paper we present the community home gateway, a system attached to a wireless community network router. The design and implementation of the community home gateway system aims at avoiding the obstacles of a closed home gateway, and allows the gateway's hardware to be part of a cloud infrastructure that is managed by P2P services. To this end, the system offers cloud infrastructure services based on resource virtualization in these low-end devices, achieved with Linux containers (LXC) ported to the *OpenWRT* operating system. In order to operate with the LXC virtual resources, both user space tools and *libvirt* software have been integrated such that these devices can be part of cloud infrastructure services. Since application services can run in Linux containers, this community home gateway can furthermore host service elements and become part of platform and application services.

II. Scenario

A. P2P cloud scenario

Figure 1 depicts several node types of a community network. The picture shows typical community nodes with connected router, servers and clients. In addition, however, these community nodes have the proposed community home gateways attached to them.

Decentralized mechanisms such as proposed in [1] running on the community home gateways will enable to manage the virtualized resources as a cloud infrastructure service. In these managed resources of the community home gateway, services and end user applications can be hosted.

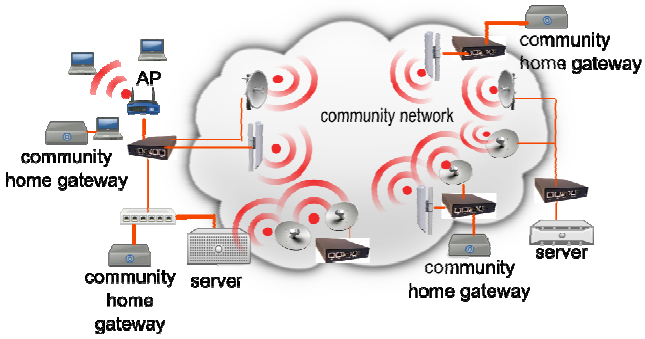

Fig. 1 Nodes in a community network with community home gateways.

B. Deployment

Community home gateways have been deployed in Community-Lab[6], a testbed built by the CONFINE project from the FP7 FIRE initiative, which enables and invites researchers to conduct experiments in community networks [4]. Figure 2 shows some outdoor nodes of Community-Lab. The wireless routers integrated in the antennas connect to other nodes of the community network. In Figure 3, the device used as community home gateway in Community-Lab is shown.

Fig. 2 Outdoor nodes deployed in Community-Lab.

Fig. 3 Community home gateway based on Jetway JBC362F36W, Intel Atom N2600 CPU, 2GB RAM, 120GB SSD, deployed in Community-Lab.

IV. Demonstration

The demonstration at the P2P 2013 conference is a live demo of the community home gateway in two parts: 1) A live demo of the access to community home gateways deployed in the Community-Lab testbed. For this purpose we will connect to the Web interface of the Community-Lab portal and connect to testbed nodes integrated in the Guifi.net community network. 2) A live demo of operational community home gateways (4-5 nodes) deployed at the conference demo location and interconnected through wireless routers. Virtual resources are created with Linux containers in the community home gateways. In order to demonstrate platform and application services, a set of decentralized applications (e.g. file-sharing, video-streaming, storage) will be running in the virtualized resources of the community home gateways. The demo will exemplify to the researchers the feasibility of building P2P clouds with community home gateways and will allow discussing the research challenges and obstacles of building P2P services for such systems and environments.

References

[1] Ozalp Babaoglu, Moreno Marzolla, Michele Tamburini, "Design and implementation of a P2P Cloud system", *SAC '12 Proceedings of the 27th Annual ACM Symposium on Applied Computing*, 2012

[2] Distefano, S., Puliafito, A., Cloud@Home: "Toward a Volunteer Cloud" , *IT Professional* (Volume:14 , Issue: 1)

[3] V. Valancius, N. Laoutaris, L. Massoulié, C. Diot, P. Rodriguez. Greening the internet with nano data centers. *In CoNEXT '09 Proceedings of the 5th international conference on Emerging networking experiments and technologies*, 2009.

[4] A. Neumann, I. Vilata, X. León, P. Escrich, L. Navarro, E. López, "Community-Lab: Architecture of a Community Networking Testbed for the Future Internet", *International Workshop on Community Networks and Bottom-up-Broadband* (CNBuB), October 2012.

[6] http://community-lab.net/