A P2PSIP Demonstrator Powered by OverSim

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I. Introduction

A fundamental problem in studying peer-to-peer networks is the evaluation of new protocols. This commonly involves both the simulation of the protocol in a large-scale network as well as the testing of the protocol in connection with real applications in networks like PlanetLab. To facilitate these tasks we developed the overlay simulation framework *OverSim* [1]. It was designed to fulfill a number of requirements that have been partially neglected by existing simulation frameworks.

In our demonstrator we show how OverSim can not only be used to simulate overlay protocols in large-scale networks, but also demonstrate its real-world capabilities by means of a P2PSIP testbed.

II. Overlay simulation framework OverSim

OverSim [1] is a flexible overlay network simulation framework based on OMNeT++. The framework includes several structured and unstructured peer-to-peer protocols like Chord [2], Pastry, Koorde, Broose and Gia. These protocol implementations can be used for both simulation as well as real world networks. To facilitate the implementation of additional protocols and to make them more comparable OverSim provides several common functions like a generic lookup mechanism for structured peer-to-peer networks and an RPC interface. Several exchangeable underlay network models allow to simulate complex heterogeneous underlay networks as well as simplified networks for large-scale simulations. With OverSim simulations of overlay networks with up to 100,000 nodes are feasible.

For reusing overlay protocol implementations without code modifications in real networks, we developed a special underlay network model. Either each OverSim instance only emulates a single host, which can be connected to other instances over existing networks like the Internet, or this can be used to demonstrate overlay protocols and applications like P2PSIP with a limited number of physical devices by connecting them to a large number of overlay nodes emulated by OverSim on a single host. For this, a special "router" module can be added to the simulation scenario which acts as a gateway to a real network.

All of the underlaying network models have a consistent UDP/IP interface to the overlay protocols. Hence, using a different underlaying network model is fully transparent to the overlay layer, which provides the *Common API for structured peer-to-peer overlays* [3] to support a broad range of applications.

III. P2PSIP

An emerging use case for overlay protocols are decentralized VoIP networks. Recently an IETF working group has been formed to develop protocols for the use of the Session Initiation Protocol (SIP) in networks without centralized servers. Decentralized VoIP networks can e.g. be used as failover for traditional server-based SIP networks in emergency cases.

For our P2PSIP approach we have chosen to use an external DHT as distributed name service to register and lookup SIP identifiers. Apart from this decentralized name resolution the call setup is based on the standard SIP protocol. The benefit of this approach is that we can easily connect legacy SIP phones to our P2PSIP network. This connection is accomplished by a SIP proxy located between SIP phone and DHT which handles the name resolution.

Designing protocols for P2PSIP poses several security challenges. Due to the decentralized nature of the network, SIP identifiers can't get assigned by a trusted central authority. Therefore there have to be security mechanisms to prevent the stealing of SIP identifiers and to guarantee their uniqueness, if users should be able to pick an arbitrary identifier on their own. Securing the data stored in a DHT is an expensive task (in terms of communication overhead), because the data has to be replicated on several nodes. In our approach we therefore minimize DHT usage by using the underlying *key-based routing layer* [3] (KBR) to resolve *(NodeID, IPAddress)* mappings. To allow the user to still pick easy to remember SIP identifiers, there is an optional *(SIP identifier, NodeID)* mapping, which is resolved by querying the DHT. Since in our approach we're using permanent *NodeIDs*, the mapping between *SIP identifier* and *NodeID* usually doesn't change and therefore reduces DHT replication overhead.

IV. Demonstrator setup

Our demonstrator will show some of the key features of the OverSim framework. We first show how OverSim's protocol implementations can be reused in real networks and how the KBR and DHT services provided by OverSim can be used by real applications. We further show how OverSim can be used to emulate a large number of overlay nodes on a single host to make demonstrations with few physical devices more realistic.

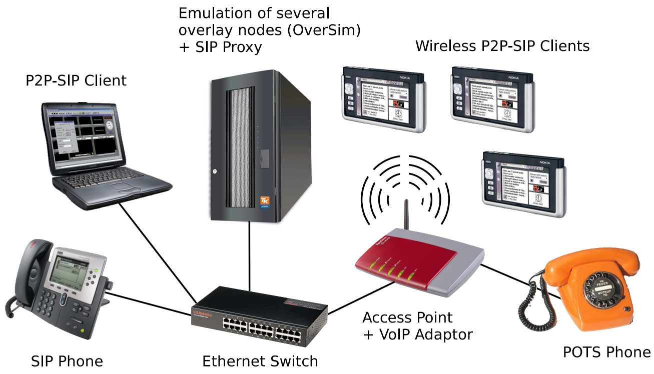

Fig. 1. Architecture of the demonstrator setup

Finally we demonstrate the visualization of a Chord overlay topology under churn by OverSim's GUI capabilities.

A. Architecture

The demonstrator architecture comprises several Nokia 770 Internet Tablets with 802.11g interfaces, a Linux laptop, a legacy SIP phone connected by Ethernet, and an old POTS phone. Finally there is a high-performance server, that emulates a large number of additional overlay nodes. An overview of the architecture is shown in Figure 1.

Each of the Nokia 770s and the Laptop is running the SIP softphone application *minisip*, an *openser* based SIP proxy and an OverSim instance. OverSim is used to provide the KBR and DHT services to the SIP proxy via an XML-RPC interface based on the *Common API* [3]. The OverSim instances communicate over the 802.11g interfaces with each other to build a logical Chord ring.

The legacy SIP and POTS phones also use a SIP proxy located on the server computer to connect to the P2PSIP network. To make the overlay topology more realistic additional overlay nodes are emulated by another OverSim instance running on the high-performance server. This OverSim instance also has a GUI to visualize the emulated network topology and overlay traffic.

B. P2PSIP scenario

In the P2PSIP scenario we will demonstrate how SIP identifiers get registered and looked up in the Chord overlay network. At first the the user chooses an arbitrary SIP identifier on one of the Nokia 770s. The device then connects to the overlay network and stores the SIP identifiers on one of the other overlay nodes, i.e. another Nokia 770 or an emulated node on the high-performance server. If the same SIP identifier was already registered by another user before, the registration is rejected.

In the next step the newly registered identifier may be called from one of the other Nokia 770s or traditional SIP phones. This involves a lookup of the stored SIP identifier in the DHT. The whole lookup process is visualized by the GUI on the server.

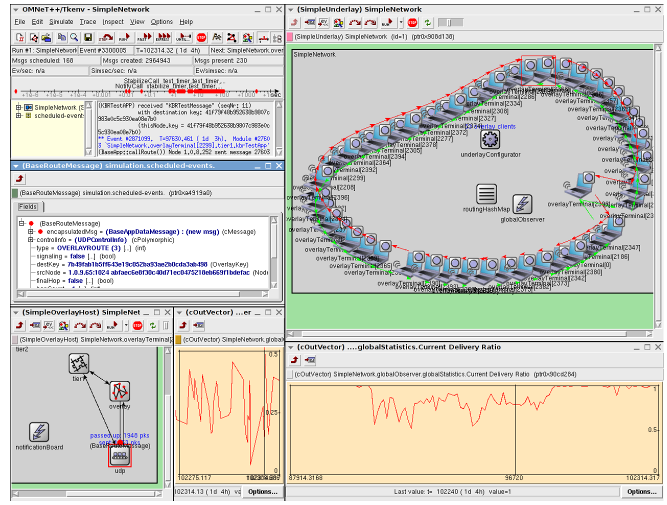

Fig. 2. Screenshot of the churn simulation scenario

C. Visualization of overlay protocols under churn

In a second scenario we demonstrate the simulation capabilities of OverSim and visualize the behavior of overlay protocols under steady churn (Figure 2).

Overlay nodes join and leave the network periodically using a configurable time interval. The permanently changing overlay topology is visualized in the main simulation window. In Chord e.g. the overlay nodes' successor and predecessor nodes are pointed at using colored arrows, so that topology adjustments and repairs are easy to follow.

Every node is running a test application, which periodically sends probe messages to random *NodeIDs* to constantly measure the overlay's performance. The delivery ratio i.e the rate of successful delivered messages to its destination is plotted in an extra window during the whole simulation run. The effect of joining and leaving overlay nodes on the delivery ratio can be accentuated by changing the time interval nodes join and leave the overlay.

Acknowledgment

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