Emulating Multi–hop Wireless Networks over a Planetary Scale Testbed*

Elio Salvadori[1], Roberto Doriguzzi Corin[1], Roberto Riggio[1], Attilio Broglio[2], Fabrizio Granelli[2], and Andy Bavier[3]

[1] CREATE-NET, via alla Cascata 56/D, 38123 Trento, Italy
[2] DISI – University of Trento, via Sommarive 14, 38123 Trento, Italy
[3] Princeton University, Princeton NJ 08544, USA

1 Introduction

The most commonly used technique to evaluate novel solutions is to leverage on simulation studies which are largely based on a simplified model of the system behavior. Such an approach provides an approximate evaluation of the system's performances, which can be potentially far away from the behavior on a real deployment. Another solution is to exploit real world prototypes and testbeds. Such testbeds are generally based on a limited number of nodes and, due to their experimental purposes, they only partially present the challenges of a real operational environment with hundred or thousand users. Furthermore, the limited number of nodes limits the possibility to study scalability issues.

In this paper a novel architectural framework and its implementation are proposed in order to provide a realistic environment where innovative techniques for multi–hop wireless networks can be tested in a controlled environment. The objective of the proposed solution is to depart from the limitations of simulated or real world testbed, while providing a testing environment which facilitates performing experimental studies of real network nodes firmware at large scale. To this purpose VINI (VIrtual Network Infrastructure) [1], an extension of PlanetLab – a planetary distributed testbed composed of thousand of nodes, has been selected as the basis for the proposed framework.

2 Architecture and Preliminary Results

Figure 1 illustrates the framework that has been set up in order to provide an effective emulation platform on top of VINI. The contribution of this paper is twofold: on the one hand we extend VINI with a *wireless link emulator*, which mimics wireless link conditions in a "wired" environment, and with a *virtual*

* This work was partially supported by the Seventh Framework Programme (FP7/2007-2013) of the European Commission, within the SMART-Net project (grant number 223937) and by the Italian Ministry of Scientific Research (MIUR) within the framework of the Wireless multiplatfOrm mimo active access netwoRks for QoS-demanding muLtimedia Delivery (WORLD) project (grant number 2007R989S).

T. Magedanz et al. (Eds.): TridentCom 2010, LNICST 46, pp. 599–601, 2011.
© Institute for Computer Sciences, Social Informatics and Telecommunications Engineering 2011

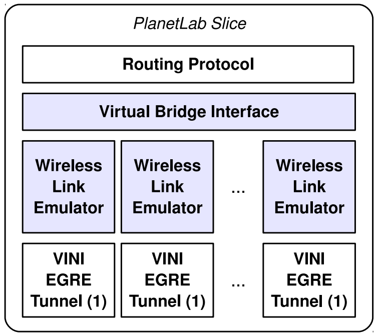
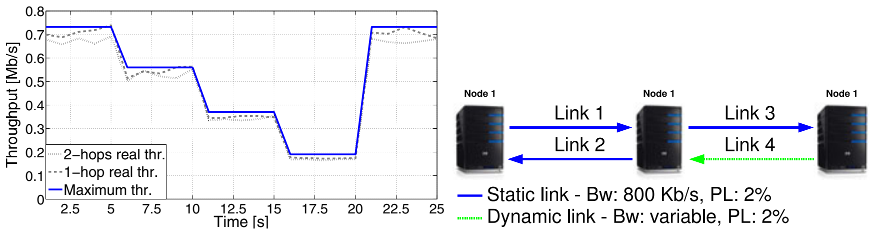


Fig. 1. A VINI "private instance" extended with our modules providing *wireless link emulation* and with *virtual bridging* functionalities

bridge which allows for L2 bridging among virtual interfaces in a slice. On the other hand we assess the viability of our approach by running WING [2], a real–world wireless mesh networking solution [3], on top of a VINI slice. The rationale behind such a choice lies behind the cross–layer techniques exploited by WING in order to perform link–quality routing. Such techniques require access to several MAC-level parameter and are thus very demanding for a network emulator. Even though the results reported in this poster refer to a slice composed by a limited number of nodes, the proposed approach can potentially scale up to thousand of nodes by leveraging on the intrinsic properties of PlanetLab.

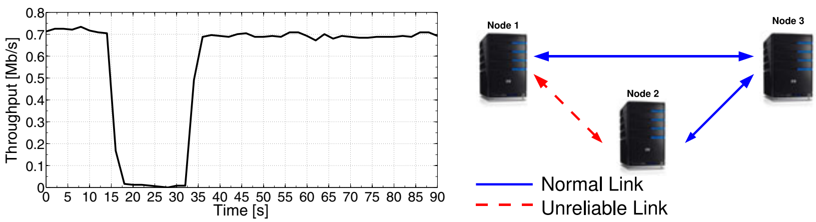
The preliminary experimental activity presented in this poster aimed primarily at assessing the correct behavior of the extension to the standard VINI architecture. Results obtained in both single–hop and multi–hop conditions show that the proposed tool provides an approximated, yet realistic, model for the wireless link conditions; furthermore, it provides researchers with an effective tool to introduce controlled events such as link degradation or disruption. More specifically, Fig. 2a shows the performance of the 2–hops path depicted in Fig. 2b when the available bandwidth at link number 4 is dynamically modified. Link bandwidth and packet loss for link 1 through 3 are respectively 800 kb/s and 2%. The picture shows the currently available bandwidth at link number 4 and the path throughput measured using the *nuttcp* [4] synthetic traffic generator.

Finally, a fully functional Wireless Mesh Network composed of three nodes has been setup using the WING toolkit [2]. It is worth noting that the WING routing protocol that is currently exploited in commercially available platforms has been ran over a PlanetLab slice composed of 4 nodes without any modification to its source code. Figure 3a demonstrate the routing protocol self–healing capability by simulating a link failure in a single–hop scenario in a triangular network topology. The network outage is relative to the time need by the routing protocol in order to switch from a single hop path to a two hops path.



(a) Path throughput. (b) Network topology.

Fig. 2. Controlling a 2-hops path throughput by dynamically reconfiguring a wireless link's parameter (bandwidth)



(a) Path throughput. (b) Network Topology.

Fig. 3. Testing path reconfiguration delay by simulating a link failure

3 Conclusions

In this work a novel wireless network emulation framework built on top of VINI and enabling testing and development of innovative solutions has been presented together with an early assessment of its performance and capabilities. A number of future activities are envisioned, among them one of the most promising is the improvement of the wireless link emulator in order to take into account the broadcast nature of the communication medium, including carrier sensing.

References

1. Bavier, A., Feamster, N., Huang, M., Peterson, L., Rexford, J.: In vini veritas: realistic and controlled network experimentation. In: Proc. of ACM SIGCOMM (2006)
2. Granelli, F., Riggio, R., Rasheed, T., Miorandi, D.: WING/WORLD: An Open Experimental Toolkit for the Design and Deployment of IEEE 802.11-Based Wireless Mesh Networks Testbeds. Eurasip Journal on Wireless Communications and Networking 24 (2010)
3. Riggio, R., Scalabrino, N., Miorandi, D., Granelli, F., Fang, Y., Gregori, E., Chlamtac, I.: Hardware and software solutions for wireless mesh network testbeds. IEEE Communication Magazine 46(6), 156–162 (2008)
4. nuttcp, `http://www.lcp.nrl.navy.mil/nuttcp/`