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Tools to foster a global federation of testbeds

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ABSTRACT

A global federation of experimental facilities in computer networking is being built on the basis of a thin waist, the Slice-based Federation Architecture (SFA), for managing testbed resources in a secure and efficient way. Its success will depend on the existence of tools that allow testbeds to expose their local resources and users to browse and select the resources most appropriate for their experiments. This paper presents two such tools. First, SFAWrap, which makes it relatively easy for a testbed owner to provide an SFA interface for their testbed. Second, MySlice, a tool that allows experimenters to browse and reserve testbed resources via SFA, and that is extensible through a system of plug-ins. Together, these tools should lower the barriers to entry for testbed owners who wish to join the global federation.

1. Introduction

The internet is an old network, based upon protocols that were developed forty years ago. Its design choices were not made with current needs, such as mobility, wireless communications, real-time interactions, audio and video transmission, contemporary security concerns, etc., in mind. Applications such as the web, peer-to-peer communications, video streaming services, and many others were not anticipated. As we look to the future, with an explosion in the number of communicating agents using the network, and an increasing heterogeneity in the way the network is used, there will be a growing incoherence between the underlying technology and the uses to which it is put.

The shortcomings of the current internet architecture have prompted research initiatives to develop the so-called Future Internet, either through a continuation of incremental deployments or via a clean-slate approach based upon a complete rethinking of the internet's architecture. Testbeds have emerged from the need to explore this range of possibilities experimentally. They allow for experimentation on a multitude of existing and emerging technologies (sensor networks, wireless access, distributed computing clusters, switches, optical networking, etc.).

A great challenge in the development of these testbeds is to make them both highly capable and easily accessible to experimenters. The capabilities that we seek include great flexibility (for instance, to try radically new approaches at all layers of the protocol stack), global scale, an access to real end-users, high performance, and the ability to test cutting edge technologies. Such capable testbeds are complicated and expensive to put in place, and any

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given type of testbed might exist at only a few institutions, requiring experimenters to cross administrative boundaries in order to access them.

Because of scarcity, there is a need to share testbed resources among many different experimenters, granting each one what is termed a *slice* of the whole. Slicing can be achieved through sharing, either through virtualization, where this is possible; through other forms of simultaneous resource division (spatial, frequential); or through temporal division of resources, granting them to different users at different times.

Efforts are underway in Europe (the FIRE initiative), the United States (GENI [1]), and elsewhere in the world to promote the widespread availability of Future Internet testbeds through federation. In a federated system, experimenters at one institution can be authenticated and authorized to gain access to testbed resources hosted by other institutions. In addition, if physical interconnections exist between testbeds, a highly capable federation has the potential to allow experiments that span multiple testbeds at once.

The de facto standard for testbed federation today is the *Slice-based Federation Architecture*, or SFA. A testbed owner who wishes to enter their testbed into the global federation needs to provide that testbed with an SFA interface. However, this is not necessarily an easy task. Several variants of SFA exist, both in the form of working code and written specifications [2–4]. Some aspects of SFA, such as its authentication mechanisms, require specialized knowledge to implement. Other aspects, such as parsing capabilities for resource descriptions, can be laborious to put in place.

The contribution of this paper is the introduction of two tools, SFAWrap and MySlice, that lower the barriers to entry for testbed owners who wish to join the global federation. SFAWrap enables an owner to easily provide an SFA interface for their testbed, and MySlice is a tool for experimenters that accepts plug-ins that understand the semantics of individual testbeds. Both tools follow an open community development model and are released under free and opensource licenses.

Fig. 1 shows both tools in relationship to the experimenter (on the left), the testbed and its resources (on the right), SFA (in the middle), and other federated testbeds (below). Section references in the figure describe the organization of this paper. Section 2 provides background on SFA. Section 3 describes SFAWrap. And Section 4 describes MySlice. Section 5, not shown on the figure, draws conclusions and points to future work.

The technologies and tools introduced in this article have a broad range of applications. We are specifically using them as the building blocks of the OneLab experimental facility [5], a federation of major testbeds for experimentation in computer networking.

2. The Slice-based Federation Architecture (SFA)

To set the context for understanding the two major contributions of this paper, the SFAWrap and MySlice tools, this section describes the Slice-based Federation Architecture (SFA) that they support.

2.1. Overview

SFA has been designed to provide a minimal set of functionalities, a 'thin waist', that a testbed can implement in order to enter into a global federation. An experimenter in an SFA-based environment can transparently browse resources on any federated testbed, and allocate and reserve those resources.

Because of the potential for a very large number of testbeds, a global federation architecture faces a serious scalability issue. SFA introduces a fully distributed solution in which each peer testbed serves as the authority of reference for the resources that it brings, and each user community, along with its experiments, is represented by an authority (possibly, but not necessarily identified with an

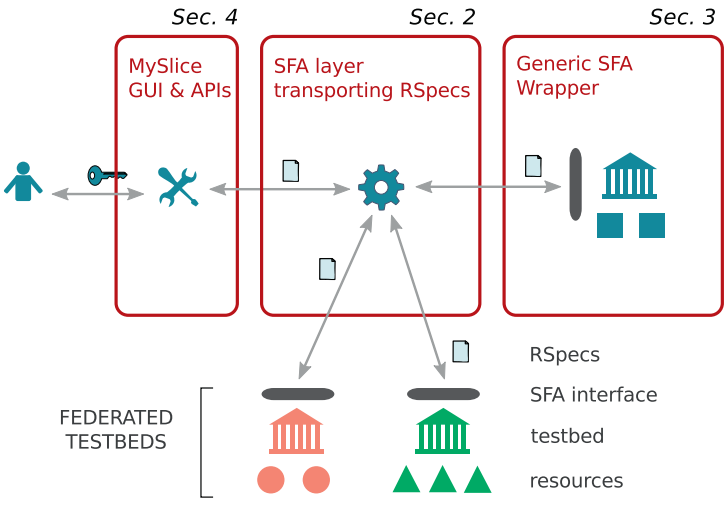

Fig. 1. Positioning of the MySlice and SFAWrap tools presented in this article, illustrated by an experimenter browsing the list of available resources provided by an SFA-based federated testbed environment.