NorNet Core – A multi-homed research testbed ☆,☆☆

Ernst Gunnar Gran *, Thomas Dreibholz, Amund Kvalbein

Simula Research Laboratory, Network Systems Group, Martin Linges vei 17, 1364 Fornebu, Norway

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ABSTRACT

Over the last decade, the Internet has grown at a tremendous speed in both size and complexity. Nowadays, a large number of important services – for instance e-commerce, healthcare and many others – depend on the availability of the underlying network. Clearly, service interruptions due to network problems may have a severe impact. On the long way towards the Future Internet, the complexity will grow even further. Therefore, new ideas and concepts must be evaluated thoroughly, and particularly in realistic, real-world Internet scenarios, before they can be deployed for production networks. For this purpose, various testbeds – for instance PlanetLab, GpENI or G-Lab – have been established and are intensively used for research. However, all of these testbeds lack the support for so-called multi-homing.

Multi-homing denotes the connection of a site to multiple Internet service providers, in order to achieve redundancy. Clearly, with the need for network availability, there is a steadily growing demand for multi-homing. The idea of the NorNet Core project is to establish a Future Internet research testbed with multi-homed sites, in order to allow researchers to perform experiments with multi-homed systems. Particular use cases for this testbed include realistic experiments in the areas of multi-path routing, load balancing, multi-path transport protocols, overlay networks and network resilience. In this paper, we introduce the NorNet Core testbed as well as its architecture.

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1. Introduction

The Internet has become a critical infrastructure in our modern society. Individuals, organisations and governments rely on the algorithms, protocols, services and applications that constitute the Internet for conducting their business. Failures or unavailability of central components in the network immediately transforms to irritation,

monetary loss and sometimes also breakdown in public services. Add to this the enormous scale of the Internet, and it becomes evident that the barrier for making changes to this infrastructure is high. New ideas must be thoroughly tested and validated before they can be deployed in production networks. It has long been clear that such testing must be done in a setting that transcends the traditional lab environment, in order to capture the complexity of scale, traffic and network heterogeneity that exists in a real network. Such tests can, however, often not be done in existing production networks, since they can potentially influence the stability of the network. This has led to an increased interest in recent years for large-scale distributed network testbeds to support experimentation with Future Internet technologies. The characteristics of these testbeds vary. Some offer a large number of nodes and are well suited for testing scalability [1], others target particular technologies such as optical [2] or wireless [3] networks, while
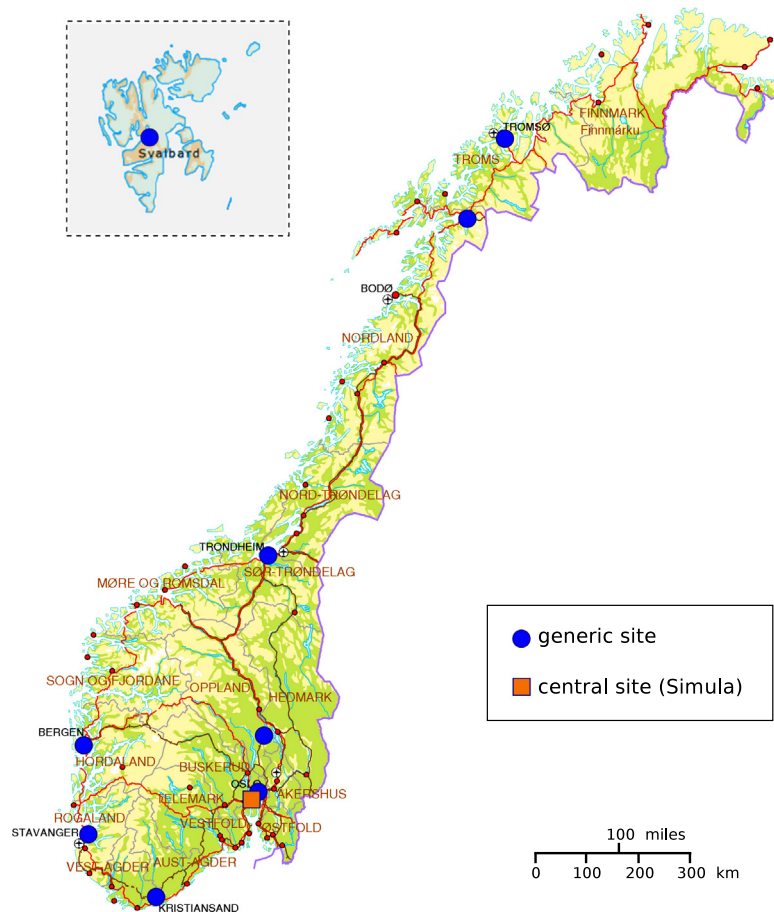
Fig. 1. The current NorNet sites map.

yet others offer the compute power that is needed to test the functionality of heavily distributed applications [4]. The common goal for these testbeds is to provide a realistic environment for testing out an idea, beyond what can be achieved at a single location.

This paper presents NorNet Core,[1] a distributed, wired testbed for experimental networking research that is currently being constructed in Norway. The NorNet Core is built in the context of the NorNet project, a project that also builds the complementary test-bed NorNet Edge [5,6]; a flexible research infrastructure for conducting measurements and experimentation with mobile broadband networks. Initially, the NorNet Core consists of 10 programmable sites that are geographically spread across most of Norway, mainly at universities and other research institutions, as shown in Fig. 1. In addition, two international sites in Essen, Germany, and Haikou, China, provide a view on the Norwegian network from abroad. Further international sites will be deployed in the future. The defining characteristic of NorNet Core is a strong focus on supporting experiments that exploit multi-connectivity. Each site will be connected to at least two wired Internet Service Providers (ISPs), and all these

connections will be exposed and available for use. Furthermore, all the sites being part of NorNet Core will be interconnected as a fully connected mesh, including all possible combinations of available ISPs as the individual sites. This allows the use of multiple (potentially partly overlapping) paths between any pair of sites in the testbed. This in turn opens up the possibility for a range of experiments in the areas of multi-path routing, load balancing, multi-path transport protocols, overlay networks or network resilience, just to mention a few.

NorNet Core is built on the MyPLC software developed by the PlanetLab[2] [1] consortium. This has the advantage of a large and well-maintained code base and user community, and eases federation with other similar testbeds. NorNet Core extends the functionality offered by MyPLC by giving experimenters access to multiple network connections. Anybody can apply for a user account in NorNet Core, but access will be regulated in order to guarantee that each experiment receives sufficient resources.[3]

The rest of this paper is organised as follows: In Section 2, we give an overview of relevant Internet testbeds.

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[1] NorNet: http://www.nntb.no.

[2] PlanetLab: http://www.planet-lab.org/.

[3] In case of contention, priority will be given to experiments with the involvement of a Norwegian research group.