Testing Mobile Apps in the ToMaTo Testbed

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I. Introduction

The Internet has gained huge importance over the last two decades and completely changed the way people as well as computer systems interact. Software systems become more and more distributed using cloud computing technologies and the paradigm of service orientation. This increasing distribution of the components results in a rising complexity of the systems and their network topology that traditional ways of software testing cannot handle. The fast rise of mobile applications aggravates the problem, because non-functional properties that depend on the network connection cannot properly be covered by traditional software testing methods.

The Topology Management Tool [3], [4] (ToMaTo) has been developed in the context of the German-Lab research project [2] as a testbed for networking experiments and software tests. This demonstration will show how ToMaTo enables the testing of distributed mobile software using the mobile application from the iGreen project[1]as an example.

II. ToMaTo

ToMaTo allows users to build networking topologies containing *devices* and *connectors*. Devices are active components, like computers, that run the software of the experiment and are the only sources and sinks of data. Connectors are network components that connect devices and transport their data exhibiting certain configurable characteristics.

Different types of virtual machines with different features and resource consumption can be selected. This diversity allows both lightweight virtual machines for running Linux and full-featured machines for running any operating system including Linux and Windows.

Four types of connectors allow the users to select hubs, switches, routers, and to connect the topology to external network adapters. One core feature of ToMaTo is the ability to emulate link characteristics including latency, bandwidth, and loss ratio (all with complex statistical distributions) on its connections.

ToMaTo features an easy-to-use graphical user interface for creating and configuring topologies as well as for accessing the devices. The user interface is web-based, and is thus platform independent, and can be used without software installation. Additionally, ToMaTo also allows capturing network traffic on connections and to analyze them using well-known tools like Wireshark.

[1]The German-Lab project and the iGreen project are both funded by the German Federal Ministry of Education and Research (BMBF) under the grant numbers 01BK0808 (German-Lab) and 01IA08005G (iGreen).

III. iGreen scenario

The research project iGreen[2] aims to introduce location-based semantic services in the agricultural industry in order to make use of data available in the public or private sectors directly in the field. Using Internet-based services in rural areas is a challenging task because of the lack of high-quality network coverage for WiFi or even cell phones. The use of satellite connections with high delay as well as the low availability of network coverage for cell phones imposes interesting requirements for testing mobile applications used in the agricultural sector.

The iGreen mobile application (shown in figure 1) is designed to offer access to various iGreen services supporting the decision making process related to agricultural tasks like proper fertilization or application of pesticides. This application will run on mobile devices in the field or as embedded software on farm machines. In both cases, the application has to access services that run in a compute cloud using whatever network connection is available at its location, i.e. connectivity by mobile carrier or by a direct satellite link.

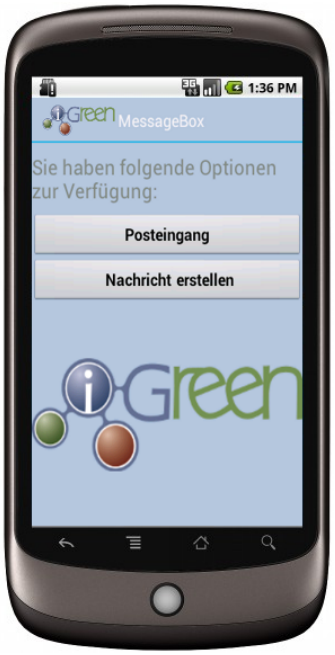

Figure 1. iGreen mobile app

These connection types pose special requirements on services due to their restricted bandwidth, high latency (up to 700ms for satellite connections), and intermittent connectivity. The mobile application has to compensate for this by reducing the amount of data being sent and the number of round trip times needed for interactive usage. Techniques from delay tolerant networks could also be investigated to solve this problem.

In this scenario the prototype version of the mobile iGreen application should be tested in different network connectivity scenarios and using different service providers and service frameworks (like the Venice framework [1]).

[2]iGreen project website: http://igreen-projekt.de

IV. Testing mobile Apps with ToMaTo

The Topology Management Tool has been specifically designed for networking experiments and software tests with complex topologies and is therefore adequate for software tests of distributed systems like the iGreen system in this scenario.

With ToMaTo, users can setup topologies and start using them for their test runs in a very short time. The Topology Management Tool features an easy to use graphical frontend that allows users without deep knowledge of system administration to design and configure network topologies while still allowing experienced users to tweak configuration options.

ToMaTo offers several types of virtualization that can be used to run different parts of the experiment in devices that fit their needs. The KVM virtualization technology can run an emulator for mobile devices using the Android framework while programmable devices can be used to model networking components like firewalls, NAT routers, and gateways.

Topologies in the Topology Management Tool can contain virtual networks that are fully contained as well as external networks that can be used to access other experimental facilities or public services from the components inside the topology.

ToMaTo is able to capture packets on its virtual network connections and allows users to view the capture using an online service or to forward copies of the captured packets to a Wireshark instance run by the user. This can be used to analyze the connections and obtain statistical values of the communication like consumed bandwidth or packet rate and also inspect the communication data.

The Topology Management Tool can emulate link characteristics on all of its virtual network connections. This can be used to test mobile applications in various environments, modeling GPRS, EDGE, UMTS, HSPA, etc. as well as satellite links. Characteristics like bandwidth limitations, link latency, packet loss, packet duplication and packet corruption can be emulated separately for uplink and downlink direction. Link characteristics like latency and per packet probabilities can be emulated with complex statistical distributions and correlations.

In the ToMaTo most settings, including link emulation attributes, can be changed during the test run, allowing for complex test runs with changing link attributes, including intermittent connectivity.

V. Demonstration

The demonstration will show how the iGreen mobile application is tested in different network environments using the Topology Management Tool.

Figure 2 shows the topology used for the tests. The mobile device runs inside a KVM virtual machine using an Android device template that has a pre-installed emulator for mobile applications using the Android framework. This mobile device communicates with a service cloud that is located on the Internet and included in the topology using an external network connector. The connection between the mobile device and the service cloud is routed via a gateway device that is implemented using a programmable device with a simple script. The connection between the gateway and the mobile device contains the link with the emulated characteristics that is used to test the application performance in various networking environments.

Figure 2. Test setup

First, the demonstration will show how this topology can be created and configured using ToMaTo. Then the iGreen mobile application will first be run with a perfect network connection to test its functionality and to obtain reference values of the performance under perfect conditions. After that, the application will be run with different link characteristics including mobile and satellite connectivity profiles to determine its perceived performance under these circumstances and finally decide whether the iGreen app has to be further adapted to suite these mobile environments.

References

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