Self-Aware Adaptive Service Networks with Dependability Guarantees

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Problem statement

Disasters striking in inhabited areas pose a significant risk to the development and growth of modern societies. The impact of any disaster would be severe. In case a disaster strikes, fast and safe mitigation of damages is important. Information and communication technology (ICT) plays a crucial role in helping reconnaissance and first response teams on disaster sites.

Most rescue teams bring their own network equipment to use several IT services. Many of these services (e.g., infrastructure, location, communication) could be shared among teams but most of the time they are not. Coordination of teams is partly done by pen and paper-based methods. A single network for all participating teams with the possibility to *reliably publish, discover and use* services would be of great benefit. Despite the participating teams and course of action being different on every site, described service networks display certain common properties:

1) They arise spontaneously.
2) The number of nodes and their capabilities are subject to high fluctuation.
3) The number and types of services are also fluctuating strongly.
4) There is no global administrative configuration.

Because of these properties all network layers involved would need to be configured automatically. Based on the *Internet Protocol* (IP) – the only well-established global networking standard – a number of mechanisms promise to automatically configure service networks. In disaster management scenarios, where various services are critical for operation, mission control could benefit from these mechanisms by getting a live view of all active services and their states. It needs to be investigated if and how they are applicable.

Given an ad-hoc, auto-configuring service network, how and to what extent can we guarantee dependability properties such as *availability*, the ability to perform in the presence of faults (*performability*) and ultimately the ability to sustain certain levels of availability or performability (*survivability*) for critical services at run-time? So far there exists no comprehensive evaluation for such heterogenous and dynamic service networks.

Approach

The goal of this dissertation is to embed a run-time dependability cycle into the network. In this cycle, the network is constantly *monitored* and, based on monitoring data, dependability properties are *evaluated at run-time*. If necessary, *adaptation* measures are triggered which in turn can cause the monitoring to be reconfigured. This cycle is the base of a *self-aware adaptive service network*.

Seen from the point of view of the network, a distributed service discovery layer provides network-wide service presence monitoring. This will be extended to provide monitoring for availability and performability assessment. In the evaluation phase the survivability of critical services can be estimated by calculating the expected availability or performability with a given fault model which is the base of the decision for any adaptive measure. Even if no adaptation is possible, run-time awareness of critical states is already a huge benefit.

Current and future work

To use service discovery mechanisms for monitoring we need to know their temporal behavior. The tradeoff between reliability and efficiency needs to be estimated. In a virtualized testbed the probability for successful discovery operations in time (*responsiveness*) is being measured. Results will be verified in a wireless testbed that properly matches expected disaster environments. The monitoring layer will be enhanced to support automatic reconfiguration regarding variable selection, coverage in location and coverage in time.

Methods to evaluate service dependability properties *at run-time* from local monitoring snapshots will be developed in a following step. Properties will be combined with user utility functions to evaluate the user-perceived service state.

How adaptation strategies improve dependability properties of services will be shown in an exemplary disaster management service network.

Selected Publications

[1] A. Dittrich, J. Kowal, and M. Malek, "Designing survivable services from independent components with basic functionality," in *International Workshop on Dependable Network Computing and Mobile Systems (DNCMS 08)*, Naples, Italy, October 2008, pp. 33–38.