DRAMA: A Distributed Policy-based Management System

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Abstract

We present DRAMA [1], a distributed policy-based network management system[1], with a demonstration outline. This system was designed to manage mobile ad hoc networks, which pose various unprecedented network management challenges of different nature. To tackle these challenges, we craft a distributed management system and learn through experience that its generic design allows it to support other applications with similar requirements. In this extended abstract, we discuss various possible real-life applications that could be supported by the DRAMA system through a set of demonstration scenarios.

Introduction

Due to rapid advances in wireless networking technology, today's networks shift towards depending less on fixed infrastructure and providing services on demand. As examples of this trend, we see dynamic overlay networks such as peer-to-peer networks as well as emerging wireless ad hoc and sensor networks. These networks pose different requirements in a multitude of areas such as autonomy, security, reliability, robustness, bandwidth consumption, power efficiency, etc. They are often highly dynamic because of voluntary node participation, unrestricted node movement, and unpredictable loss of network connectivity. As a result, there exists a strong motivation for having self-forming, self-reconfiguring, and self-healing capabilities in these networks. Potential applications over such dynamic networks cover a wide range of possibilities including assistance to theme park visitors, guidance to museum tourists, health monitoring of the elderly, services for first-responder squads, control of distributed robots, coordination of sensor-equipped household appliances, vehicular telematics, just to name a few.

We have developed a generic, distributed policy-based management system, DRAMA, that can be used to address the management needs of these applications. This system incorporates a novel middleware [1] that provides a customizable computing platform to shield applications from having to deal with the dynamicity of networks. Today's policy-based systems in general are limited to specific applications such as VPN management and firewall management. These systems usually lack a common framework that enables extensibility and do not scale in terms of network size and the number of policies. Further, these solutions are mostly centralized by nature and will not function in a dynamic, unstable environment where distributed control is favored.

Because of the introduction of a generic policy framework, our system allows an administrator to express system requirements using policies and let policies be automatically enforced in the system. The use of policies enables administrative objectives to be accomplished without human intervention via dynamic adaptations of system behaviors to changes in operating environments. This approach provides an administrator with the capability to specify policies at a high level that describe long-term, system-wide objectives. Our policy-based system is also distinguished by the use of an asynchronous event bus that enables the enforcement of one policy triggering the enforcement of other policies.

Demonstration Descriptions

The demonstration scenarios are designed to highlight the main features of DRAMA. Below we list these features, describe their purposes, illustrate them with a set of vignettes, and discuss possible uses of the features in some real-life settings.

- *Enables modular and customizable distributed management*
  <*Purposes*> To show why this system can perform the management tasks any specific business logic requires and to illustrate how distributed management is exercised in this system.

  <*Scenario*> We will start with introducing the basic system functions comprising distributed monitoring and reporting, and then delve into a system behavior adjustment example with the use of policies. The focus of this

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scenario is that monitoring results could be used to dynamically trigger appropriate system reconfigurations. What will be shown in this scenario is the dynamic enabling and disabling of an active network probing application. The monitored bandwidth usage of a link is used as a trigger. If the bandwidth usage rises above a threshold, active probing activity will be suspended; if the bandwidth usage later falls below a certain line, the active probing activity will be resumed. The thrashing of the system behavior is prevented through the use of separate values for enabling and disabling the application, in addition to the data sample aggregations that smooth the fluctuation of the monitoring result.

<*Applications*> Any system consisting of distributed devices that requires or prefers frequent updates and configuration tune-ups. Possible applications include vehicular telematics, health monitoring of the elderly, assistance to theme park visitors, etc.

- *Provides autonomous and adaptive management functions*
  <*Purposes*> To show that with the use of DRAMA, once policies are in place, human intervention could be greatly reduced. That's because a DRAMA system can adapt to a wide range of condition changes autonomously.

  <*Scenario*> We will demonstrate the concept of adaptive reporting based on external triggers. The trigger that will be used in this scenario is *role change*, which could take place on-the-fly in a DRAMA system due to the network connectivity changes. What will be shown in this scenario is that once a new role is assumed by a node, the set of active policies under enforcement will reflect the role change immediately. We will see the reporting behavior of a node changes on-the-fly as the role change events occur.

  <*Applications*> Any distributed system that demands minimal human maintenance effort or in that human intervention is not possible. Possible applications include guidance to museum visitors, services for first-responder squads, coordination of sensor-equipped household appliances, etc.

- *Accommodates large-scale deployment through self-organization and self-healing*
  <*Purposes*> To show that how large-scale deployment of a DRAMA system is enabled, and why the system-wide behavior adjustments can be performed reliably.

  <*Scenario*> We will demonstrate that the system is self-organized in the sense that nodes always organize themselves autonomously into a management hierarchy. The formation of the management hierarchy is decided by the dynamic network connectivity changes. This scenario is made possible with a technology developed for testing systems for use in the dynamic environments. By taking advantage of this technology, it is possible to run multiple instances of DRAMA software concurrently on multiple virtual nodes hosted by one single machine. The management hierarchy changes will reflect the changes made to the link connectivity between the virtual machines.

  <*Applications*> Any system that requires distributed management over a large set of nodes. Possible applications include control of distributed robots, guidance to museum tourists, and assistance to theme park visitors.

- *Supports management of heterogeneous systems*
  <*Purposes*> To show DRAMA is platform independent and capable of managing heterogeneous system if the management interface is already defined.

  <*Scenario*> Nodes used in the demonstration will consist of both Linux-based and Windows-based machines. Linux-based machines will be used to manage the Windows-based machines via SNMP. We will demonstrate the DRAMA system is capable of performing SNMP-based management operations to manage remote nodes other than the hosting nodes.

  <*Applications*> Any distributed system consisting of homogeneous or heterogeneous devices such as cell phones, PDAs, laptops, smart sensors, etc., that calls for autonomous, seamless management.

References

[1] R. Chadha et al. "Policy Management for Ad Hoc Networks," submitted to *IEEE Milcom 2005 for publication*

[2] C. Chiang et al. " AMS: An Adaptive Middleware System for Wireless Ad hoc Networks," submitted to *IEEE Milcom 2005 for publication*