

# Chapter 27

## Location–Awareness with Action Systems

**Luigia Petre**

*Åbo Akademi University, Finland*

**Kaisa Sere**

*Åbo Akademi University, Finland*

**Marina Waldén**

*Åbo Akademi University, Finland*

### ABSTRACT

*The location of various network resources is of outmost interest when trying to model and analyze various computing and communicating contemporary platforms. Formal methods - fault-avoiding techniques for constructing robust software and systems - are instrumental in providing precise modeling formats and various analysis and development tools. In this chapter, the authors present their approach to embedding location information into action systems, a formal method dedicated to distributed systems that are not aware of their physical location.*

### INTRODUCTION

Our lifestyles are more dynamic by the year (Tanenbaum, 2003): we talk on the mobile phone while on the go; we can work on our wirelessly connected laptops mostly everywhere in the big cities, and we can attach network chips and wireless sensors to basically everything around us, thus making the environment aware of our requests and needs (Culler, Estrin, & Srivastava, 2004). While there are important issues related to these opportunities, such as economical, ethical,

social, and environmental implications (Bohn, Coroama, Langheinrich, Mattern, & Rohs, 2005), they also opened a wide range of applications (Romer & Mattern, 2004) that can make people much more efficient, in control, and almost all the time connected.

The technologies supporting this dynamic way of computing and communicating are continuously developing and becoming more complex. In order to be confident in the flexibility introduced by mobile phones, laptops, and wireless networks and sensors, we need to ensure that they work

DOI: 10.4018/978-1-61520-655-1.ch027

dependably. *Dependability* refers to the degree of reliance that can be placed on these devices and infrastructures (Laprie, 1985; Laprie, Avizienis, & Kopetz, 1992; RODIN) and encompasses characteristics of a system such as security, that is the non-occurrence of unauthorized disclosure of information; integrity, that is the non-occurrence of inadequate information alteration; availability, that is the readiness for correct service of the system; reliability, that is the property of the system to continuously provide service.

In order to analyze whether a system is dependable, we need to have a model for it. One feature that is characteristic of models for mobile phones, laptops, wireless sensors, and networks is that of *location*. Mobility implies a starting and an ending point. Wireless sensors provide, for instance, data about the environment or habitats (Klimat; Teymorian, Ma, & Lu, 2009) whose location is the most important aspect. The wireless devices are working as long as they are in range, i.e., another location-based concept. Hence, all these devices and infrastructures take location into account and their functioning adjusts accordingly to the values of their locations.

One way to ensure dependability is provided by mathematically-based modeling, analysis, and development of the location-aware systems. These techniques are known as *formal methods*. The approach implies the capture of system requirements in a specific, precise format, which is a formal model that can be analyzed for various properties and, if the formal method permits, also stepwise developed until an implementation is formed. By following such a formal development, we are sure that the final result implements the requirements of the system. In this chapter we present the approach to location-awareness provided by the *action systems* formal method.

Action systems were introduced for modeling and analyzing distributed systems (Back & Kurki-Suonio, 1983). The main idea is that the system *state*, given by variable values, is non-deterministically evaluated and modified by

atomic guarded statements called *actions*. An action system is a finite collection of state variables and actions. The state and the actions in an action system can be interpreted as distributed over a network, however, their distribution has traditionally been location-transparent. This is enough for modeling computations in local area networks where there is no significant mobility. For modeling dynamic and mobile computations that are aware of their surrounding contexts (Neovius, Sere, Yan, & Satpathy, 2006) locations were introduced to action systems (Petre, Sere, & Waldén, 1999).

Variables, actions, and action systems are thus considered network resources and, by definition, each has a location in the supporting network. While the locations of variables (data resources) and actions (code resources) are independent, the location of an action system is defined as a function of the locations of its component variables and actions. Several replicas of a resource can be defined at distinct locations in the network. Movement is defined as the update of the resource's location; if that resource is replicated, then only one copy changes its location, while the others stay put.

Location awareness extends the modeling domain. New features can be captured such as replication or mobility and eventually also analyzed and developed towards implementation in a correct manner. In this chapter we overview the location-embedding into the action systems formalism from its modeling in Section 2, to its semantics in Section 3, and its execution model in Section 4. We conclude with related approaches and future work in Section 5.

## THE APPROACH TO LOCATION

In this section we present our approach to embedding location information into the action system framework. The location-aware action system is called *topological action system*, introduced

19 more pages are available in the full version of this document, which may be purchased using the "Add to Cart" button on the publisher's webpage:

[www.igi-global.com/chapter/location-awareness-action-systems/66483](http://www.igi-global.com/chapter/location-awareness-action-systems/66483)

## Related Content

---

### The Role of Standards in the Development of New Informational Infrastructure

Vladislav V. Fomin and Marja Matinmikko (2014). *Systems and Software Development, Modeling, and Analysis: New Perspectives and Methodologies* (pp. 149-160).

[www.irma-international.org/chapter/the-role-of-standards-in-the-development-of-new-informational-infrastructure/108814](http://www.irma-international.org/chapter/the-role-of-standards-in-the-development-of-new-informational-infrastructure/108814)

### A Survey, Design and Analysis of IoT Security and QoS Challenges

M Kesavan and J Prabhu (2018). *International Journal of Information System Modeling and Design* (pp. 48-66).

[www.irma-international.org/article/a-survey-design-and-analysis-of-iot-security-and-qos-challenges/218171](http://www.irma-international.org/article/a-survey-design-and-analysis-of-iot-security-and-qos-challenges/218171)

### Goal-Based Requirements Elicitation for Service Reuse in Cloud Computing

Lin Liu (2012). *Software Reuse in the Emerging Cloud Computing Era* (pp. 278-305).

[www.irma-international.org/chapter/goal-based-requirements-elicitation-service/65176](http://www.irma-international.org/chapter/goal-based-requirements-elicitation-service/65176)

### A Formal Method for the Development of Agent-Based Systems

P. Kefalas, M. Holcombe, G. Eleftherakis and M. Gheorghe (2003). *Intelligent Agent Software Engineering* (pp. 68-98).

[www.irma-international.org/chapter/formal-method-development-agent-based/24145](http://www.irma-international.org/chapter/formal-method-development-agent-based/24145)

### Ensemble Deep Learning Intrusion Detection Model for Fog Computing Environments

Kalaivani K. and Chinnadurai M. (2022). *International Journal of Software Innovation* (pp. 1-14).

[www.irma-international.org/article/ensemble-deep-learning-intrusion-detection-model-for-fog-computing-environments/303587](http://www.irma-international.org/article/ensemble-deep-learning-intrusion-detection-model-for-fog-computing-environments/303587)