Autonomic sensor networks for future enterprise services

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Abstract. As we move towards the "Internet of things", it can be expected that millions of devices of different size and capability will be connected and interact with each other. That in conjunction with the trend towards a service oriented business infrastructures leads to increased complexity that has to be managed. Future enterprise services will interact with this vast number of devices and services that depend on them. Central management is not favoured and maybe even not possible. Intelligence will probably be distributed at several layers between enterprise systems and the devices themselves. Therefore the devices are expected to feature at some level self-* features such as self-management, self-healing etc, which in conjunction with cooperation capabilities will lead to self-sustained autonomic sensor-network infrastructures.

1 Motivation

A smart item is a device that is able to provide data about itself or the object it is associated with and can communicate this information to other devices. Wireless sensor networks constitute communities of advanced smart items and although visions have been laid out, and significant progress has been done in the research domain (theory, algorithms, protocols, implementations, trials etc), several challenges still remain to be tackled if they are ever to establish a basis for real-world enterprise services.

We move towards a service-oriented ubiquitous infrastructure, where in the near future according to the "Internet of things" vision [1], it can be expected that millions of devices of different size and capability will be connected and interact with each other over IP e.g. sensor networks [2]. New innovative services are expected to empower business solutions and provide new approaches to known problems that were not possible today due to the missing granularity and real-time delivery of information sensor networks can deliver. Therefore it is expected that sensor network dependent services will be vital for future business scenarios in a number of industry domains. However their reliable integration with existing services and business processes poses new challenges to enterprise systems as they are hardly designed to operate effectively in such distributed, information-rich, highly complex future infrastructures. Enterprise systems can not manage on per-item basis such a huge infrastructure nor is that wished.

Autonomic computing [3] was introduced by IBM as a mean to target increasing computer system complexity and aimed initially at automating management of enterprise computational systems. In "The Vision of Autonomic Computing" [4] it is stated that the dream of interconnectivity of computing systems and devices could become the "nightmare of pervasive computing" in which architects are unable to anticipate, design and maintain the complexity of interactions. The essence of autonomic computing is system self-management, freeing administrators of low-level task management whilst delivering an

optimized system. This will get a new dimension once the millions of anticipated smart items are on-line and start cooperating. Autonomic concepts in a sensor network infrastructure are needed in several layers including networking and communication as well as control and management. In a self-managed autonomic system, the enterprise service does not control the system directly, but only defines general policies and rules that serve as an input for the self-management process. In such complex environments self-* features will be probably evident not only in the enterprise services themselves, but also in the sensor networks as well as the layers that reside between them. Desirable autonomic features include self-configuration (automatic configuration of components), self-healing (automatic discovery and correction of faults), self-optimization (automatic monitoring and control of resources to ensure the optimal functioning with respect to the defined requirements) and self-protection (proactive identification and protection from arbitrary attacks).

2 Conclusions

Future real-world enterprise services will heavily depend on large-scale sensor networks. The increased complexity can be tackled by delegating intelligence at several layers between enterprises' backend systems and the physical devices. The essence of autonomic concepts is the support of these complex dynamic infrastructures that can deal in a self-controlled proactive way with the changing environment context, contributing therefore to an efficient overall system. Without such approaches, large-scale complex computing systems will be unmanageable and their integration with enterprise services in a reliable way probably not realistic and only on a small scale. Of high importance is the validation of autonomic concepts on real-world scenarios. Designing future real-world dependant enterprise services can't be based exclusively neither on lab experience nor in intuition since the overall behaviour is based on a dynamic ecosystem of highly distributed services and devices (e.g. sensors). Therefore, since it will be extremely difficult due to complexity, to model deterministically the behaviour of all components, it is expected that autonomic concepts will be able to empower future systems at several levels; as a result a more reliable and dynamic infrastructure is expected that can better support future enterprise services.

3 References

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