

Is Self-Management a Right Buzzword for Modern Management Challenges?

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Abstract

Self-management is promoted as an approach to information and communications technology (ICT) systems management that will, finally, deal with the ever-increasing complexity of managed systems. Its popularization brings positive attention to the ICT systems management community and a lot of excellent research is conducted related to this topic. Nevertheless, we argue that the term 'self-management' is not an appropriate buzzword because it is ambiguous, potentially misleading, and not descriptive of the main challenges of managing modern ICT systems.

As an alternative to the 'self-management' buzzword, we advocate adopting a term that better describes the main challenges of managing modern ICT systems. Our suggestion is "the 5 Cs of ICT systems management": 1) cost-benefit relationship, 2) complexity, 3) conformance to higher-level objectives, 4) circumstances, and 5) change. Self-management is only one of approaches that should be used to address the 5 Cs and other management challenges.

1. Introduction and motivation

Over the last several decades, the information and communications technology (ICT) systems management community has achieved important results on managing complex ICT systems. (We use the term "ICT systems management" as an umbrella term for computer and communications network, systems, application, and service management.) Recently, self-management became a hot buzzword in the ICT systems management community. It is frequently used to denote an approach to ICT systems management that will, finally, deal with the ever-increasing complexity of managed systems. The wide popularization of this term and related terms, such as autonomic computing [1], brings positive attention to the ICT systems management community. There is also a lot of excellent completed or on-going research related to self-management, as is evident from this workshop.

The majority of our 8-year industrial and academic experience in ICT systems management is tightly related to self-management. In 1990s, we collaborated on a project using artificial intelligence techniques to solve management challenges. More

importantly, our whole current income comes from a project in which a degree of self-management is one of the main competitive advantages (cf. [2]). We think that self-management concepts are very useful.

However, we strongly object the current over-hyping of the term 'self-management'. We recently encountered papers where the thesis was approximately "We proved that self-management can be used for X.", but there was no examination of management objectives and circumstances, limitations and drawbacks (e.g., cost) of self-management techniques, limitations and benefits of alternative approaches (none was mentioned), and important prior research on using similar techniques (a number of papers was published during the 1990s, but the oldest related reference was from early 2000s). In our opinion, over-hyping of the term 'self-management' is partly to blame for misleading the authors.

Our goal with this position paper is to point to inadequacies of using the term 'self-management' as a buzzword for ICT systems management research and to discuss possible alternatives. We use the term 'buzzword' with the meaning "fashionable technical or specialist word; catchword" [3]. We do not give negative connotation to this term. On the contrary, we recognize the importance of buzzwords for drawing popular attention and advocate choosing right buzzwords. We want to find a buzzword that is catchy, yet relatively completely and precisely describing the management challenges we are all facing, so that it can be used for catalyzing and evaluating research in ICT systems management. Note that we are not suggesting abandoning research related to self-management – we think that that many approaches used for self-management are time-proven.

In this section, we gave a brief introduction and motivation for this position paper. In the next, we discuss how the term 'self-management' is ambiguous and potentially misleading. In Section 3, we examine the major challenges facing ICT systems management and suggest a buzzword that describes them better. In Section 4, we examine to what extent and how the work on self-management addresses (or does not address) these challenges. In the final section, we summarize conclusions and challenge the ICT management community to find better buzzwords.

2. What does ‘self-management’ mean?

We find the term ‘self-management’ ambiguous, potentially misleading, and not descriptive of the main challenges of managing modern ICT systems.

The term is ambiguous because it is hard to find an undisputed definition of what is (and what is not) self-management. Wikipedia.org, a very popular on-line encyclopedia, states that “Self-management is the process by which computer systems shall manage their own operation without human intervention.” [4]. On the contrary, all 4 experts in the excellent DSOM 2003 panel on self-management [5] recognized that human involvement in high-level management tasks will remain. We understand management as the process of monitoring and control. We also note that no human-built system, not even a deep space probe, operates without some human monitoring and/or control, in one way or another. For example, humans set (i.e., manage) desired temperature for thermostats.

Some definitions state that self-managing systems operate without direct human intervention, but humans define general policies and rules for their operation. There are at least two ambiguities in such statements. First, it is not clear where is the line between direct and indirect intervention. Second, the term policy is itself ambiguous and causes debate in the ICT systems management community. For example, if a human sets thermostat’s desired temperature, is she setting a (goal) policy or issuing a command?

Some definitions of self-management refer to closed control loop in which the system itself monitors some metric and keeps it within some range. However, the closed control loop has been used in human-made systems for millennia [5]. There are many examples of ICT systems where the closed control loop can be found. For example, consider the classical network management architecture with agents executing on managed elements and a manager that sends GET and SET requests to the agents. If the manager performs at least some processing without human input of GET results to determine SET parameters, this can be considered a closed control loop and, thus, a self-managing system. Note that such a system might be self-managing for some metrics, but require direct human intervention for others. In our opinion, there is no real (or, at least, no successful) management (of any human-made system or even human teams) without a closed control loop – some metrics have to be monitored and some control actions have to be made based on processing monitored data. In some cases, there are humans in the loop, but this brings us back to the ambiguity discussed above.

To conclude, no system is truly ‘self-managing’ and, at the same time, numerous examples of ‘self-managing’ systems already exist – it all depends what human input is viewed as management, what metrics are considered, and where system boundary is drawn.

In our experience, this ambiguity makes the term ‘self-management’ potentially misleading. The term (and particularly its ‘self-’ part) does not convey that ICT systems are always parts of larger socio-technical systems, such as businesses, and that human involvement in management is paramount. It must be clear that ICT systems are not “islands unto themselves” independent from complex, contradictory, and changing human environments. In one way or another, they serve humans. Ultimately, human involvement in management is mandatory because only humans know what are their needs. This involvement can be in the form of setting higher-level objectives, such as business goals and policies. However, in some critical situations humans must take more direct control and the ICT systems must let them. For example, cruise control in cars is largely self-managing, but humans can turn it off and take control. ICT systems management experts and most self-management related works, such as autonomic computing [1], recognize this fact. However, the problem is that the ‘self-management’ buzzword does not convey this to non-specialists. Contrary, it leads to misunderstandings, such as the mentioned Wikipedia definition [4].

Finally, the term ‘self-management’ does not tell what are the real management challenges that have to be addressed. It does not say that self-management is not a goal, but a tool.

3. An alternative buzzword – “the 5 C challenges of ICT systems management”

Since the ‘self-management’ buzzword is not adequate for us, we decide to search for a better one. We would like to find a buzzword that would be catchy and easy to remember even by non-specialists, but would completely and precisely describe management challenges of modern ICT systems and thus serve as a guiding light for future research and evaluation of achieved results. Our suggestion is “the 5 C challenges of ICT systems management”:

1. Cost-benefit relationship of management solutions determines their usefulness for particular problems.
2. Complexity of managed systems rapidly grows.
3. Conformance of both management and managed systems to higher-level objectives is important for their adoption by humans.
4. Circumstances of deployment and execution can be very diverse.
5. Change is inevitable.

It seems to us that these 5 Cs represent the main challenges of managing modern ICT systems. We can notice them both during design/deployment of management systems and during execution (i.e., run-time). Apart from these 5 Cs, there are certainly other important challenges and we welcome refinement of this list. Let us briefly discuss the 5 Cs.

1. Some benefits (e.g., improvements in performance, availability, security, etc.) are expected from deploying a management solution in practice. On the other hand, it is well known that management incurs cost, both in the terms of the run-time overhead (e.g., processing time, memory, bandwidth, electric power) and in financial terms (management software is expensive). The ICT systems management community developed a number of important management methods and technologies in the past, and will certainly develop many in the future. The challenge is to choose appropriate methods and technologies to be built into a management system during design and deployment and executed during run-time.

2. Modern ICT systems become more complex in terms of scale, heterogeneity, distribution, mobility, dynamism (run-time change), various non-trivial and non-obvious interdependencies between sub-systems, and other aspects. Humans alone cannot manually manage modern ICT systems because the system complexity is too high for human grasp and human reactions are relatively slow, expensive, and error-prone. The challenge is to build management systems that will handle this complexity, yet not introduce additional complexity that can not be handled.

3. Since ICT systems operate within larger socio-technical systems, they have to conform to higher-level objectives determined by these larger systems. For example, if a higher-level objective is ‘exceptional customer satisfaction’, then the ICT system should be managed towards this objective, and not necessarily towards a technical objective, such as the maximal number of processed transactions. Some of the associated challenges are to model higher-level objectives (e.g., policies) so that they can guide management activities and to handle potential conflicts between higher-level objectives.

4. Diverse circumstances affect management activities and determine management approaches and tools used in practice. During development and deployment of management systems, one sometimes has to consider broader technical, business, company-level political, legal, or even ethical conditions. During run-time, execution context of a managed system can change (particularly if the system is mobile) and the management system has to adapt its actions to the new context. There is no ‘one size fits all’ or ‘silver bullet’ management solution. In various circum-

stances, all management solutions have advantages and disadvantages. For example, distributed management might be very useful in general, but centralized management is a better solution for some centralized systems. The challenge is to choose the right management solution for particular circumstances, while considering the cost-benefit relationship.

5. In modern ICT systems, changes are frequent and the speed of change often increases. The challenge is to design and deploy management systems in such ways that they can be relatively easily modified and to build into them management solutions for handling anticipated and unanticipated changes in managed systems and execution environments.

We tried to identify the main approaches that can be used to address these challenges. Our suggestion is “the 5 A approaches to ICT systems management”:

1. Analysis of benefits and costs.
2. Automation of management activities.
3. Aims (objectives, policy) modeling and processing.
4. Accommodation of different circumstances.
5. Adaptability.

Each of these 5 A approaches is most relevant for the corresponding challenge from the list of 5 Cs.

1. Analysis of benefits and costs can be non-trivial. In principle, benefits of a management system should be maximized and its costs minimized, but oftentimes there is also a minimal level of acceptable benefits and a maximal level of acceptable costs. Further, not all benefits can be quantified easily and precisely. One example is ‘customer satisfaction’.

2. A way to handle complexity of management (of any human-made system) is to provide automation of management functionality. This was the basic motivation and topic of the work of the ICT systems management community from its beginnings. In our opinion, automation of management functionality should encompass not only interaction with managed systems and decision making, but also interaction with the external environment, particularly humans.

3. To achieve conformance to higher level objectives, such as action/goal/utility policies and plans, they have to be modeled (described) and algorithms for their processing have to be built into management systems. There are a number of results on policy-driven management, but many open issues remain.

4. To be able to accommodate different circumstances one has to be aware of them, model them properly, and build into management systems appropriate algorithms. Context modeling and management is relatively well researched, while analysis of socio-technical conditions in which a management system has to execute is not yet in a research focus.

5. One way to accommodate change is to build adaptability into system’s design. There are several

mechanisms. For example, a management system can have built-in adaptation points for its run-time modifications from external sources, such as humans. It can also provide such adaptation points (e.g., proxies) for run-time modification of managed systems. An example is software patch distribution. Another adaptability technique is to use closed control loops to handle run-time disturbances.

There are additional approaches with time-proven usefulness, such as using ‘divide and conquer’ for handling complexity. It is crucial to emphasize that even an extended list of approaches would not be enough for solving the 5 Cs, because of the partial conflicts between the challenges (or corresponding approaches). For example, built-in adaptability introduces additional level of complexity and increases costs (particularly, run-time overhead). In practice, a compromise (trade-off) is necessary and it is often not easy to find/reach it. To conclude: “To address the 5 C challenges you need at least the 5 A approaches and a compromise.”

4. Self-management for the 5 Cs

In our opinion, any research on ICT systems management should clearly indicate to what extent and how it addresses (or does not address) all 5 Cs and other management challenges. Yet, this is not always the case with self-management research. Therefore, we examined how the self-management concept relates to the 5 C challenges. Due to the diversity of self-management techniques, this is only a general discussion.

In short, our conclusion is that self-management is an important step forward, but not the ultimate management solution. We find that self-management research emphasizes addressing complexity using automation. To a bit lesser degree, it studies adaptability to handle change. Some (e.g., IBM’s autonomic computing [1]), but not all, self-management works recognize the need of conformance to higher-level objectives using policies. Several approaches include context management, but the accommodation of other important circumstances and analysis of benefits and costs are usually missing. Most importantly, the fact that partial conflicts in the 5 C challenges (or the corresponding management approaches) require difficult compromises is usually not conveyed. Including management functionality into a managed system to achieve self-management increases complexity and costs (e.g., overhead). In particular, resources of embedded devices are limited. Making such devices not self-managing, but only manageable by external entities (software and/or humans), could provide better cost-benefit relationship for some circumstances.

Even for more powerful managed systems it can be more efficient to outsource some management tasks to specialized external systems or humans than to be self-managing.

This means that self-management techniques should be viewed not as a ‘silver bullet’, but only as one of management techniques that should be used to address the 5 Cs and other management challenges.

5. Conclusions and future work

An old proverb says that asking the right question is a half of the answer. We strongly believe that by focusing on ambiguous buzzwords, such as ‘self-management’, we are asking incomplete questions. For example, the questions: “How can we make ICT systems self-managing?” and even “How can we use self-management techniques to manage ICT systems?” are incomplete questions because they do not describe the problem space well. On the other hand, the questions such as “How can we address the 5 Cs (and other management challenges) of modern ICT systems?” and “To what extent can we address the 5 C challenges using self-management techniques?” seem as much more complete and precise questions.

Since several well-known business buzzwords, such as the “5 Cs of credit” and the “4 Ps of marketing”, have analogous format, we believe that the “5 Cs of ICT systems management” is a catchy phrase. It is relatively complete and precise, descriptive, and able to guide future research and its evaluation. In our opinion, the 5 A approaches are also easy to remember, but we recognize that this list is incomplete. We advise using the list of 5 As only in the context of the 5 Cs. The 5 Cs and the slogan “To address the 5 C challenges you need at least the 5 A approaches and a compromise.” are intended as input into discussion. We welcome their critique and refinement and challenge the ICT systems management community to find better buzzwords, helping us all produce high-quality management research and products.

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