Improving Collaborative Knowledge Flow Design on Social Networks through Autonomic Computing Systems Properties

Abstract

Autonomic computing is an approach to systems management that can give them the ability to perform management activities based on situations they observe in its environment. Social networks are groups of links that organize people, groups, and institutions in an equalitarian and democratic way around a common objective. Its members can collect and disseminate data, information, and knowledge in a collaborative way. For that, the design of the entire social network is very important and must be improved to facilitate the collaboration. This paper discusses how autonomic computing is being applied to improve the knowledge flow over social networks, and propose a generic architecture based on autonomic elements.

1. Introduction

Social networks are groups of links that organize people, groups and institutions in an equalitarian and democratic way, around a common objective [Barnes 1987]. In other words, a social network is a dynamic and flexible model, with freedom and spontaneity among its links, which respects the individuality, based mainly on mutual trust. Social networks can dilute disciplinary and organizational barriers and national borders. Due to its principles of non-hierarchy, freedom, free formation and construction based on similarities (such as, interests) and trust, a social network is an approach which allows its members to obtain and spread data, information and knowledge faster.

Since the social network can be mapped and represented it is possible to identify its strengths and weaknesses. Examples of weaknesses are the lack of communication between individuals and groups working in the same area, as well as deficiencies in the spread and flow of knowledge in the network as a whole, amongst others. These improvement points can only evolve if there is cooperation between those involved and, consequently, the knowledge flow of the social network as a whole is improved.

Our approach focuses mainly on how to preserve and improve the knowledge flow in a social network, observing and respecting the context where the knowledge was created, and where it is necessary. We believe that if social networks inherit autonomic properties then they will facilitate problem analysis and solution, and consequently, maintain knowledge accessible in the network. In this context, our main goal is that a social network can be self-CHOP [13].

The next section brings us to a brief discussion of autonomic computing. Section three presents our proposal and proposed architecture. Finally, conclusions and future work are shown in section four.

2. Autonomic Computing

Autonomic computing is a new approach to systems management that can give them the ability to perform management activities based on situations they observe or sense in the IT environment. This approach has been inspired in the human autonomic nervous system, imitating its self-management capacity, and using minimum human interference. Its main goal is the development of self-managed computer systems [De Wolf and Holvoet 2006].

Autonomic systems are able to adapt to unpredictable situations, preventing and recovering from failures, continually optimizing themselves and autonomously taking care of their own safety. They are marked by their self-*properties (self-configuration, self-healing, self-optimization, and self-protection) [De Wolf and Holvoet 2006] [Huebscher and McCann 2008].

Self-configuration means that an autonomic computing system configures itself according to high-level goals, that is, by specifying what is desired, and not necessarily to how to accomplish it. Self-optimization means that an autonomic computing system optimizes its use of resources. It may decide to proactively initiate a change to the system in an attempt to improve performance or service quality. Self-healing means that an autonomic computing system detects and diagnoses problems and, if possible, the application attempts to solve the problem. Self-protection means that an autonomic system protects itself from malicious attacks from other software and end users who inadvertently make software changes.

We believe that, to maintain and improve the knowledge flow into a social network, autonomic system properties are of great value and this is what we will discuss in the next section.

3. Proposal

Our work proposal is to allow the knowledge flow that is found in a social network to remain active and improve its flow. To achieve this, autonomic system properties can be applied to a social network to allow the addressing issues that limit or halt the knowledge flow into a social network. To solve these problems, our main strategy is to enable social network balancing [Monclar, Oliveira and Souza 2009]. It can be understood as the identification of the troublesome points in the social network, and suggestion of modification of its structures, in order to solve or minimize these problems. With the social network properly balanced, it is possible to suppose a knowledge flow increase in the network once suggested relationships are accepted [Monclar et al. 2007]. In order to balance the social network, we first have to identify the problems in the social networks formation, which are discussed below.

3.1. Problems in Social Network Formation

Troublesome points are problems in social network formation that can hamper knowledge flow in it. People who have no relationship with others, people who are distant from others in the net, people who are the only link between two groups with common interests (bridges), people who are linked in a weak way to the social network (periphery), knowledge centralizers, and so on. These problem points are leveraged through the use of specific algorithms in each one. Once identified, such problems should be solved or at least minimized. To solve these problems, our proposal recommends some contextualized changes in social networks, suggesting the creation of new ones, the invigoration of others, and the killing of some relationships. For this re-structuring, called balancing [Monclar, Oliveira and Souza 2009], we use the principles of autonomic computing. For that, we will explain the autonomic properties and how it can be mapped on our approach in the next section.

3.2. Autonomic Properties Applied to Social Network Issues

3.2.1. Self-Configuration. This property is used to deal with issues related to new people in the social network and current members.

When a new member joins the social network our main concern is to prevent one from being or feeling isolated from other network members. This should be done to enable a better environment and to allow one to make more interesting contacts considering one's interests and duties. For this reason, it is expected that the network could suggest some prioritized contact to the new member. This suggestion may be based on profile characteristics of the new member and on the profiles of existing members. Examples of such attributes may be psychological characteristics (such as MBTI profile [Myers, 1995] or temperament types [Kersey 1984]), competences one has or would like to have or needs to acquire, or common interests. Moreover, the suggestion of first contact may also take into account existing communication tools, user preferences and successfully accepted past recommendations to suggest when and how the contact should occur. The suggestion can indicate a communication tool (such as chat, email, etc.) or a way (such as a personal or telephone call, etc.) through which the contact may happen.

Considering persons already on the network, self-configuration is also important. Two network members should not be very distant in terms of accessibility. At this point we take into account the six-degree separation theory [Watts 2003] according to which a person needs no more than six other contacts to reach anyone in the world. When a person is at a distance greater than this, the network suggests new relationships to their members to reduce this distance and consequently improve the knowledge flow between them. This suggestion is based on the similarity of user profiles, common competences, and interests they have.

Another point raised regarding existing members is about the relationships the network already has. Based on the analysis of the current network member profiles the social network may suggest the strengthening of relationships considered relevant while letting others considered less relevant disappear. This relationship suggestion can also take into account existing communication tools, ways in which the communication can occur, and successfully accepted past recommendations. This analysis can be made periodically, always considering current member profiles: a relationship that is interesting today may not be so tomorrow.

3.2.2. Self-Protection. Property used to address issues related to people entering the social network, the network structure, and a possible loss of knowledge.

When new people enter the social network it must protect itself from possible problems that might happen. One of these problems stems from intrigues that can happen between two members of the social network. In this case, the new entries and allocations must be made in a way that minimizes possible problems. For this, information on incompatible profiles can be used. Intrigues and relationship problems can harm existing relationships in the social network and, consequently, obstruct or harm the information flow of the social network. Moreover, one should avoid situations such as A has a good relationship with B and B has a good relationship with C, but C does not have a good relationship with A. Over time, it may be that the negative influence that A could have over B about C will weaken or even extinguish the relationship of B and C.

The problems raised previously should also be considered when dealing with existing members of the social network. When relationship problems between members or groups are detected, the social network can make a reallocation or even shield the problematic people or group to avoid further problems for the network as a whole.

Other problem is related to junk knowledge. In a social network there can be people (or groups) that disseminate old ideas and old concepts and, when faced with new ones they cut it down and do not allow its flow over the network. For them, addicted ideas have priority over new ones. The network needs to protect itself against this situation.

The social network should also be able to prevent its loss of knowledge. If a particular external factor (a new law on retirement, a new proposal for work, or course accomplishment) can cause that particular person or group of people to leave the organization, the social network should predict it and take steps against the loss of knowledge. To do this, it must create new relationships that allow the knowledge transfer before those involved leave the organization and take the knowledge with them.

3.2.3. Self-Heal. The self-healing property is used to address issues related to problems found in the social network. In this case, there is no way to avoid the problem as it is already in the network and may interfere in the knowledge flow. In this work, self-healing is used to treat two main problems: the knowledge that does not flow in the network and the network that dissolves itself. To avoid these problems, the social network must identify and deal with clusters, cliques, social circuits, bridges, knowledge centralizers, and so on.

Clusters are organizations of people in social the network that do not overlap [Monclar et al. 2007]. The existence of clusters, in itself, is not a problem. However, the existence of many clusters in a social network is regarded as a problem as it shows that there is little interaction of members of a cluster with other social network members. Moreover, when a cluster of members of the social network no longer communicates with other members it may signal the emergence of problems of flawed information within the group.

The issue of intrigues mentioned above is also faced with the self-healing property. When such a problem is detected the social network may relocate members in order to avoid further problems that might block the knowledge flow.

Another issue dealt with self-protection refers to the network structure. The social network should be able to detect and resolve the presence of:

- Bridges: people who serve as a link between two distinct groups of the social network. They can represent people with great power in the network because they are bottlenecks and, thus, can exert control over other members, filtering data, information, and knowledge;
- Peripherals Nodes: members that are weakly linked to social networking. These members are being neglected or under-used in the social network and may be lost at any time;
- Knowledge Centralizers: members of a social network who centralize knowledge and do not distribute it adequately. They can be a great danger to the social network, since when they leave the network a considerable part of the knowledge present in the social network is lost. Recovering the lost knowledge can take a long time;
- Centralizing Nucleus: members that centralize relationships with other members of the social network. As in the case of knowledge centralizers, they can cause great damage to a social network. When one of them leaves the organization some members could be totally disconnected;
- Isolated People: they are very common in the general context of social networks and are represented by people who, despite belonging to a social network, do not relate to other members. The social network should identify them and encourage them to communicate with others through the suggestion of people and ways for communicating with them.

3.2.4. Self- Optimization. The self-optimization feature is applied to social networks to address issues related to balancing the social network, that is, identification of problems of the social network and the attempts to solve them through the suggestion of new

relationships. In balancing the social network, the structure of the network issues pointed in item 3.2.3 is also taken into account for the suggestion of new relationships.

In addition, the network should be able to optimize itself considering the profile (psychological attributes, competences, and personal interests) of each social network member and the influence and reliability of the information one may provide. Optimizing the available communication resources is also important as it prevents overloads and damages the tools could undergo.

It is important to note that the other autonomic properties also work in balancing the social network by suggesting new relationships to solve problems or to avoid problems that could affect the knowledge flow.

3.3. Some Elements that can Influence the Knowledge Flow in Social Networks

Based on the issues raised above in each autonomic property, a list was prepared for the elements that can influence the knowledge flow in a social network. A brief discussion of each of them is provided below:

- Collective Interests: sometimes collective interests may also influence the flow of information in a social network. It can be very interesting for a particular group to share information with other more experienced and active groups in a given area. This may increase the expertise of that group. Moreover, not always a group would like to share information with another, i.e., a rival group;
- Conflicts and intrigue: when the relationship between the members of the network is not good, it is known that the flow of information and the social network as a whole are affected. They can be weakened or even destroyed. The same thing happens when the relationship between groups that could exchange information is not good. Trying to improve the relationship between individuals and groups is a way to improve the flow of information in a social network and to strengthen it;
- Workgroups: it is interesting to keep the information flow always active in a workgroup. After all, if, e.g., a research group has a great dependence of one of its members, if him/her, for whatever reason, leaves the group, the group as a whole will lose much of its knowledge;
- Relationships: Preserving the relationships in a social network is a good way to ensure the knowledge flow in a social network. After all, if there are no relationships between people there is no exchange of knowledge. Trying to create new relationships between the right people at the right moment and improving existing ones is certainly a good strategy and ensures that they can continue generating good results in the social network;
- Isolated People: isolated people or those that stand distant in a social network do not contribute to maintain the knowledge flow active. Bringing together the people who have similar interests is a good strategy to enable the knowledge flow. In addition to approximating them, it is also necessary to encourage them to cooperate with one another;
- Knowledge: the knowledge of a social network member is not exactly equal to the knowledge of other members. Encouraging knowledge exchange between people who have similar interests can improve the knowledge flow in the social network, contributing towards its spread on a larger scale and towards the innovation process. Also, information sharing can improve and refine its meaning: the aggregation of information done by groups often results in better information than that which could be acquired by any member of the group [15];
- Knowledge Centralizers: people who hold a significant part of the social network knowledge. Their presence can be very important to pass knowledge on to new members of the social network. However, their knowledge should be shared with the other members to prevent its loss;
- Collaborative Tools: there is no doubt that the knowledge flow can be streamline by improving the relationships of the social network members. The presence of collaborative tools (such as chats, forums, email, conceptual maps, amongst many others), when correctly used, can improve the quality of such existing relationships and allow the creation of new ones. When the environment to which the social network belongs has a large variety of communication tools it may be interesting to suggest the use of a certain tool to contact a specific person based on the analysis of the lasts interactions and their contexts;
- Sub-Groups: when we work in groups and they grow in size it is common see, by affinity or line of interest, the emergence of sub-groups. They try to improve communication amongst their own members, but often end up isolated from the larger group to which they once belonged. When it happens, the knowledge flow in the group as a whole ends up harmed. There are no problems in the emergence of subgroups as they remain united and in collaboration with the original group;
- Network Structure: Social networks should have a structure that does not allow a very large distance

between its members and that would prevent the presence of weak bridges of communication between two groups. It should facilitate the communication between individuals, and they should not allow people to be too isolated and out-of-reach;

- Expertise and Reliability: The expertise of members and the reliability of the information one can provide in a social network should be considered when it is to improve the knowledge flow in social networks. It is more beneficial and productive for a person who is entering the social network information to ask more experienced members rather than the other novice. Even amongst the most experienced, it is perhaps not interesting for anyone to request information. The reliability of the information a person can offer should be verified;
- Knowledge Layers: Many times, in analyzing the social network as a whole, we conclude that it is well connected, distributed and united. However that could not be true when we analyze the network based on, i.e., just a branch of knowledge. For instance, the network of professors of a university can be very interlinked, but what happens if we analyze the network based on just one knowledge area? How is the social network formed by the professors that have an interest in a certain knowledge area? Thinking in aspects like these, the conclusion is that we should see the social network as a whole and also in its knowledge layers.

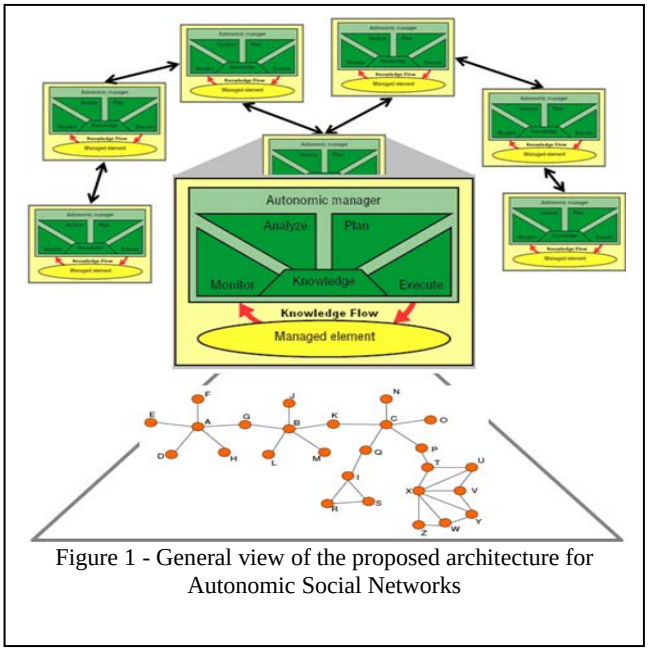

Figure 1 - General view of the proposed architecture for Autonomic Social Networks

4. Generic Architecture

To evaluate our proposal, a generic architecture is being developed and it is based on the work described in [Kephart and Chess 2003]. This architecture consists of a collection of autonomic elements which works on managed elements (such as the characteristics of the social network presented in section X). An autonomic element is a system that constitutes and is part of the whole autonomic system [Kephart and Chess 2003]. These elements include resources and provide services for humans or other autonomic elements according to pre-defined rules determined by developers and by other autonomic elements [Kephart and Chess 2003]. A schema of this architecture is exhibited on Figure 1.

Figure 1 shows autonomic elements that work on the social network. Each autonomic element is able to suggest changes on the relationships (balancing it) of the social network. This is done throw suggestions that are made to the social network members. These ones can accept or reject the suggestions in a free way. Since a suggestion is accepted by a member and, consequently, the structure and characteristics of the social network are changed, other autonomic elements perceive the chances through the use of sensors that capture the changes occurred. This is the entrance to an important characteristic of an autonomic element: its continuous control loop [Kephart and Chess 2003] [IBM 2005]. This loop is used to allow that each autonomic element be able to manage its own internal behavior and its relationship with other autonomic elements being constituted by four main operations: monitor, analyze, plan and execute - MAPE.

Since an event is captured by the monitor function of the loop, the autonomic element must analyze the kind on event and if it needs to take some action in response to that event. This is done by the analyze function. After analysis, the autonomic element must choose which action must be performed to answer that event in order to choose the most appropriate one. This is done by the plan operation and considers an rules base. Since an action is chosen, this action must be performed by the execute operation. It is important to note that all operations of the control loop take actions based on correlations, rules, beliefs, expectations, histories and other information known to the autonomic element or available to it through the knowledge repository within the Autonomic Manager [Sterritt 2005].

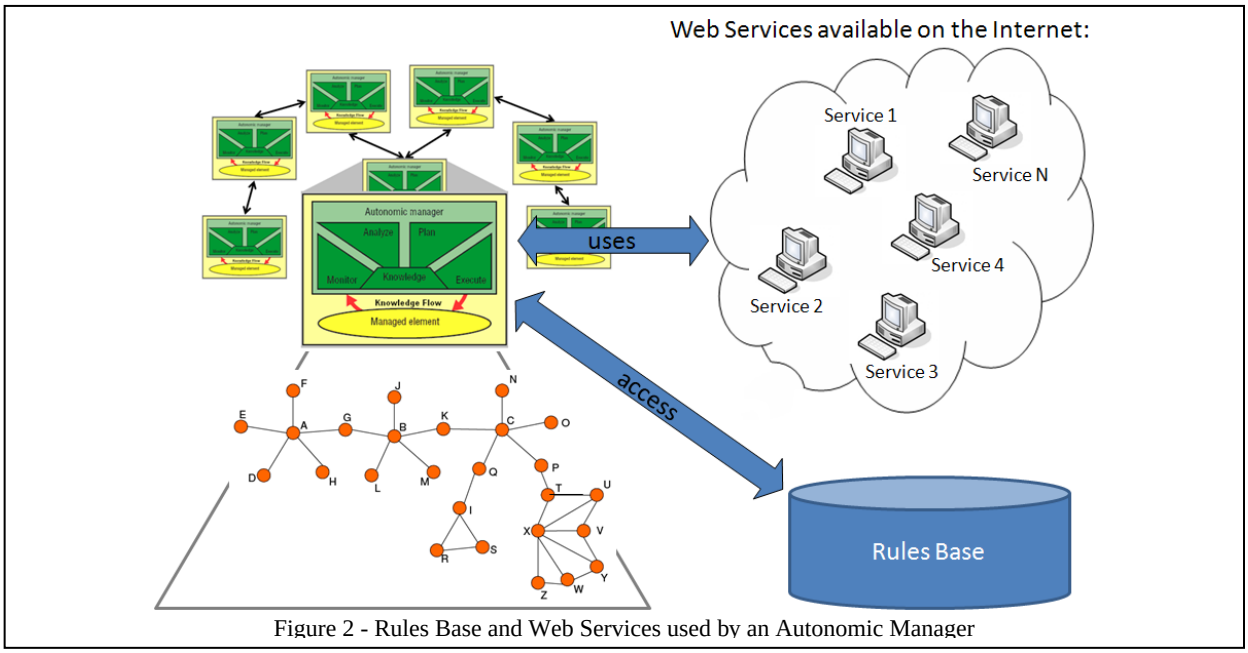

Figure 2 - Rules Base and Web Services used by an Autonomic Manager

An example of event can be the entering of a new person in the social network. In order to suggest a first contact an autonomic manager must monitor the entrance, then analyze the person profile to choose the better contact (plan) and suggest the new contact (execute).

There are many technologies that enable the autonomic computing being a reality. In our proposal the knowledge used by the autonomic manager is taken from a base of rules. This base stores information such as better measures, choices, actions taken by autonomic managers and so on. And to guarantee that the autonomic 'manager take the best choices, we want to make the necessary services available as web services. Using this we can permit that the autonomic manager can access the same service of different servers and choose the best result. The choice of what is the best service is based mainly in measures and history of choices made stored on the rules base. This internal behaviour is illustrated on Figure 2.

The Figure 3 shows two views of the same social network: one complete and the other with members who have researches on Database. In addition the figure shows autonomic managers working over the social network. It is represented through the triangles that leave each autonomic manager.

The autonomic elements will work on the items that can influence the knowledge flow over the network as described in Section 3.2. Initially, we are defining three types of autonomic elements (Figure 3). A type (Figure 3–(a)) will act on characteristics of the net as a whole, the other (Figure 3–(c)) that will act on the personal interests of the members of the social network, and a third one (Figure 3–(b)) will act on layers of the social network, such as a specific knowledge area. This choice is justifiable as there are features that need a wider knowledge of the social network (its structure, centralizing nucleus, bridges) and others that need a more personal knowledge (i.e., personal interests, values, faiths).

5. Conclusion and Future Work

In this article we have analyzed how autonomic system properties are being applied to social networks in order to eliminate (or at least minimize) the problems commonly found that could decrease or even stop the knowledge flow among its members and we presented a generic architecture based on autonomic elements.

This architecture we presented was built in order to preserve or improve the knowledge flow over the social network. This architecture uses the autonomic systems properties to identify strengths and mainly its weaknesses (such as lack of communication, deficiencies in spread and flow of knowledge, among others) and, based on this analysis, recommends some contextualized changes in the social network suggesting the creation of new relationships, the invigoration or killing of others. This restructuring is called balancing of the social network.

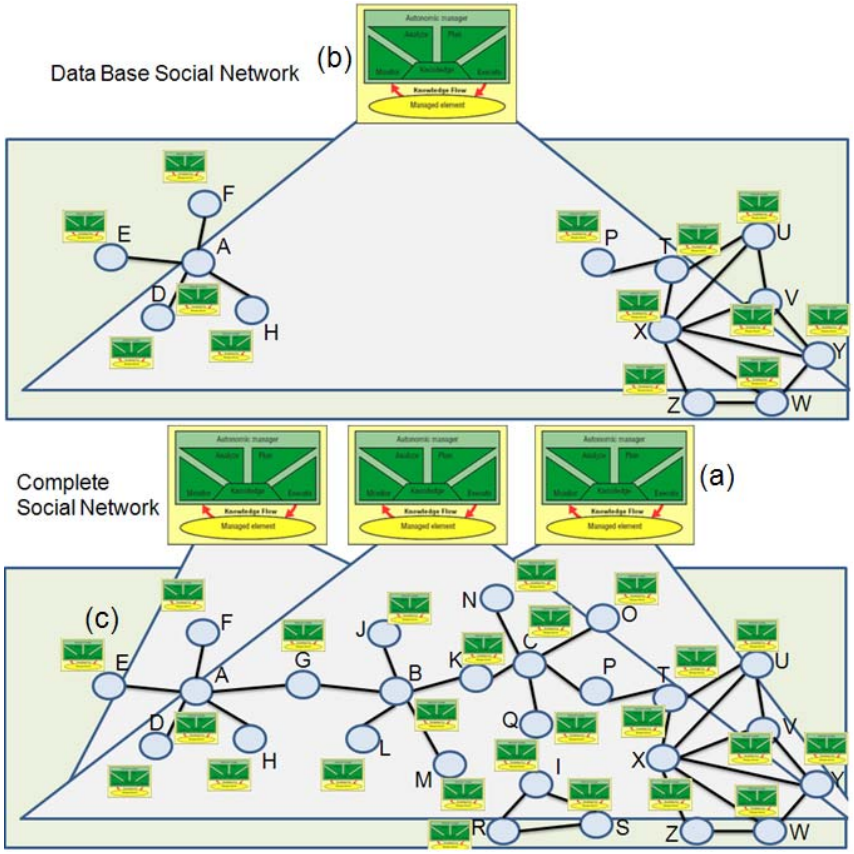

Figure 3 - Autonomic Managers working on Social Networks

It is important to note that the identified improvement points can only evolve if there is cooperation between those social network members involved. Once accepted the suggestion, a new relationship is being done and others can emerge. In this way, it is expected that the knowledge flow over the social network as a whole is improved.

This work is in progress and we are working along many research lines. In one of them we used data mining techniques to identify intra and inter organization groups of people with similar profiles in the scientific scenario in Computing Science in Brazil, assessing how researchers in the best universities and research centers collaborate and relate to each other [Silva et al. 2009]. This work will be improved with the ideas described here through the instantiation of the proposed architecture into a prototype that will work in scientific social networks [Newman 2001] and will be coupled at GCC [Oliveira et al. 2006]: an environment for scientific knowledge management.

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