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## **Computational Security Models in Organizations: Bringing a Pedagogical User-Centered Perspective**

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### **Abstract**

The security of systems and networks is a multidisciplinary challenge of increasingly importance which has stimulated the development of multiple solutions for an effective response to the requirements that are needed. In pursuing this demand much of the focus of security proposals has focused on ensuring mechanisms that prevent organizations from being attacked from outside their perimeter. However, the evolution of the tasks carried out by the internal organizations collaborators, which demand an increasing degree of use of computational resources and privileged access to multiple sources of information, emerge an increasing concern in the monitoring of the behaviours of the users. In addition to this problem, there is often an ill-defined borderline confusion over what internal workers should be able to do with the resources they have in organizations. The mix between strictly professional use and personal use can be problematic in organization's security context. Define organizations security policies, understand user' behaviours, act effectively over security incidents and promote users' organizational security culture, by a pedagogical approach seems to us to be a necessary advance in security frameworks nowadays.

This paper presents a reflection on the aspects of internal security of Local Area Networks and proposes a conceptual security framework, which aims to contribute to an effective control and understanding of LANs user' behaviour, to a real-time response to unwanted occurrences but, especially, to a pedagogical approach to help the development of users' security culture.

**Keywords:** Security Models, User-centered systems, Computational Security, Conceptual Model

### **Introduction**

In organizations, users' compliance with security is crucial for minimizing information security incidents (Bauer et. al., 2017). Security solutions based on technical aspects alone are insufficient to protect corporate data. Studies show that successful information security only can be achieved through a combination of technical and socio-organizational perspective and when users are considered an active agent (Bulgurcu et al., 2010; Montesdioca & Maçada, 2015; Spears & Bakri, 2010).

Involving users, differentiating assets within organizations, and that interact with information systems is an extremely important part of designing effective security models. However, the role of the user in the context of the definition of security models, policies and procedures is often relegated to the background.

Security models that only include users as agents that can putatively counteract security or threaten their effectiveness are examples of approaches that do not understand the determining role of the human factor in the context of computational security.

At the basis of the success of any attempt to ensure the security of information systems is the security culture that proliferates in an organization. The level of security culture always reflects the degree of

commitment of the users in the pursuit of the security policies that the technical-administrative component has defined. In this way, in our opinion, creating mechanisms for participatory inclusion of users in a symbiotic relationship with the technical component of administration will only benefit the overall effectiveness of organizational security.

However, the creation of models that support this symbiotic interaction emerges as a challenge. It is precisely to this challenge that this article proposes to respond, through a conceptual model of security. The proposed model is intended to be a pedagogical user-centered approach that support a partnership between the user and the security-administrator, contributing to an increase in security culture, improving the effectiveness of security policies and also increasing user awareness of the importance of their actions, when he uses the organization's computing resources.

### **Computer and Network Security Overview inside Organizations**

System security depends on several factors, and conscientious organizations must address all of them in order to guarantee the best system's security. It's not easy to quantify a system's security state. Based on key characteristics of attack-defense interactions, (Pendleton et. al., 2016) proposed a security metric framework with four sub-metrics: system vulnerabilities, defense strength, attack (or threat) severity, and situation understanding, being user vulnerabilities, along with interface-induced and software vulnerabilities, the central elements of system vulnerabilities.

While most of the factors that contributes to the overall measure of system security can be hardened and improved by automated and mandatory procedures, users have the "human factor" that makes them a challenge since their behavior has associated a bit of uncertainty.

According to (Workman et. al., 2008), most of the research on information security focus on the technical side of security lapses, but it is personal behavior that makes the foundation of securing organizational systems and "security technology should be user-centered". Also, the authors findings suggest that when users are aware of the severity of a threat then they tend more to implement security measures. (Hanus & Wu, 2016) findings also confirm the importance of security awareness on the perceived severity on the desktop users.

It will not bring great opposition to say that human factor is the weak point in security. Desman (2003) says that "Information security is a people, rather than a technical, issue". Therefore, it is critical to give to security culture the relevance that it deserves. This is not an easy task and it must be assumed as a permanent demand, with a constant interaction between users and the security team.

Users should know not only what are the generic security best practices but also what are the requirements and expectations for their behavior in accordance with the organization security policies. The main suggestion in the literature to ensure compliance is by training and education (Puhakainen & Siponen, 2010). The importance of giving users security awareness training is not a recent trend, and many organizations are providing it. But even in those cases, there are doubts about the real effectiveness of the training (Caldwell, 2016). In fact, an informed user doesn't necessarily mean a compliant user, and (Puhakainen & Siponen, 2010) realized that security compliance could be maximized if employees received continuous feedback about it.

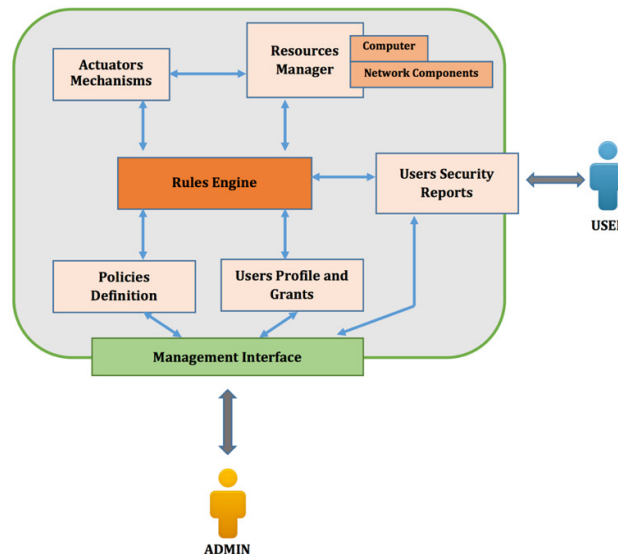
Despite the simplest and most generalized way of providing security awareness to user is an impersonalized and generic style, where every user gets the same training, a targeted approach, where each user has the training depending on his own behavior, is more desirable since is more likely to be accepted (Furnell & Vasileiou, 2017) and have a bigger positive impact in the organization security.

Designing security models, that incorporate users, implies that human factors are identified in the context of safety. Ki-Aries & Faily (2017) presents an approach for identifying security related human factors by incorporating personas into information security awareness design and implementation. It is also referred that personas as user models can also help in the identification of threats, vulnerabilities and areas of risk in their work environment (Faily & Fléchais, 2010).

Next, is presented a conceptual security model that, based on a security proactive approach, incorporates a user-centered pedagogical component that intends to support a symbiosis between the technical-administrative staff and users, in order to increase the security culture inside organizations.

### A Pedagogical User-Centered Conceptual Security Model

In order to contribute to the development of security systems, designed not only in technical security itself, but also enhancing the role of computing resources users; a conceptual model was developed that incorporates the pedagogical and educational dimension of the user security culture. This model is presented as a contribution to make available a final set of information about users behavior and how these behaviors are reflected in the organization's computational security. In this way we will educate the user and make him an active and participatory agent in the process of organizational-security Policies and procedures definition. With this approach, users will tend to cooperate with the technical structure and increase the level of security. Figure 1 presents the proposed conceptual model.



**Figure 1 : Security Pedagogical User-Centered Conceptual Model**

The proposed model incorporates a security approach that interconnects the role of the security administrator and the role of the user. This model, incorporating classic security mechanisms, highlights the role of the user as an active agent, contributed, above all, to the increase of security culture. This model emphasizes the User Security Reports module which is a contribution to a user-centered approach and the ability of the security system to contribute to the formation of a security culture in the user. The contribution of each component is described below.

#### *Model Components Description*

**Management Interface:** This component centers the management interface to which the security administrator has access. Through this, the administrator can control all existing modules either to consult or to configure all the existing functionality. It is in this sense the management console that the administrator uses to manage the security system. In particular, we must note that it will be the management interface of all the administrator and user relationship.

**Users Profile and Grants:** In this component the profiles and permissions of the users of the system are configured. These profiles and permissions cater the user as an agent that uses the organization's

computer system and the role that its activity in the organization requires of these same resources. The risk profile of the user is also defined and mapped in the form of profiles.

**Policies Definition:** This module is responsible for mapping the security policies defined by the administrator. Security policies concern the rules that must be developed and followed by users of an organization's information resources. They are in themselves the way to ensure security principles and should translate the organization's view of the security concept itself and the way the organization must guarantee it.

**Rules Engine:** This component is of particular importance since it translates the dynamics of the whole proposed model. Based on rules and intelligence, this component takes as input all the data flows and mechanisms in the model to make proactive decisions. These decisions range from purely technical aspects (e.g. reconfiguring a firewall or using data from an intrusion detection system to generating an attack alert) to actions directed to the user and/or to the administrator. These last actions translate the ability to perceive whether user behavior is violating the defined policies. In this case, both the administrator and the user will be notified. It will be the responsibility of the administrator to act accordingly, always in a pedagogical way and in order to raise awareness of the importance of correcting the user-behavior, explaining the negative impact of bad behaviors on the organization security and the security of the user's own system. This component has the ability to manage all components in real-time.

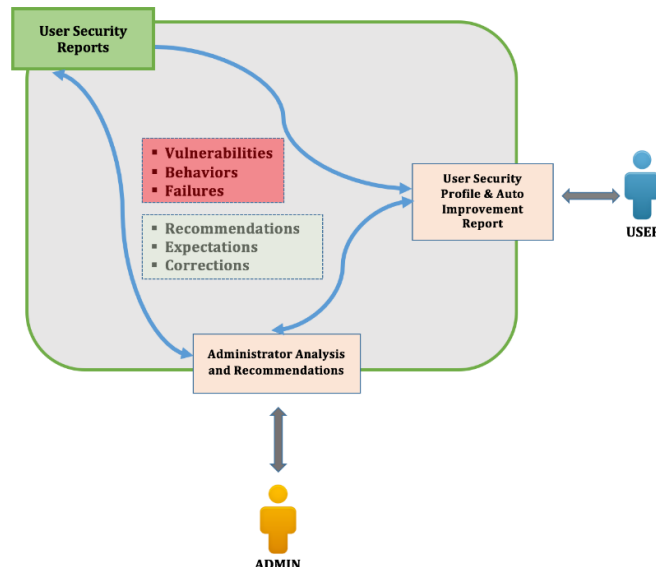
**Actuators Mechanisms:** This module translates the set of actuation mechanisms that operate on the computational resources (i.e. computers, network components, security equipment, etc.). Its real-time management by the "Rules Engine" module allows the actuation mechanism module to reconfigure all computer equipment.

**Resources Manager:** In this component are mapped all the computational resources, existing an interface of manipulation of the same. This component is managed by the "actuation mechanisms" component and by the "Rules Engine" component, in case any real-time nonconformity is detected.

**User Security Reports:** In security systems the human factor is of extreme importance for the security guarantee itself. However, the implementation of security media is often inimical to user usability and freedom. In this way, and when the user has not participated in the planning and definition of the security measures, will tend not to understand the importance and necessity of such policies. This scenario is especially true when a security culture does not exist. It is in this scenario that the "User Security Reports" component contributes to the creation of user-centered security models and pedagogical approaches to create a security culture that is, in our opinion, a key issue in the computational security context.

The Rules Engine component, as an aggregator, has the ability to record and act on events that are monitored by the security infrastructure. From this continuous action comes the ability to generate reports on user behaviors. Security report is designed to warn the users such as notify, inform and advice users about the consequence effect of its actions (Amran et. al., 2017). These reports are first sent to the administrator for analysis and to conclude what actions will be taken. In the next phase, the administrator will include the set of recommendations that should be included in the report that will be sent to the user. These recommendations should be guided by a view of the organization's impact on the user's negative behavior and, more importantly, a set of indications enabling the user to better understand the consequences of his behavior so that they can be corrected.

These reports are also very important when designing training plans for users in the field of good security practice. They also provide the opportunity for the user to include their opinions and their own contribution to improving security. In this way, a symbiosis between the security administration and the users, the security culture will tend to improve and the user will tend to feel that it is an important piece in the definition of the security policies of the organization. Figure 2 shows the symbiosis between administrator and the user and the segments of identification of the wrong behaviors versus the set of recommendations and actions to be developed in partnership with the user.



**Figure 2 : User Security Reports module overview**

The proposed model operates on the principles - monitoring, identification, reporting, action, awareness and self-improvement. This approach fills a gap in the classically presented models in the field of computational security context solutions that are too focused on data flow monitoring and control technologies and where the human / user factor is either relegated to second-importance or even non-exist.

In our opinion, beyond the major contribute of solutions based on pure technological tools (e.g. firewall, IDS, honeypots), the key to many security-problems will always begin with users who are the human resources of organizations. It is with this purpose that a user-centered model and a pedagogical approach towards the user are presented. Security, in many aspects can not be considered merely as technical problems, users who interact with technology must participate as equal partners to build systems that provides secure mechanisms (Akram et. al., 2018).

## Discussion and Final Remarks

The business world is increasingly a world filled with computer systems. Increasingly, there is a phenomenon of interconnection between systems and the massive exchange of information flows. In a new Internet of Things (IoT) scenario, security plays a growing role. This importance assumes the need for systems capable of dealing with the complexity of technological solutions available to organizations and their business.

The evolution of purely technological security solutions has produced very promising results in combating the actions of putative attackers. However, most security models do not seem to play an active and important role for users. In particular, they do not present pedagogical approaches that allow users to understand the importance of their actions as well as their consequences.

In our opinion, the creation of user-centric security models and a symbiosis between a set of purely technological solutions and a user-centered pedagogical system should be the way to go. The user will always be a differentiating agent. Its security culture will always make a difference in any technological model adopted by organizations.

This paper proposes a conceptual model that presents itself as a contribution to leverage the potential of users' security culture and make them into active and participatory agents. A symbiosis between administering the organization's secrecy and the user will, in our opinion, be the key to more efficient

security models. Strictly speaking, most organizations do not focus on segregation. However, all organizations deal with digital information and see, every now and again, in information a differentiating fact to be preserved.

We would like to point out that the proposed model is currently in prototyping phase and the most appropriate mechanisms of interaction between the security administrator and the user are being studied; in order to specify the taxonomy of the Users Security Reports module.

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