Review

Investigating an autonomous system in nursing

Mohammad Reza Nami[1]* and Jila Saneipour[2]

[1]Faculty of Electrical, IT, and Computer Engineering, Islamic Azad University- Qazvin Branch, Iran.
[2]ICU Part, Imam-Hossein Hospital, Shahid Beheshti Medical University, Iran.

The term E-nursing has been used to refer to the incorporation of ICT into nursing. Point-to-point connections using private networks are used by hospitals and clinics that deliver services directly or contract out specialty services to independent nursing service providers at ambulatory care sites. Radiology, mental health and even intensive care services are being provided under contract using Tele-nursing and telemedicine to deliver the services. An autonomous system manages complexity and improves the system complexity without interfering expert humans. The purpose of this paper is to present an autonomous virtual organization for e-nursing describing their characteristics, effects on quality factors, their building blocks architecture, and challenges.

Key words: E-Nursing, collaborative networks, information and communication technology (ICT), virtual organization breeding environment (VBE), autonomic computing, self-managing systems.

INTRODUCTION

The management and control of distributed systems and services is a challenging research problem, because the huge amount of data must be collected, coordinated, and managed. In the office and in many homes too, e-mailing has become a daily routine. New technology is revolutionizing health care. For example, monitoring patients and managing their health and care can be submitted to the mobile phone of patients. IT is improving nurse practices with modernizing health care systems. It will change the practice of every nurse, health visitor, midwife and health care assistant. IT will also affect nursing students while on clinical placements. Nurses will have to learn new skills to use this technology. They also need to be involved in concepts such as Tele-nurse (Tsutomu, 2001) (link to a patient's television set at home to monitor medication or provide advice and support), Tele-care (Luis, 2004) (remote delivery of care especially for elderly people), and Tele-health (Ela and Tony, 2002) (science of generating, recording, classifying, storing, retrieving, processing, analyzing, and transmitting health information). With ICT and e-health especially e-nursing, nurses use a decision-making process which involves monitoring the patient, diagnosing or identifying his/her

problems, planning and implementing appropriate interventions, and evaluating the results. In general, the strategy of *e-nursing* includes the following:

1. Consider nurses in all domains of practice – clinical practice, education, research, administration and policy;
2. Identify what nurses need, take advantage of existing quality products and programs, and reduce duplication of effort;
3. Benefit individual nurses and their clients, employers, nursing professional and regulatory organizations and the nursing profession as a whole, nationally and around the world.

Moreover, an autonomous system facilitates management of large-scale complex heterogeneous systems. An autonomic computing system is a system that manages itself. With emerging autonomic computing as a solution for this problem, the building blocks of an autonomic computing system play important role. Due to the importance of efficiently implementing it, it is so difficult for administrators to manage distributed large-scale complex systems. The vision of Autonomic Computing *(AC)* (Kephart and Chess, 2003) is to improve the management of complex IT systems by introducing self-management systems for configuration, protection, optimization, and healing purposes. An autonomous

---

*Corresponding author. E-mail: nami1352@gmail.com.

model for virtual organizations can improve functionality. This paper is organized as follows. Subsequently, we present an overview of self-managing systems including definition, their characteristics, and Autonomic Elements (AEs) architecture as building blocks in autonomic computing systems. Application of self-managing properties in nursing, e-nursing and e-health are discussed. Finally, the conclusion is presented.

SELF-MANAGING SYSTEMS

On March 8, 2001, Paul Horn presented a link between pervasiveness and self-regulation in body's autonomic nervous system and introduced autonomic computing systems to the National Academy of Engineering at Harvard University (Hariri and Parashar, 2005). An overview of Autonomic Computing Systems (ACSs) as self-managing systems is presented.

Definitions and properties

According to Paul Horn's definition, an autonomic computing system is a self-management system with eight elements. 'Self-configuration' means that An ACS must dynamically configure and reconfigure itself under changing conditions (Murch, 2004). 'Self-healing' means that an ACS must detect failed components and eliminate or replace it with another component without disrupting the system. 'Self-optimization' is the capability of maximizing resource allocation and utilization for satisfying user requests. Resource utilization and work load management are two significant issues in self-optimization. An ACS must identify and detect attacks and cover all aspects of system security at different levels such as the platform, operating system, applications, etc. It is called 'self-protection'.

An ACS needs to know itself. It must be aware of its components, current status, and available resources. It must also know which resources can be borrowed or lent by it and which resources can be shared. It is 'self-awareness' property. An ACS must be also aware of the execution environment to react to environmental changes such as new policies. It is called 'context-awareness'. 'Openness' means that an ACS must operate in a heterogeneous environment and must be portable across multiple platforms. Finally, an ACS can anticipate its optimal required resources while hiding its complexity from the end user view and attempts to satisfy user requests. We consider self-configuration, self-healing, self-optimization, and self-protection as major charac-teristics and the rest as minor characteristics.

Autonomic elements (AEs)

Autonomic elements are the basic building blocks of autonomic systems and their interactions produce self-managing behavior. The IBM autonomic 'blueprint' (IBM Group, 2005) considers that each AE has two parts Managed Elements (ME) and Autonomic Manager (AM). A ME can be hardware, software application, or an entire system. *Sensors* sense and retrieve information about the current state of the ME, then compare it with expectations that are held in knowledge base by the AE. The required action is executed by *effectors*. Each AM has four parts: *monitor, analyze, plan, and execute*. Monitor part collect data from a ME, monitor it (data sensed by sensor), and manage it. Monitored data is analyzed. It helps the AM to predict future status. The plan part assigns tasks and resources based on the policies (Murch, 2004). Finally, the execute part controls the execution of a plan and dispatches recommended actions into the ME. These four parts with sensors and effectors provide a control loop to create self-managing. Autonomic elements communicate with each other and react to environmental changes according to predefined policies for developing self-managing system.

E-NURSING: PROPERTIES AND CHALLENGES

Here, main concepts and challenges in e-nursing are explained.

Concepts

E-nursing (Biswadip and Judy, 2007; Biswadip and Judy, 2005) refers to the use of ICT in nursing. The aim of e-nursing includes the following:

1. Improving nurses' practices and clinic outcomes;
2. Continuously monitoring patients' signs, advises them, and supporting;
3. Connecting to other professional nurses groups and clinics nationally and around the world and enhancing knowledge;
4. Increasing quality factors in treating patients; and
5. Enhancing management of nurses' work environment.

To build an e-nursing strategy, important tools have been listed as the following:

1. Resources such as electronic tools, database, e-mail, and internet resources for integrating ICT into nursing practice;
2. Implementation of nursing informatics by nurses having high competencies; and
3. Introducing IT and decision support systems to nurses.

Main partners and sponsors in creating e-nursing include:
1) 'Government' must provide infrastructures and education tools, 2) 'Educators' should develop and present ways for incorporating informatics and nursing,

and 3) 'Nurses' should increase their competencies. Now by electronic tools, nurses are improving their ability to efficiently assess and treat their patients.

Benefits and barriers

Cost-effective, saving time, high quality, flexibility, agility, and management of risks are some benefits of using network as breeding environment for nursing. Partners or e-nursing members in should collaborate in order to improve treatment. Important attributes for good partnerships are basic principles of human interaction and business perspectives. Basic principles of human interaction include:

1. Fairness: Just to all parties, equitable.
2. Trust: Reliance on the integrity.
3. Integrity: Adherence to a strict moral or ethical code.
4. Competency: Qualities of features that distinguish a person or group.
5. Open communication: Exchanging data freely between two partners.

Relationships between properties and quality factors

Some properties of virtual environments are explained as follows (Nami and Tavangarian, 2007; Camarinha-Matos et al., 2005): 'Delocalization' is potentially space dependence. Therefore, enterprises become independent off space and capacity. It eliminates the need for a particular space. 'Temporalization' refers to inter organizational relations and to the internal process organization, in the sense of the modular and fractal organization. 'Non-Institutionalization' of inter-organizational relationships in virtual environments can be waived because operations are performed in an environment without physical attributes. 'Dematerialization' means that all object areas are immaterial. Existing mutual confidence for members, absence of physical attributes and administrator can affect system performance and flexibility. Increasing consumer demands is motivated 'individualization' property. Mass customization is one approach for manufacturers to fulfill customer demands and capture new markets. Table 1 shows relationships between quality factors and some main properties of e-nursing.

Challenges and issues

Challenges of creating

Some of the challenges of e-nursing creating include the following:

1. Negotiation of e-nursing group members includes contract templates, virtual negotiation rooms, and negotiation objects.
2. Defining roles and responsibilities of partners.
3. Building trust as the base for organization collaboration.
4. Issues related to incompatibility and heterogeneity of information sources.
5. Planning: Acquiring basic competency information of nurses and collaboration modalities.
6. Dynamically configure a new nurse (member group) from autonomous organizations as e-nursing member.

Efficient creation of dynamic e-nursing (Ela and Tony, 2002) requires a proper environment that the members are selected in, according to their capabilities and trust among them.

Security management

The concept of security in e-nursing as a virtual organization includes confidentiality and integrity of data for secure communication, authentication, and access control to resources. Each member becomes responsible not only for its security, but also for security of common resources. Security policies and mechanisms are categorized into three groups: 1) organizational, 2) legal, and 3) technical. Alteration in the organizational structure of institutions and changes in information system configuration make security management a continuous process. Estimating the risk of occurrences of threads and their effects, determining and implementing optimal security measures, continuously monitoring the system operations, detecting proper security rules, and running them are main activities of security management (Magiera and Pawlak, 2005).

Competency management

Competency of a nurse as an organization is defined as the validated capability of an organization to perform business processes, in collaboration with associated partners, having the available necessary resources (e.g. human, physical, technological), and applying known practices, with the aim to improve works. The advance functionalities of competency management in e-nursing include the following:

1. Automatically collecting competency data from organizations and nurses.
2. Competency gap analysis: This is based on matching domain competency ontology and a set of competencies existing in the e-nursing database.
3. Discovery of new competency in e-nursing database. This is based on matching competencies needed for future nursing strategy and a set of competencies existing in the e-nursing database.

Table 1. Relationships between quality factors and some main properties of e-nursing.

E-nursing properties	Quality factors
Delocalization	Portability
Temporalization	Functionality
Individualization	Maintainability and functionality
Dematerialization	Efficiency, portability, flexibility.
Non-Institutionalization	Portability, maintainability

CONCLUSION

Application of self-managing property in e-nursing, facilitates management while hiding the system complexity from the view of end users. Each autonomic element in an autonomic system plays the role of a nurse in an e-nursing environment. Self-configuration improves maintainability, usability, functionality, portability, and stability. Self-healing increases reliability, adaptability, and maintainability. Self-optimization improves efficiency, maintainability, functionality and flexibility. Self-protection enhances reliability and functionality. In this system, if one member fails, the system automatically finds it, diagnoses the fault, recovers, and reconfigures the system itself.

REFERENCES

Tsutomu M (2001). A tele-nursing system using virtual locomotion interface, HCI, pp. 958-962.

Luis M (2004). Camarinha-Matos: Tele-Care and Collaborative Virtual Communities in Elderly Care, Proceedings of the 1st International Workshop on Tele-Care and Collaborative Virtual Communities in Elderly Care (2004). TELECARE, In conjunction with ICEIS, Porto, Portugal, April. INSTICC Press.

Ela K, Tony C (2002). The Organising Vision of Telehealth, ECIS.

Kephart JO, Chess DM (2003). "The vision of autonomic computing", IEEE Comput., 36: 41-50.

Hariri S, Parashar M (2005). "Autonomic Computing: An overview", Springer-Verlag Berlin Heidelberg, 3566: 247-259.

Murch R (2004). Autonomic Computing, Prentice-Hal.

Group IBM (2005). "An architectural blueprint for autonomic computing", Available at http://www-03.ibm.com/autonomic/pdfs/AC%20Blueprint%20White%20Paper%20V7.pdf, June.

Biswadip G, Judy E (2007). Scott: Effective Knowledge Management Systems for a Clinical Nursing Setting. IS. Manage., 24(1): 73-84.

Biswadip G, Judy E (2005). Scott: Comparing knowledge management in health-care and technical support organizations. IEEE Trans. Inf. Technol. Biomed., 9(2): 162-168.

Nami MR, Tavangarian D (2007). "Virtual Organizations: A New Approach in IT", The 7th IEEE International Conference on Computer and Information Technology (CIT), Aizu, Japan, October, pp. 93-98.

Camarinha-Matos LM, Afsarmanesh H, Ollus M (2005). Virtual Organizations: systems and practices, In Springer Science.

Magiera J, Pawlak A (2005). "Security frameworks for Virtual Organizations", In Virtual Organizations, Springer, pp. 133-148.