Users Management in Interactive Networked Collaborative Environment

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***Abstract*—**In interactive networked collaborative virtual environment (NCVE), users work in a group to involve in activities such as game, discussion and learning. However, their existence is not visibly presence. Therefore, there is a crucial need to represent the invisible users so that users know with whom they are interacting with, when to communicate and what to do during the collaboration. Most NCVE systems support non-verbal communication cue only to a limited degree causing unnatural communication and degrading communication quality. This leads to miss communication and miss interpretation of information during the collaboration. Research works on identifying this situation have been performed by many researchers that lead to the issues of awareness. There is a lack of research that focusing on the use of effective digital elements in networked collaborative virtual environment. In this research, we investigate what are the digital elements used and how they present invisible users. In this way, the appropriate digital elements can be used to model the invisible users in terms of their presence, states and roles. Thus, conflicts in communication between users can be avoided and the digital elements can provide the mean of knowing the participants in the virtual space.Then, our research further explore various roles played by users and access right granted to each role, specifically in e-learning, project management and game. A clear role and well defined job function can strictly outline users' access right for ensuring smooth communication and secure protection as well as privacy of users.

***Keywords*—**Communication, Collaborative Applications, Digital elements, Networked Collaborative Virtual Environment (NCVE), Role, Social Awareness, User Management.

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I. INTRODUCTION

Interactive network collaborative environment (NCVE) allows users from diverse locations to work together via internet on various kind of collaborative works including project management, e-learning, virtual office, virtual enterprise, knowledge management, simulation and game [1-4]. Participants log into a virtual room as their meeting point to get together and work on different tasks. Since users are not at the same location and they are invisible to each other, it is important that NCVE systems provide effective communication tools to ensure smooth transfer of information among users. The reason is that communication in a virtual space is tend to miss a lot of communication cues such as gesture, facial expression and voice tone [5, 6]. Lacking of such communication cues can cause miss-interpretation of the message received [1]. Other problems may arise such as the possibility to lengthen project duration and incur more cost that finally may cause a project conflict.

Working in a virtual room with invisible users requires a systematic human resources management system. For instance, each invisible user must be assigned with a well defined job function and specific role to avoid role ambiguity. However, managing invisible users and their activities is a difficult and challenging task [7] due to dealing with different organizations and background. At the same time, users' roles are dynamic such that they hold to the role for a duration of time or until the goals are achieved. Futhermore, not much is known about user management and human resources in virtual environment [5, 6].

It is important to have an effective user management system because roles like project leader, secretary, teacher, students, visitor and administrator are always associated with access control. It is vital to note that access control is permission to sensitive information resources. Therefore, in order to ensure security protection and privacy to the resources as well as smooth communication [7], role must be stated clearly and a precise access right to the information resources must be outlined.

The aim of this paper is to study the digital elements and how they can represent invisible users for their presence, states and roles. In addition, the paper analyzes and classifies roles that are associated with access rights. Furthermore, access control models that utilize NCVE systems are outlined. Hence, this research seeks answers in relation to invisible users such

as follows:

- How to identify invisible users that are at disperse locations in terms of their presence, states and roles?
- What are the structure of their virtual organizations in collaborative environments?
- What are their common roles in NCVE?
- How to manage their roles that are associated with their rights to access resources in NCVE?

The rest of this paper is organized in three sections. Section 2 discusses about communication in networked collaborative environments and how users' roles are portrayed. Section 3 investigates the use of digital elements to represent users. Moreover, this section discusses the classification of the users' roles, before the discussion and future work in section 4.

II. Related Work

Networked Collaborative Virtual Environment (NCVE) was first introduced in 1987 for military training by utilizing dedicated hardware. Later, it gained popularity and reached its peak in 1997 [8]. Users who work together in NCVE form a virtual team. A virtual team is defined as a group of two or more participants who collaborate interactively in achieving common goals. At least one of them operates from different location, organization, or time such that communication and coordination are highly based on electronic communication media (e.g. email, fax, phone, video conference) [7].

In general, the virtual team has the competitive advantage for utilizing different expertise regardless of place and time. For example, in business transactions, the fast respond to the market demand can be achieved since supplier and customer are closely connected. Thus, cost on travelling and office space can also be saved [1, 2].

A. Communication in Networked Collaborative Virtual Environment

A strong team has a positive effect on communication that leads to the success of collaboration in virtual space [9]. Unfortunately, team building is difficult to establish in virtual space due to computer-mediated communication. In a virtual space, communication is usually task-oriented within limited contact that has lack of trust [10], unity, personal friendship and communication cue. These elements are important in communication [11] for effective grasp of the transferred information.

In order to improve communication and team building, a game is proved to be one of the effective tools [9]. It is due to the ability of users to communicate, coordinate and cooperate in the game collaboratively. The study also reveals that much of the communication occurs in games is established through the interpersonal relationship. Such relationship allows users to share issues on private lives and working environments [12].

In addition, working in a team also requires users to know their roles so that they know with whom they work, when to act and how to react. Furthermore, in collaborative environments, users are expected to share some of the resources while the communication is taking place. Thus, the role and access right are prime elements in successful and effective communication in NCVE.

B. Users' Roles and Access Rights

A role is defined as the sum of all behavioral expectations of a social system of a role actor. The role actor has a certain position that links to tasks and functions. The role has four dimensions as follows [13]:

- Position – role is a position in a social system relative to other position.
- Functions and Tasks – the explicit description of a position that links to certain functions and tasks with right and obligation. For instance, job description and task assignment.
- Behavioral Expectations – the implicit or non-documented description of a role. For instance, social ethic and manner when dealing with customers and partners.
- Social interaction – role actor can redevelop role expectation into explicit behavior that fulfills a unique role.

In collaborative work, a role is consistently associated with access control. The access control is 'the right to use' which includes mechanisms and policies that lay down the access boundary to information resources [2].

The policy for access control is complex within an organization. It is more challenging when it involves multiple organizations such as in collaborative commerce. For example, the complexity is increased due to the rapid change in the participating users, complex interrelationship among users, diversified users and heterogeneous virtual space [10]. Thus, a new set of policies must be formulated. The policies require a carefully plan and design to avoid conflict since it involves the integration of internal and external activities [14, 15].

There are several approaches of resource sharing across organizations. For example, Li et al. [14] recommend mandatory access control (MAC) and discretionary access control (DAC) to access shared database and some functionalities in its applications. On the other hand, Gu et al. [15] prove that virtual enterprise oriented access control (VEOAC) which is based on trust mechanism for protecting resources efficiently. Alternatively, Chen et.al. [10] propose the use of virtual enterprise access control (VEAC) model for the same purposes. VEAC model involves two trust sub models which govern trust between two virtual enterprise roles and between two projects. Therefore, users' roles and their access rights need to be managed properly to ensure successful collaboration.

III. User Management

Managing users in virtual space involves mechanisms to deal with users whom are invisible among themselves

physically. Thus, communication between users are lacking of implicit behavioral expectation and social interaction such as facial expression, emotion, communication cues and gestures. The users' presence is solely depending on digital elements. These digital elements should also clearly exhibit users' roles so that all the users know their team members as well as their expected tasks to perform at any state in their specific collaborative session.

A. Users' Presence

Invisible users can be represented by using digital elements such as text, two dimensional (2-D) graphics, three dimensional (3-D) avatars and audio-video. These elements play the important role in presenting users' presence, role and state. Each of the digital elements has its own unique way to support users' visibility [1] in the virtual space. Table 1 depicts the overview of how the digital elements are used for presenting users.

Table 1: Digital elements and their presentation of users' presence, state and role.

Digital elements	Presence	Role	State
Text	words	words	words
2-D graphics	graphic	graphic	graphic
3-D Avatar	graphic	graphic	graphic
Audio-video	in person	in person	in person

Text represents users in the form of words. Users can be denoted by their identifications (id), names [16], nicknames and messages [2]. Similarly, users' roles can be illustrated by text with different font sizes and colors. For example, a project manager may be represented by a larger font in red to distinguish him from other users. Users with the same roles or belong to the same group will be illustrated with the same font size and color. With this differentiation, it is easier to identify the roles they are playing.

During collaboration, users' states are changing such as from being active to inactive participants. The changes can occur from time to time because users are not always available throughout the collaborative session. For example, users have to leave the virtual room temporarily due to several reasons (e.g. answering phone, having lunch, going to the restroom). Like presence and role, users' states can be illustrated by using different font sizes and colors. In addition, users' states can be highlighted by means of tag cloud or indicator [17]. Some examples of text indicators are 'Online', 'Free for chat', 'Low attention', 'busy', 'Online but elsewhere', 'Away', 'Extended away', 'On the phone' and 'Do not disturb' [18]. They usually appear beside users' identification in the list of users to indicate that changes have occurred.

Unlike text, 2-D graphics represent users' (presence, role and state) in the form of shapes and graphical images which can be as simple as a dot [19]. The 2-D graphics also have different sizes and colors. In most applications, users' colorful graphics are posted on a map, graph, radar or hierarchy tree, to make users' presence and role become more visible. For users' states, extra images can be added to users' identification image. The images can be in a form of overlay icon, arrow [17], emoticon, color and simple animation.

The 3-D avatar represents users in a form of human embodiment with some specific sizes and appearances [1]. The avatar's dress and costume portray users' roles such as a king will be dressed differently from his army. The avatar's actions show users' status. For examples, an avatar will be wearing speck when the user is busy in different window, the avatar with microphone indicates that users are busy on instance messaging and the avatar will stare at empty space when users are not available [19].

Lastly, the digital element that is used in NCVE is audio-video. It represents users in person where users' face appears on a screen. Their roles are normally identified at the early, prior to the collaborative session. When users are in action, their states can easily be identified from their body language like facial expression and voice tone. For instance, if they yawn, this action indicates that they are bored [1].

B. Users' Roles

During collaborative session, users' roles can be changed dynamically. For example, in computer support collaborative learning (CSCL), at any time, a tutor can change his role and become a coordinator. Similarly, in collaborative game, a user is assigned a right to hold to a particular role for one level or for one game. In project development, a user is assigned to a particular role based on phase and task at the specific time.

Since a role is associated with access control, the relation between role and access right need to be identified. Table 2 shows the taxonomy of roles and their access rights to resources.

Table 2: Users' Roles and Access Right

Role Type	Classes of roles	Access right and control							
		Content steward	Floor Advisor/ Influencer	Task mgr	Floor mgr	Shift user	Account mgr	Access right	System mgr
1.	top manager	✓	✓	✓	✓	✓	✓	✓	×
2.	manager	✓	✓	✓	✓	✓	×	×	×
3.	administrator	×	×	×	×	✓	✓	✓	✓
4.	active member	✓	✓	×	×	×	×	×	×
5.	non-active member	✓	×	×	×	×	×	×	×
6.	visitor	✓	×	×	×	×	×	×	×
7.	hidden	✓	×	×	×	×	×	×	×

Based on the exploratory studies, seven classes of roles are identified. The roles are analyzed based on eight functional activities. Different roles are permitted to access different functionalities in order to assure security as well as privacy of the resources.

1) Role Class 1: Manager

Managers hold the highest role in the virtual room organization. They are frequently known as project manager [20], course manager or moderator [21]. They ensure the overall users' duties that are parallel to the missions of project and organization. In addition, their works involve observing the relationship between users and their activities associated with consumed resources [20]. In summary, they govern the overall virtual organization including users, processes and activities of the collaborative work.

People who are under this class (Role Class 1) are the decision makers. They decide who should hold the roles and perform associated responsibilities. Furthermore, they have the authority to terminate any users when necessary. With their authorities, they can grant or deny any request to create new facilities. For example, in learning environment, the top manager can grant the creation of new courses requested by tutors [22]. Similarly, in a virtual environment, they can approve the creation of new virtual room for private communication. This type of role class can be called *Course Managers*.

The course managers are responsible to the organization and management of participants (students and tutors). They select and set the best tutors for every course and the tutors can view users' profile in order to make strategic decision [22]. Typically, there is only one tutor per virtual room at any given time [22, 23].

In addition, the course managers also manage classes. For example, they schedule all classes within the virtual system. They are also responsible to the content of the course. They create and manage courses to be taught in the virtual room. Lastly, they are responsible to select and administer the topics to be posted in forums or bulletin board [22].

2) Role Class 2: Team Leader

Team Leader is superior, coordinator, conflict-mediator, coordinator, teacher, tutor and mentors [21-24]. They are grouped into *Team Leader class* who assist *Manager* in management and policy formulation. For example, they support *Manager* by giving alternative solution and viewpoint in decision making. In virtual space, there is usually no more than one *Team Leader* per group [22, 23] such as one system analyst in a group of programmers. Even though *Team Leader* can perform most of the *Manager's* tasks, their authorities are limited. For example, they cannot perform account management and access right, however, they can propose to the *Manager* for any user's access right.

Unlike *Manager*, they are not capable of terminating users' account but they can reshuffle users into different rooms. For instance a tutor can move a small number of weak students to a separate virtual room. By doing so, it gives the students an opportunity to ask questions and get feedback privately [22]. Another example is where a superior can block certain problematic staffs from entering certain room or force them to leave the room [22].

In relation to task management, they work closely with their subordinates as compare to *Manager*. Users in *Team Leader* position create group, distribute task to group members, schedule their activities as well as monitor their progress to ensure the objectives are met [21]. It is part of *Team Leaders'* duties to give feedback to their subordinate regarding their performance. For example, tutors or teachers will give feedback to their students in relative to their performance in the course [21]. Similarly, a supervisor will perform the same feedback to their workers. Moreover, *Team Leaders* can view some of the sensitive data like history of users' activities, projects' history as well as the cost of projects [21].

Team Leaders are certified to manipulate the asynchronous content. In the case of Computer Supported Collaborative Learning (CSCL), teachers can be viewed as *Team Leaders* who will create and maintain learning materials, examinations, and tests [20]. In other applications, *Team Leaders* can upload files in files directory in order to be utilized by others and download outdated files. They will also make decision on what to be presented on the white board [22].

Similar to *Managers* in handling the floor control, *Team Leaders* can administer the communication during collaboration by giving permission to users to communicate [22], pass control to others, encourage passive users to participate, and avoid the floor from being monopolized by certain users. *Team Leaders* can also terminate users who disturb the discussion and create uncomfortable environment [22]. For example, a tutor can terminate the student who consistently disturbs the class. In addition, *Team Leaders* control the decision making process by initiating a vote. Furthermore, in certain emotional conflicts, *Team Leaders* act as a mediator [21].

3) Role Class 3: Administrator

Administrator is inclusive of administrators and technical supporters. *Administrators* are platform owners [22] who handle the collaboration system by themselves. Their tasks involve maintaining the overall system and the network to ensure the collaborative work takes place smoothly. They trouble shoot the system whenever malfunction occurs [20, 22] and consistently take preventive action towards the system performances.

In addition, *Administrators* are responsible to manage and maintain resources as well as security of the resources [22]. It is necessary to ensure that resources are used according. For example, files are identified for read only, both read and write or solely meant for execution. Even though authorizing the

access right to information resources is beyond the control of the *Administrators*, they are responsible to manage and maintain the resources.

Beside managing resources, *Administrators* maintain each of the user's account. Their tasks include creating, deleting, recreating, reshuffling and reorganizing the users' accounts when there are changes in their positions and authorities [22, 24]. The changes should come together with the permission and command from top management.

Setting and maintaining users' right to system's functionality and content are parts of the *Administrator's* vital task. They set users' right to the location of the available files and configure users' access to the file content. For instance, only certain users are given the right to access other users' artifacts while the rest of the users can only toil on their own artifacts.

Another *Administrator's* responsibility is adding, removing and modifying the system functionality [22] such as forum, chat, calendar, whiteboard, scheduling system, and activity tracker that are related to the changes in business policy and direction. For instance, *Administrator* can create a virtual room upon requested by a small group of users. They can communicate privately among themselves and require an extra virtual room [22]. Therefore, *Administrator* can perform sensitive tasks and access to sensitive resources as directed by the higher authority.

4) Role Class 4: Active Member

Active Members are people who mainly concern with the content. Thus, most of them are content experts. Unlike *Managers* and *Team Leaders*, they do not involve in management. However, they can influent the *Managers* and *Team Leaders* in decision making through advice and expertise. Examples of *Active Member* are project member, author, editor, freelancer, domain expert, decision-initiator, conclusion maker and student [20, 21].

Similar to *Managers* and *Team Leaders.2*, *Active Members* can access most of the system functionalities especially those which are significant to their tasks. Some of the functionalities include forum, activity calendar, file sharing (upload and download), e-mail, chat, activity tracker and bulletin board. They can also log into virtual room to participate in virtual discussion [22].

In CSCL environment, the *Active Members* are students. All of them are assigned the same role without detail classification, even though, some of them are class representatives or monitors. Given the same role, some of them are charismatic enough to emerge as a leader. They initiate voting, add comments in the communication process and suggest the final conclusion [21].

5) Role Class 5: Inactive Member

Inactive Member is a person who is not involve in a task. In some applications, they are called *member* or *registered applicant* [22-25]. They have identification number (ID) and password to enter the collaborative system. Thus, they are allowed to navigate the system. *Inactive Members* are permitted to use most of the system facilities like forum, activity calendar, messaging system and bulletin board. In CSCL environment, they can survey the courses offered as well as register for courses [22].

Similar to *Administrators*, they are not authorized to participate in the virtual room. For example, a student who has registered to a system but has not registered for a course is blocked from participating in the course discussion. However, they are still eligible to participate in general forum [20]. Unlike *Active Member* who is assigned reading and writing mode to content, *Inactive Member* can only read limited content.

6) Role Class 6: Visitor

Visitors are users who enter the system without registering, sometimes known as *enquirer* and *guest*. They have a very limited access to the system as compared to previously mentioned roles. They are merely allowed to view static information such as company background, objective, mission, contact information, achievement, and other information related to the company or organization. They are not granted any right to access and test the system functionalities. However, they are allowed to register to be members. In other words, they are only the receivers with no contribution in return [21, 22, 25].

7) Role Class 7: Hidden User

Lastly, *Hidden Users* are legal users who enter the system without being noticed. Similar to *Visitor*, they do not participate and make any contribution during collaboration but they are allowed to enter and use system facilities. For example, they enter a virtual room to do observation and survey without being noticed by others.

In conclusion, like any other organization, virtual organization stands and operates on a well defined organization structures. The structures make up of roles which determine responsibilities and access controls of its members. *Manager*, *Team Leader* and *Administrator* are ranked into a top-down structure where the *Manager* is the highest level. Therefore, this structure is defined as *hierarchical-based*. In the hierarchical-based structure, a role that appears at the higher level has more responsibility and superior access control. On the other hand, *Active Member*, *Inactive Member*, *Visitor* and *Hidden User* are not in top-down hierarchical-based structure, and they are of the same level and having the same responsibility and access control. This structure is defined as *peer-based*.

C. Peer-based Collaboration

Peer-based structure is commonly found in collaborative games. This study focuses on the initial stage as well as the processing stage of the games. Furthermore, users' roles and responsibilities are investigated. The results are depicted in Table 3.

Table 3: Roles in games and their responsibilities.

Roles (Initial stage)	**Role (Processing Stage)**	Playing	Planning	Influence	Provide Help
Player	**Leader**	✓	✓	✓	✓
	Team member	✓	×	✓	✓
	Helper	✓	×	✓	✓
Trial User	**Trial User**	✓	✓	✓	×
Viewer	**Viewer**	×	×	×	×
Supporter	**Supporter**	×	×	✓	×

Based on Table 3, users are classified into four roles as stated as follows;

- *Player* - *Players* are the users who have logged into and participate in the virtual game. They are assigned equal access right with three possible roles; *Leader*, *Team member*, and *Helper*. The *Leader* is a person who manages a group of players (*Team members*). The *Team member* always follows and receives direction from the *Leader*, while the *Helper* spends most of the time assist others in the game.
- *Trial User* - *Trial User* is a player who experiences the game for the purpose of making strategic planning to achieve the goals of the game.
- *Viewer* - *Viewers* are the observers that cannot participate in the game, but they influence the decision making.
- *Supporter* - *Supporters* back their team by giving advice without playing. They have no embodiment representing themselves in the game. Furthermore, they can help other team member who is left behind or lost.

In most collaborative games, users log in as players with equal access control. They communicate and collaborate to achieve the goal. However, most of them prefer to play alone. They will communicate and collaborate with other members whenever they find any difficulties in achieving the goal [9, 26]. During the game, a few new roles will emerge. Normally, one person will emerge as a *Leader* [9, 26] who will formulate strategic planning and influent others to follow the plan. The role is dynamically changed among users as different kind of expertise is required in different part of the game [27]. A *Leader* can naturally emerge in a team when most of the *Team members* are new players and less expert in playing the game [28]. At the same time, other users take role as *Team members* who receive directions from *Leader* [9, 26, 28]. *Team members* strive to win the game by contributing ideas and helping each other. By doing so, they increase their own self-esteem, social status and gain respect from the *Team members* [26].

Similarly, *Helpers* are those who help *Team members* whenever the *Team members* fall behind or lost in the game. For example, *Helpers* help the *Team members* to complete their task by adjusting the position of an object [9]. Another example of *Helper* is acting as a facilitator who plays along with a group of small kids and helps them whenever required [28].

Unlike *Players*, the *Trial Users* join a game for the purpose of testing and analyzing before making decision whether to be *Players* or not. In certain cases, old members accept new *Players* as *Trial Users* for a certain period of time to test the performance of the new users before accepting them as *Team members* [26]. After the *Trial Users* become the *Team members*, they have a chance to switch to *Leader*, *Team member* or *Helper*.

The role *Viewer* and *Supporter* are static throughout the games. Due to inactive involvement in the game, no transferring of role is taking place and their communication with *Team members* is limited. The dynamic change of roles fails to happen [9].

In summary, there are four types of roles in a game that started with *Player*, *Trial User*, *Viewer* and *Supporter*. Nevertheless, the role of *Player* and *Trial User* is gradually changed depending on their personal skills and characteristics. Roles like *Leader*, *Team members* and *Helpers* emerge during the processing stage of the game. The role evolution is influenced by communication and coordination among *Players* in the collaborative game.

D. Access Control Model

Roles in virtual space are consistently associated with access control. Access control system is used to protect organization's information resources against unauthorized access or modification [29-31]. Beside protection, access control system ensures that authorized users get the privilege to access the resources as needed.

Access right can be assigned to task, role and users [32]. When it is assigned to a task or role, whoever holds the position is granted the permission. In contrast, if the access right is granted to a user, only that particular user can access the resources.

This section reviews several access control models. They can be categorized as static or dynamic model. Static model means that users have to hold to the permission for a specific duration of time (e.g., for the entire project or throughout the game). On the other hand, dynamic access right permits user to change their access right when needed. Table 4 summarizes the model of access control rights and their role model types. Each model supports either static or dynamic role.

Table 4: Access Right Model and their role modeling.

Access Right Model	Dynamic	Role-based
Access Matrix Model	×	×
Context-Awareness Access Control (CAAC)	✓	✓
Context-based Team Access Control (C-TMAC)	✓	✓
Discretionary Access Control(DAC)	✓	×
Dynamic Coalition-based Access Control(DCBAC)	✓	✓
Mandatory Access Control (MAC)	✓	×
Role-based Access Control (RBAC)	×	✓
Team-based Access Conrol (T-BAC)	✓	✓
Task Base Access control (TBAC)	✓	×
Task-Role-Based Access Control (T-RBAC)	✓	✓
Threshold-based Collaborative Access Control (T-CAC)	✓	×
TeaM-based Access Control (TMAC)	✓	✓
Team and Task based RBAC (TT-RBAC)	✓	✓
Trust-base Access Control (TrustBAC)	✓	✓

The access right models are listed as follows:

- *Context-Awareness Access Control (CAAC)* - It is based on Role Based Access Control (RBAC) model. Permission is assigned to role and not users, thus, it is dynamic [32].
- *Context-based Team Access Control (C-TMAC)* - Permission is granted based on the time of access and location of the resources when access is requested [2, 33].
- *Discretionary Access Control (DAC)* - Restricted access right to resources is based on user's identity. Thus, it is not a role-base model. Furthermore, resource's owner has the rights to grant access right to other users [34, 35].
- *Dynamic Coalition-based Access Control (DCBAC)* - It allows a user to request an access right to resources which belongs to another coalition entity. The decision is made based on users and resources' credentials [35]
- *Mandatory Access Control (MAC)* - The model uses labels that are attached to users and resources. The labels can be marked as unclassified, unmarked, restricted, confidential, secret, and top secret. Users are granted access right based on their labels and resources labels [33, 34]. It is dynamically assigned to users.
- *Role-based Access Control (RBAC)* - Access right is assigned to a role and not directly to user. Then, users are assigned to the roles and receive the permission. It is the basic of role-based model and it is dynamic [2, 35].
- *Team-based Access Control (T-BAC)* - Permission is based on users' role and current activity of the team [31]. Once the activity is completed and the team moves to other activity, a new permission is granted. Thus, it is dynamic.
- *Task Base Access control (TBAC)* - Permissions are assigned to tasks and users get the permission while the task is in execution [32].
- *Task-Role-Based Access Control (T-RBAC)* - Permissions are assigned to tasks and next, tasks are assigned to roles and lastly, users are assigned to roles [33].
- Threshold-*based Collaborative Access Control (T-CAC)* - Every permission is linked to threshold and users' contribution determines their permission to access organization's resources [32].
- *TeaM-based Access Control (TMAC)* - Roles are assigned to a group of users [33, 35].
- *Team and Task based RBAC (TT-RBAC)* - Initially, a team is formulated before roles and tasks are assigned to the teams. Next, users are assigned to the roles and teams [33].
- *Trust-base Access Control (TrustBAC)* - Users' past credential, interaction and characteristic determine their trust levels. Then, the trust level is assigned to role where role is assigned to access right [35].

RBAC is slowly becoming the standard of access control. This is due to easy maintenance and security [35, 36]. It is originally static-based model. However, through the hybridization, it becomes dynamic-base model. The hybrid models include TMAC [10, 33], C-TMAC [33]

DCBAC[35,10], TrustBAC[35], T-RBAC[31,33], TT-RBAC[33], AAC[33], C-TMAC[10,33] and (T-BAC).

In conclusion, static model is unfavorable as compared to dynamic model due to the dynamic feature of virtual world itself. Furthermore, users in virtual space keep on changing within seconds and at the same time, their identities are frequently changed.

IV. Conclusion

Interactive networked collaborative virtual environment (NCVE) provides a virtual meeting space for people from remote location as invisible users. Unlike face-to-face situation, communication in virtual space lacks of cues which is vital in any human interaction. Without the cues, exchanged messages can be easily misinterpreted. The communication cues are represented by digital elements such as text, 2-D graphics, 3-D avatar and audio-video. Text represents users, states and roles through words with variety of font colors and sizes. On the other hand, 2-D graphics can represent users in colorful image with animation. 3-D avatars embody human and perform most of human actions for non-verbal communication.

Similar to any organization, virtual organization can be structured into hierarchy and peer-to-peer. Users in the organization hold a redefined role which linked to sensitive information resources. Therefore, a role management should not be taken for granted. Role in virtual collaborative environment can be divided into seven classes which are *Manager*, *Team Leader*, *Administrator*, *Active member*, *Non-active member*, *Visitor* and *Hidden Users*. Each of the roles is granted with a specific predefined access right to the organization information resources.

In a collaborative game, *Players* usually start with peer-to-peer structure but gradually, as the game is in progress, the hierarchy structure has the tendency to emerge. It happens naturally as a charismatic *Player* surfaces as a *Leader* while others become a *Team members*, *Helper* or *Trial User*. On the other hand, *Viewer* and *Supporter* are static role that remains as it is throughout the game.

Lastly, for security purposes, the access rights play the prominent roles in such environment where information resources are shared. There are a lot of access right models that control and maintain the security and privacy of organization. Most of them are based on Role Base Access Control model (RBAC). Even though RBAC is static, most of its hybrids are dynamic.

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