# Using the Floor Control Mechanism in Distributed Multimedia Presentation System

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## Abstract

*Establishing a web-based distributed multimedia presentation system environment is a technical challenge .In this paper, we describe how to present different multimedia objects on a web presentation system with floor control mechanism as a result of the distance learning environment indispensably. The distributed approach is based on an extended timed Petri net model. Using characterization of extended time Petri net, we express the temporal behavior of multimedia objects; on the other hand, we introduce the concepts of user interaction. The main goal of our system is to provide a feasible method to represent a schedule and navigation of different multimedia objects with user interaction. In addition, users can dynamically modify and verify different kinds of conditions during the presentation. To verify the structural mechanism, we implement an algorithm using the Petri net diagram, analyzing the model by time schedule of multimedia objects, and produce a synchronous set of multimedia objects with respect to time duration. Specially, we consider the interactive facilities to support the distance-learning requirement. We propose a floor control mechanism, which provides four types of control (free access, equal control, group discussion, and direct contact). These control mechanisms are sufficient to the use of distance learning environment.*

**Keywords: Petri Net, Distributed Multimedia Presentation, Distance Learning, Floor Control**

## 1. Introduction

To control and demonstrate different types of multimedia objects is one of important functions in distributed multimedia presentation system. Unfortunately, we saw many "Black magic" compromised multimedia presentation systems; there is little theory to describe the methodologies of such compromised system. The concept of our model is based on the Petri net [1-3]. Petri net is a graphical and mathematical modeling tool applicable to many systems. Its features can be used with both practice and theory. Thus, it provides a powerful medium of communication between them. Additional extensions have been proposed, and this has led to the following types of Petri nets: the timed Petri net, the stochastic Petri net, colored Petri net, and object-related Petri net.[6-12] The "Object Composition Petri Net"(OCPN) and the "extended Object Composition Petri Net"(XOPCN) were two graphic-based models that proposed synchronous theoretical for multimedia. The OCPN is a comprehensive model for specifying timing relations among multimedia data. The XOPCN can specify temporal relationships for the presentation of pre-orchestrated multimedia data, and to set up channels according to the required Qos of the data [4, 5]. These two models lack methods to describe the details of synchronization across distributed platforms and do not deal with the schedule change caused by user interactions in interactive multimedia systems [13]. However, when considering the network transport issue of multimedia and the floor control with multiple users, OCPN/XOPCN model are not sufficient to deal with those problem. In this paper, we use the extended timed Petri net to construct the web operations on a distance learning system. When multimedia objects are represented on the



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system, we have to consider different situations of multimedia objects such as asynchronous operation, time scheduling, and flow control. In addition to system operations, dynamical operations of users are important issues. Thus, we can apply characteristic of Petri net to implement our mechanism and study the theory.

This paper is organized as follows. The Petri net and other extended models of Petri net are introduced in Section2. Section 3 defines multimedia objects based on DOCPN. Section 4 constructs an algorithm for our web system based on the Petri net and uses an example to verify the algorithm and the group communication mechanism with floor control mode. Section 5 gives the conclusions.

## 2. Related Petri Nets Models

Petri net were named after Carl A. Petri who created in 1962 a net-like mathematical tool for the study of communication with automata. Petri net can be used to model properties such as process synchronization, asynchronous events, concurrent operations, and conflicts or resources sharing. These properties characterize discrete-event systems, and computer-based systems. Petri net as graphical tools provide a communication medium between the user, typically requirements engineer and the customer. Complex requirements specifications, instead of using ambiguous textual descriptions or mathematical notations difficult to understand by the customer, can be represented graphically using Petri net. This combined with the existence of computer tools allowing for interactive graphical simulation of Petri net, puts in hands of the development engineers a powerful tool assisting in the development process of complex system [1, 2, 3].

This paper is focus on the multimedia presentation application. The related Petri net models will introduce in this section briefly.

### 2.1 Petri Net

Petri net is composed of four parts: a set of places $P$, a set of transitions $T$, an input function $I$, and an output function $O$. the input and output functions relate transition and places. The input function $I$ is a mapping from a transition $t_j$ to a collection of places $I(t_j)$, known as the input places of the transition. The output function $O$ maps a transition $t_j$ to a collection of place $O(t_j)$ known as the output places of the transition. The structure of a Petri net is defined by its places, transitions, input functions, and output functions [2].

Definition: A Petri Net structure, $C$, is a four tuple, $C = (P, T, I, O)$. $P$={ $p_1, p_{2......}, p_n$ }is a finite set of places, n≥0. $T$= { $t_1, t_{2......}, t_m$ }is a finite set of transactions, m≥0. The set of places and the set of transaction are disjoint, $P \cap T = \varnothing$. $I$: $T \rightarrow P^{\infty}$ is the input function, a mapping from transitions to bags of places. $O$: $T \rightarrow P^{\infty}$ is the output function, a mapping from transaction to bags of places.

### 2.2 DOCPN Model

J. S. Yang et al. proposed a prioritized Petri nets model [13]. It extends traditional Petri nets with priority. The different of priority Petri nets from traditional Petri nets lies in the introduction of priority into functions. Input functions are treaded unequally at some transitions. A priority input event arrival at a transition may force firing without waiting for the other arrival of non-priority events. By using these features, we can deal with the time schedule dominates an event transition in the real communication world. Even though some conditions are not yet, an event will occur when its time schedule is due. This will happen when real time constraint is concerned and when a downgraded service can be achieved with out some pre-specified resources. The priority Petri model can be applied to these cases by using a clock or time schedule and priority arc driving those time-sensitive transitions.

Definition: A priority Petri Net structure, C, is a five-tuple, $C = (P, T, I, I_p, O)$. $P$ = { $p_1, p_{2......}, p_n$ }is a fine set of places, n³0. $T$= { $t_1, t_{2......}, t_m$ }is a finte set of transactions, m³0. The set of places and the set of transaction are disjoint, $P \cap T = \varnothing$. $I$: $T \rightarrow P^{\infty}$ is the input function, a mapping from transitions to bags of places. $I_p$: $T \rightarrow P^{\infty}$ is the priority input function, a mapping from transitions to bags of places. $O$: $T \rightarrow P^{\infty}$is the output function, a mapping from transaction to bags of places.

Fire rules: A transaction with non-priority input events would fire when all events are complete and ready. A transaction with a priority input event, without waiting for other non-priority events. For the same priority events concurring at a transaction, we apply the "AND" rule. A place with a token and several transaction enabled from this place will fire the transaction with a priority arc from this place.

The Distributed Object Composition Petri Net (DOPCN) model includes the following properties:

1. Inheriting the characteristics of Petri Net, that is, waiting at a transition until all input signals arrived, and then firing concurrently.

2. The arrival of priority input at a transition may cause firing of a transition without waiting for other non-priority input concurring at the same transition.
3. Using the synchronous methods inherited from OCPN and XOPCN to achieve synchronization among inter-media objects.
4. Extended OCPN to a distributed environment that handles asynchrony across platforms using a global clock.
5. Adding user interaction control into OCPN, thus user interaction can be a new important factor in synchronization.

## 3. DMPS

The multimedia presentation system in distributed environment can be taken it into a communication tool for virtual conferencing or distance learning. The communication tools need to considerate the group communication and floor control mechanism. In order to achieve these objectives, the distributed multimedia presentation system (DMPS) needed to build a global clock first (as shown in figure 1). The global clock is a standard time in the present period of the client sides. A communication tool which be held "Synchronous" one is because of the bonded delay time. The global clock not only provides the global time frame facility but also control the higher priority of user interaction floor control. For instance, in a group communication case, user need to initial the group first, then every user can set their communication medias of what they needed via our DMPS tools (as shown in figure 2 DMPS communication window).

The DMPS server build a communication group and initial a global clock when the client side had initialed the communication configuration. The global clock admission control is centralized mode. It has the highest priority to handle the transition enforced to fire immediately or not. If the clock in client side is faster than global clock, the current transition will not fire until global clock arrives. On the other hand, if the local clock in client side is slower than global clock, the transition will be fire without delay. In the presenting period, user can request the floor control and change the presenting media. The floor control include four modes:

1. Free Access
2. Equal Control
3. Group Discussion
4. Direct Contact

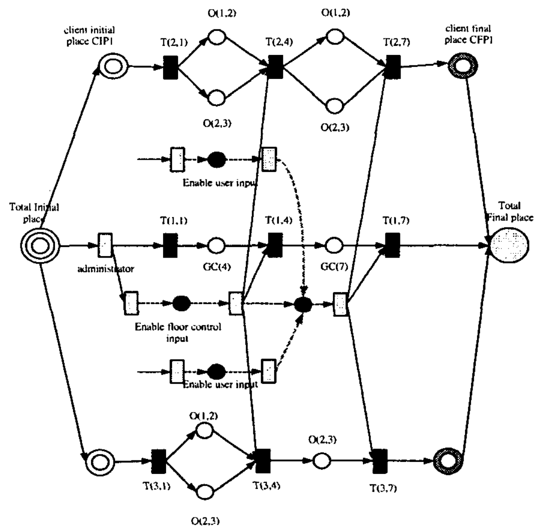



Figure 1: An overview of distributed multimedia presentation Petri net

We used the Z notation to represent our floor control mechanism. The detail about our algorithms will be discussed as below:

**The Z notation :**

| | |
|---|---|
| "= =" | "is define by" |
| "**P** X" | "a set of object X" |
| " : =" | "a data type", the type name is given on the left of " : =" and constants on the right are separated by optional "I " |
| "..." | "Omitted item" |

**Terminology Definition:**

Policy_Factors : = NETWORK_BOUND I CPU_BOUND I MEMORY_BOUND

Resource = = Network $\times$CPU$\times$Memory ...

FCM_Mode : = Free_Access IEqual_Control I Group_Discussion I Direct_Contact

Member_Set = = **P** Member

Group_set = = **P** Group

Group$\subset$ Member_Set

Network = = REAL

CPU = = REAL

Memory = = REAL

Priority = = INTEGER

Free_Access = = STRING

Equal_Control = = STRING

Group_Discussion = = STRING

Direct_Contact = = STRING

**Global Variables and Constants**resource_available : Resource_Available

a : REAL

b : REAL

a > ba is the basic system resource available; b is the minimal system resource available; a must be greater than b so that different levels of treatment are used when the source is not sufficient. )

**Floor Control Mode Arbitrating Algorithm**FCM_Arbitrate : Group $\times$Member $\times$FCM_Mode $\times$Host_Station

$\forall$G: Group, M : Member,

F : FCM_Mode,

X : Host_Station, DG: Group, DM :Member$\bullet$ FCM_Arbitrate(G, F, X, DG, DM)$\Leftrightarrow$ Resource_Available(G, F, X, DG, DM) $\geq\alpha\Rightarrow$ G$\notin$Joined_Groups (G, X)$\Rightarrow$

Abort_Arbitrate (G, X)

$\vee$ G$\in$Joined_Groups (G, X)$\Rightarrow$ FCM_Mode$\in$Free_Access$\Leftrightarrow$

$\forall$M$\in$G$\Rightarrow$Media_Available(G, M, X)

$\vee$FCM_Mode$\in$Equal_Control$\Leftrightarrow$

$\exists$M$\in$G$\wedge$Priority$\geq$2$\Rightarrow$?

Media_Available(G, M, X)

$\vee$FCM_Mode$\in$Group_Discussion$\Leftrightarrow$

$\exists$M$\in$G$\wedge$Priority$\geq$2$\Rightarrow$?

Media_Available(G, M, X)

$\vee$FCM_Mode$\in$Equal_Control$\Leftrightarrow$

$\exists$M$\in$G$\wedge$DM$\in$G$\wedge$Priority$\geq$2 $\Rightarrow$?
Media_Available(G, M, X)
$\wedge$Media_Available(G, DM, X)

Resource_Available(G, F, X, DG, DM)$\geq\beta\Rightarrow$ G$\notin$Joined_Groups (G, X) $\Rightarrow$

Abort_Arbitrate (G, X)

$\vee$G$\in$Joined_Groups (G, X)$\Rightarrow$

Media_suspend(G, M, X, DG, DM)

Resource_Available(G, F, X) < $\beta\Rightarrow$ Abort_Arbitrate (G, X)

**Media_Suspend (G, M, X, DG, DM)**Media_Suspend : Group $\times$ Member $\times$ FCM_Mode $\times$ Host_Station

$\forall$ G: Group, M : Member, X : Host_Station,

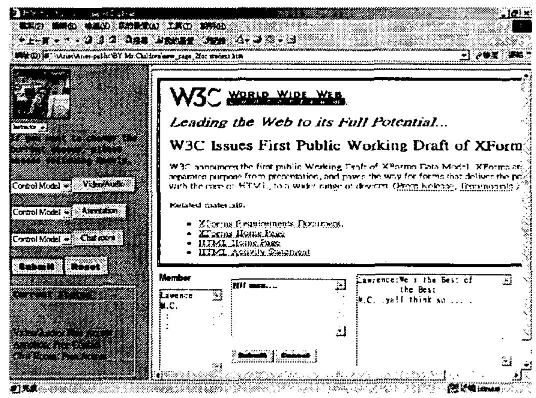
DG: Group, DM : Member $\bullet$ Media_Suspend (G, M, X, DG, DM) $\Leftrightarrow$ $\exists$ MS : Member_Set$\cdot\bullet$ ($\forall$M':Member$\bullet$M'$\in$ MS$\wedge$M'.Priority <M.Priority)

$\Rightarrow$Media_Suspend(G, M, X)

$\wedge$(Resource_Available(G, F, X)$\geq\beta$

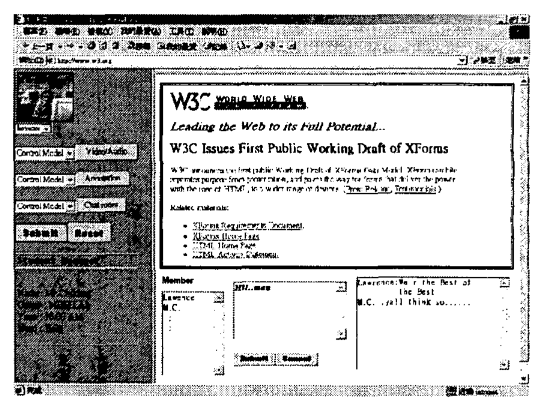
$\Rightarrow$Media_Available(G, M, X) $\vee$Resource_Available(G, F, X) <$\beta\Rightarrow$

Media_Suspend(G, M, X))



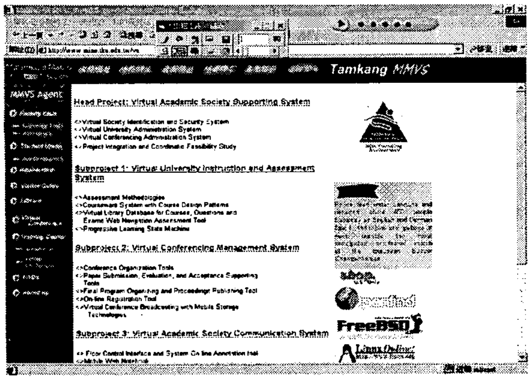

2(a) DMPS communication window for student

Free access means everyone (ex: including session chair and participant) can send the message to the message-window or whiteboard. This mode is like general discussion with no privacy and priority. We have a limitation of speak in equal control mode. In this mode, there is only one (session chair or participant) can deliver at the same time until the floor control token passed by the holder.



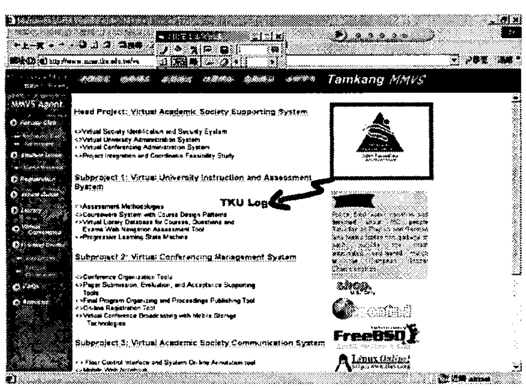
2(b) DMPS communication window for teacher

Figure 2: An example of the DMPS communication windows

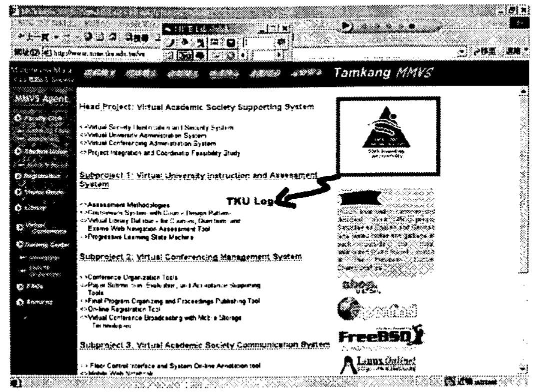



3(a) Start to send the teacher's annotation message initialization; the connected light will be turn to red.

Participants are encouraged to propose their ideas in some time. So, another small group discussion mode is provided. The manner is that a user can create a new group to invite others. For example, user A wants user B receiving his invitation, he can send an inviting message. User B can makes a decision to accept or not. If yes, user B will be chosen as listen group of user A, and the user A will be the session chair in his small group. Everyone can choose whom to receive the message actively. Therefore, all participants in the same group can send message together, we regard it as private communication group. The fourth floor control mode is direct contact. Actually, it is similar to the third mode. It means two people can communicate directly in a private window and communicate with others via free access, equal control, and direct contact at the same time.




3(b) If all the connected light turn to green, which mean all the connection with no problem and client side had accepted the messages form server already.




3(c) If some of the client side disconnected, the light will be red; teacher can move the mouse to this red light to check the problem.

Figure 3 : Some examples at communication statge.

The floor control model is managed by group administration of the DMPS server. All the users floor control request inputs are sent to the server, the server will take the messages with their rationality to handle the floor control in group communicating period. If the users floor control requests are permitted, the request will combine with the global clock control and with the same highest priority.

## 5. Conclusions

The main goal of our multimedia presentation system provides an interactive Petri net model. We suggest a method constructing a web structure on a distance learning system. We hope that the algorithm is independent to any operating system applied different platforms. In addition, we provide a friendly user interface to transmit multimedia resources on the system. The prototype system was developed on MS Windows 98 or MS Windows NT to justify our approach. We will focus the performance of the system and improve the web multimedia presentation in the future research. We have some contributions in the paper. We provide a model for web multimedia presentation on distance learning by the extension of timed Petri net. With the system, we hope to bring a feasible method including structural design and analysis for the design of the distributed multimedia presentation. Collocating with floor control mechanism, the distributed multimedia presentation system is very suit for tele-teaching. The model can be used for computer-supporting cooperating work (CSCW), in education, business, and others.

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