RESEARCH ON GRID-BASED MOBILE BUSINESS PROCESS AND SIMULATION

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Keywords: Grid management, Mobile grid, Mobile business process.

Abstract: Since the emergence of mobile commerce, there have been much research and practice on how to improve wireless communication technology and safety technology and so on (Hull, 1997), however, the research which integrated wireless technology and business processes of the original e-commerce is still in its early stage, lacking of systematic analysis and theoretical support regarding the information sharing, business collaboration, and effectively access of mobile devices in practice. In this paper, mobile business processes is the research object. On the basis of combing and analyzing the current mobile business process, utilizing the grid management theory construct mobile business process based on grid. Furthermore, a quantitative simulation will be made on non-grid and grid-based mobile business processes in order to prove the superiority of mobile business processes based on grid.

1 INTRODUCTION

Currently, mobile business is receiving more and more attention with the features of flexibility, convenience and people are eager to enjoy the convenience of mobile commerce. With further research, it was discovered that the business process can reflect the integrated features of wireless information technology and traditional business. In the research of mobile business theory and method, mobile business process is the backbone throughout. Utilizing the modern theory of process reengineering and internal logic of mobile business to optimize mobile business process, in order to enhance the capacity of mobile commerce services, and resource utilization levels has become the focal point of current mobile business research.

The research of mobile business research is still scattered on this stage, lacking an overall research and modeling approach. The lack of theory will delay the development process of mobile business processes and increase the cost of development (Taudes et al., 2000). Based on recent research, grid-based management is an effective method to solve the problems of resource sharing, collaborative work in the whole system, meanwhile, the latest finding-mobile grid is the expansion of traditional grid in the wireless computing environment, it can also effectively solve problems of mobile devices access, offering a solution for overall optimization, resource sharing, efficient management, wireless access and other issues in the mobile business process (Varshney et al., 2000) .As it has a quantitative mathematical description, so the logistics flow, information flow and operation flow in the grid management system can be quantitatively calculated, achieving a transmission of qualitative analysis to quantitative analysis. Besides, this mode can also use simulation for quantitative analysis, which reflects the superiority of grid management methods.

In this paper, with mobile business process as the research object and grid management as the research theory, combing the computer simulation, conduct a research of mobile business process based on grid management. Following is the research ideas. Firstly, analyze the existing mobile business process, finding the problems. Then construct a grid-based mobile business process in the support of grid management theory. Finally, conduct a simulation comparison between grid-based and non-grid based mobile business process.

Chang D. and Si L..
RESEARCH ON GRID-BASED MOBILE BUSINESS PROCESS AND SIMULATION.
DOI: 10.5220/0003550200860093
In *Proceedings of the 13th International Conference on Enterprise Information Systems* (ICEIS-2011), pages 86-93
ISBN: 978-989-8425-56-0

2 THEORY

2.1 Grid Management

1. Content of Grid Management

Grid management is the integration of a variety of distributed resources of the community to achieve the goal of efficient, economical, fast and convenient management for the purpose of efficient transmission of information to save materials and energy and enhance the efficiency of resources.

Huanchen Wang proposed grid management as an emerging management mode to deal with the current complex management issues; this idea is based on the grid boundaries in the chosen system to achieve information integration, operational synergies, and combined slice of modern style of a management network system. In the view of system structure, grid management should have the features of grid layout. In the view of resource association, it should have the feature of resource sharing. In the view of the operation of the system, it should have the feature of operate cooperatively and presses orderly (Wan et al., 2007). In the structure and operation grid management, it involves at least five essential factors, namely material, energy, information, space and time, referred to as MEIST.

2. Basic Process of Grid Management

Fig. 1 illustrates the basic process of grid management that can be abstracted into the following aspects.

(1) Business acceptance: Accept all classified business within the network.

(2).Business dispatch: Standardized assessment and operational coordination, after the approval of the command center, the segmentation of tasks will go to the corresponding functional department.

(3) Business process: Functional department accept business task, organizing work tasks to meet demand.

(4). Service delivery: The completed task will turned back to the reception center, by passing to the users.

(5).supervision and inspection: Monitoring center compared the completion of verification of service and user demand.

(6) Disclosure of Information: During the entire business process, users can query the real-time business process (Zhen et al., 2005).

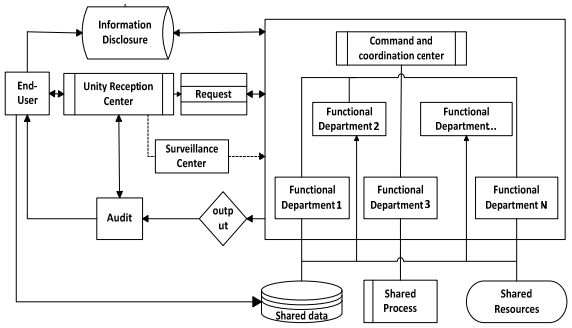


Figure 1: Basic process of grid management.

2.2 Mobile Grid

With the rapid development of mobile wireless network system, the user can access to global network resources at any place and any time, which means grid system should also take mobile nodes into consideration, and this combination leads to mobile grid computing. It supports mobile users and resources in a seamless, transparent, safe and effective way; it is an integration of wireless technology and girds computing. Mobile grid integrates mobile devices into grid, becoming a new type of resource sharing network.

Currently, most grid structures and algorithms do not take mobile devices into account as mobile devices have not been considered as a legitimate grid computing resources or interfaces. There two methods to locate mobile devices in the grid computing environment. The first one: as the as the interface to interact with the grid system, the user can require service via mobile devices from grid system to complete tasks, you can perform remote monitoring and obtain required results from the grid system. The other one: as the computing resources of grid system, mobile devices involves in grid computing task, not just the recipient of grid service. Therefore, effectively embedded into the grid, the mobile device can not only work as a recipient of the grid service but also can be used as grid service providers. Fig. 2 is the designed mobile grid computing system structure.

The grid system is divided into three parts: static grid sites, mobile devices group and the gateway which connects static and mobile resources. Mobile devices can be connected to Internet via WLAN or remote cellular network. On the side of mobile devices and gateways, mobile agents and service agents are required. When a mobile user submits a task to obtain the service of grid computing service,

it interacted by the mobile agents in the mobile device and gateway first and then submitted to grid system by mobile agent in the gateway (Wang and Wang, 2003).

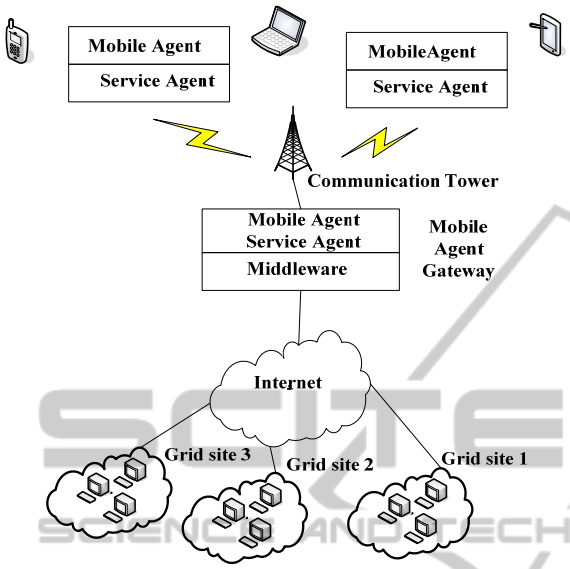


Figure 2: Mobile grid system structure.

2.3 Arena Simulation Software

Arena was visualized interactive integration simulation software developed by System Modeling Company; it provides a good organic integration of computer simulation and visualization. The theoretical basis of Arena is discrete event simulation theory, using the event scheduling method. The basic idea is to use the view of events to analyze the real system, by defining the events and the change to the system when events occur. The mobile business process is a need arrived, processed and finished process, in line with the principle f discrete event simulation; accordingly, Arena can be used for quantitative simulation research.

3 EXISTING MOBILE BUSINESS PROCESS ANALYSIS

3.1 The Main Process of Existing Mobile Business

Mobile business works in the Internet open network environment, based on the application of mobile communication devices, realizing the B2B and B2C transactions, a new business operation mode of mobile payment. As a new economic form, mobile business is co-created by network economy and modern logistics. Fig. 3 illustrates the main dynamic transaction flow.

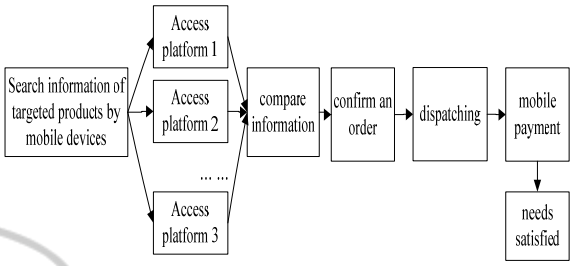


Figure 3: The main process of mobile business.

1. Once the user has need, he can use mobile devices to login on mobile business information platform to search for information of targeted products. However, as each platform assigns different access rights to different users, so resource and information cannot be shared in a certain format.
2. After obtaining the required information of targeted products, users still need to login on different platforms to compare the product information, in order to find the satisfied product and fill orders.
3. Business confirms the order with customer, informing the payment, preparing the product and organizing the logistic delivery.
4. Customer receives the product, after acceptance, paying the payment via mobile devices, transaction finished.

3.2 The Shortcomings of Existing Mobile Business Process

The application of information technology greatly contributed to the development of mobile business; however, information technology alone cannot achieve a holistic approach to mobile business reorganization of the participants. The shortcomings of existing mobile business process are as follows:

1. Mobile operators do not fully play his role as a bond. Compared with other market participants, the mobile operator takes a control role and dominant position by holding the network resource and customer base; it can affect the development trend in depth. However, its advantages do not play an effective role in a series of cooperation (Ma, 2008).
2. Inadequate cooperation among mobile business participants. As a new business operating model, the greatest strength of mobile business lies in its

integration of a range of social resources using latest mobile communication technology and tools, serving for end users and realizing the maximization of social benefits. However, the lack of cooperation within mobile business participants inevitably leads to information asymmetry and low efficiency in transaction.

3. Within the mobile business domain resources distributed unevenly. In some small enterprises, the lack of resources hindered the development of mobile business, whereas, some large enterprises have vacancy resources which results in a great waste.

4. Internal and external information Island phenomenon exists. Due to the unsuccessful integration of enterprise e-commerce systems, a great sum of resources on the network cannot be fully shared.

5. The whole mobile business field is not well integrated, so that members cannot update information dynamically and efficiently.

3.3 Feasibility Analysis

Grid management provides effective solutions for the problems in mobile business. Grid broke the previous technical limitations, so that people can use a new, freer and more convenient way to utilize resources, which brings following benefits:

1. The emergence of mobile grid technology makes the application of grid management into the research of mobile business process possible. It supports mobile users and resources in a seamless, transparent, safe and effective way, an integration of wireless technology and grid computing.

2. Grid management integrates varied application systems together into a unified platform, enables enterprises to fully share resources and business process, breaking the bottleneck of information exchange between enterprises.

3. Grid management breaks the restriction that sharing and collaboration is only limited to data transmission, it enables resources sharing can reach a remote operate and control level.

4. Grid messaging service mechanism can facilitate information exchange between mobile business systems in a timely manner, making the communication between businesses and customers more flexible.

4 CONSTRUCTION OF GRID-BASED MOBILE BUSINESS PROCESS MODEL

4.1 Basic Ideas of Construction of Grid-based Mobile Business Process Model

The general concept based on the problem analysis of mobile business process, fully using the existing grid management and mobile grid research results to construct a grid-based mobile business process, achieving the goals of good service, efficient management and effective regulatory of mobile business process.

This paper will utilize the research result of grid management, redefining the job roles of participants, responsibility and right norms, and business process within the current mobile business system, in order to build a basic mobile business process based on grid management, to form a unified operation of business process, and to provide grid end-user an integrated service platform.

4.2 Basic Model of Grid-based Mobile Business Process

Grid-based mobile business process is based on the principles of "unified service, resources sharing, and business collaboration" of grid management to determine process links, basic data and service port sharing mode. Accepting the demand in a unified way for task decomposition, and then distribute it into various department foe processing. The grid-based mobile business process can be abstracted into a unified mode: demand starts→ order accepted→ goods delivery→ mobile payment→ evaluation and feedback see as the Fig. 4 demonstrate.

Further refinement of the steps:

1. Login on the unified platform. End-users login on the unified platform, sending requirements through the business platform, the requirements will be sent to the grid computing service end through the mobile agents in the mobile device and gateway. After the unified processing in the grid computing site, end-users can get useful information through the interaction between mobile agents in the mobile device and gateway.

2. Analyze product information. By comparing the goods information offered and communicating with

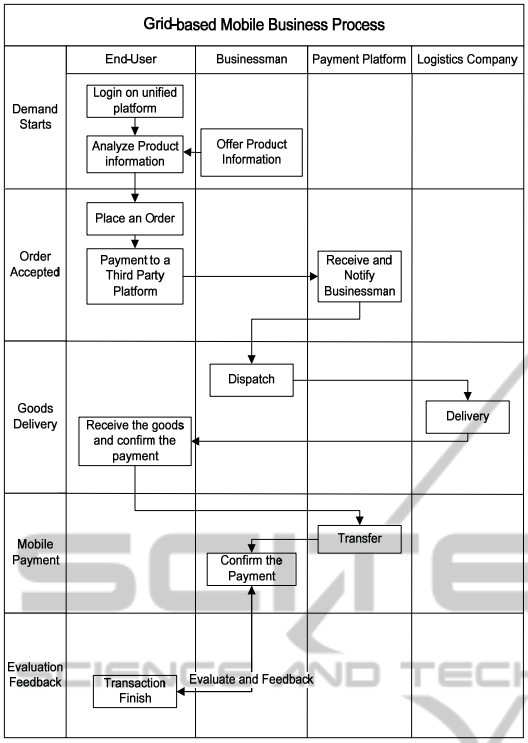


Figure 4: Grid-Based Mobile Business Process.

with businessman online, customer gets a good understanding of goods.

3. Place an order. End-user fills the order bill, including price, quantity, delivery address and contact information.

4. End-user pays for the goods to a third party payment platform. End-user should pay for the goods within a certain period of time, or the order will be cancelled. The third party payment system ensures the security of transaction by transferring the payment to businessman only after the customer has received the goods.

5. Receive payment and notify businessman. The third party payment system will automatically send a notification to businessman after receiving the payment from customer.

6. Dispatch. Businessman prepares the goods and chooses a logistics company for delivery.

7. Delivery. The third party logistics company delivers the goods to customer.

8. Receive the goods and confirm the payment. Customer checks and receives the goods, confirming to transfer the payment to businessman.

9. Transfer. The third party payment system transfers the payment to businessman after receiving the confirmation from customer.

10. Businessman receives the payment.

11. Evaluation and feedback. Customer evaluates the goods, service quality and logistics quality or gives suggestion for improvement.

5 COMPARISON OF GRID-BASED AND NON-GRID MOBILE BUSINESS PROCESS SIMULATION

5.1 Non-grid Process Simulation Model I

1. Simulation Model Description of Model I

Fig. 3 illustrates the existing mobile business process, namely the non-grid mobile business process. The specific description of the process: Suppose a mobile business platform provides X (x =1,…, X) categories of service for the public, each kind of resource is available 8 hours a day, 5 days a week and users can access and submit requirement to the 24-hour system. When the mobile user needs to get the No. x business service, it is required to login on n (i =1, …, n) business websites to search for useful information. As to users, it means they have to login on many distinct platforms until they get the wanted information. For simplicity, in this paper, we assume that users give up searching for information if they cannot find the required information after three times of attempt.

2. Build the Logical Simulation Model

For the convenience of description, in this paper non-grid mobile business process will be abbreviated as MBP (Mobile Business Process). In process model I, users need to search for distinct mobile business platforms, login on and submit requirement for several time to get the required information. Fig. 5 demonstrates the model.

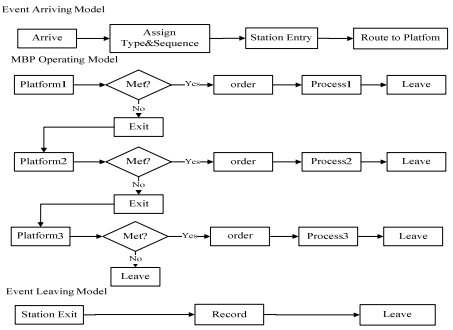


Figure 5: Model I Simulation Logic Model.

Table 1 (Zhao, 2007) illustrates the model unit, function and distillation function of Model I.

Table 1: Model unit of Simulation Logic Model.

Model unit	Function of model unit	Distillation function
Arrive	User arrives or service needs occur	Generation time is subject to a random distribution
Route	Transfer path between sites	Transfer time is subject to a random distribution
Process	Specific service provided by institutions.	Service time is subject to a random distribution
Decide	Service judgment	/
Record	Record related events and indicators	/
Leave	Service finished; leave	/
Dispose	Leave system	/

5.2 Grid-based Process Simulation Model Ⅱ

1. Simulation Model Description of Model

Fig. 4 illustrates the grid-based mobile business process model. Each time user login on the platform, the requirement submitted and the service department will transact the service by rules and regulations. Users can access and submit requirement to the 24-hour system. For simplicity, in this paper, one resource servers one requirement, not considering a need having two or more resources.

2. Build the Simulation Logic Model

Grid-based mobile business process focuses on requirement service. Users can submit their requirement through unified processing window directly and the order will be sent to various providers for implement. The response cycle of grid-based process includes landing process, unified information service and service waiting time. For simplicity, the mobile business center will be abbreviated as MBC (Mobile Business Center), as Fig. 6 illustrated.

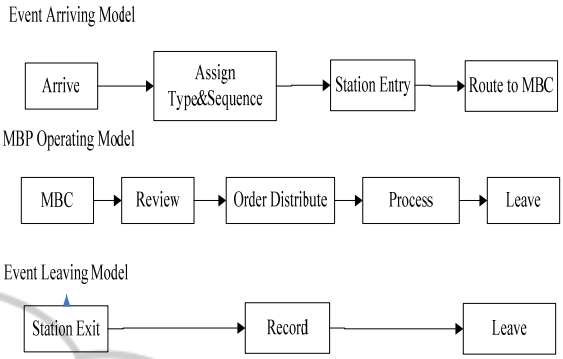


Figure 6: Model Ⅱ Simulation Logic Model.

5.3 Simulation Results Analysis of Grid-based Process and Non-grid Process

1. Simulation Evaluation Index

According to the grid-based mobile business process's goal of serving for the public, in this paper, some common service quality evaluation indicators(Chi, 2008) are selected to evaluate the service of grid-based mobile business process.

(1). Average queue length L_q

L_q ——Average waiting queue length, expectation value of the number of customers waiting for service in a steady-state system.

$$L_q = \lim_{T\to\infty} \int_0^T \frac{Lq(t)dt}{T} \tag{1}$$

$Lq(t)$ is the waiting queue length at the time of t, T is the operation time. Average waiting queue length means the number of customers waiting for service in the mobile business process.

(2). Average queue length

L ——Average queue length, expectation value of the number of all customers.

$$L = \lim_{T\to\infty} \int_0^T \frac{(Lq(t) + S(t))dt}{T} \tag{2}$$

$S(t)$ means the customers receiving the service, queue length at t means $Lq(t)$ plus $S(t)$. The sum of average customer number marked as WIP. Average queue length in a real mobile business processes means the total number of

customers in the system (the number of customers waiting in line plus the number of customers who are receiving service and).

(3). Average waiting time

W_q ——Average waiting time, the expectation value of waiting time

$$Wq = \lim_{K\to\infty} \sum_{i=1}^{K} \frac{Zi}{K} \quad (3)$$

Z_i indicates the time customer i spends waiting for, K indicates the total customer service number .Waiting time in the real business processes indicates the period of time from the requirement is submitted to the time the requirement is processed.

(4). Resource utilization

In terms of each resource, Arena will report two kinds of utilization statistics, namely Instantaneous Utilization and Scheduled Utilization.

①Instantaneous Utilization is the resource utilization at a certain point of time. If $B(t)$ is the number of resource at a t in a busy state, $M(t)$ is the number of available resource at t. Suppose $U(t) = B(t)/M(t)$, $M(t) > 0$. If $M(t) = 0$, and define $U(t) = 0$. If the simulation starts from 0 to T, then the Instantaneous Utilization is:

$$\int_0^T U(t)dt / T \quad (4)$$

That is the average time of function $U(t)$.

②Scheduled Utilization is the ratio of the average number of resources in the busy state with the average number of available resources. The Scheduled Utilization is:

$$\frac{\int_0^T B(t)dt / T}{\int_0^T M(t)dt / T} = \frac{\int_0^T B(t)dt}{\int_0^T M(t)dt} \quad (5)$$

In summary, the first three indicators are commonly used to evaluate the steady-state capability, the services responsiveness and service congestion can be evaluated from the view of user and process service.

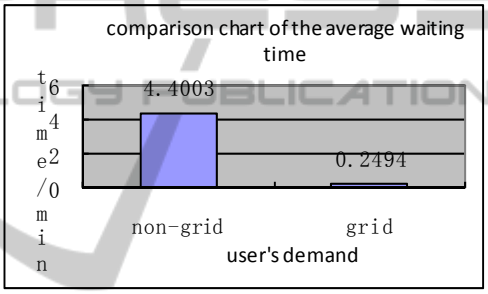
2. Simulation Hypothesis

It is assumed that non-grid and grid-based service model have the same business, namely user submit requirement in the same way, arrival time has the same distribution and the arrival time follows TRIA（1，3，5）triangle distribution, making the simulation comparable.

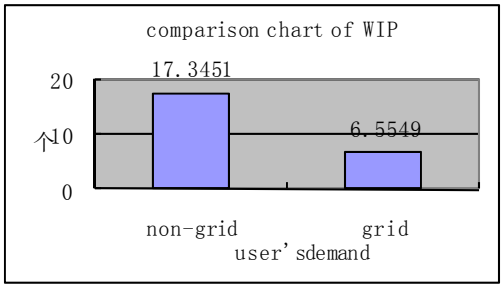
Assuming the service cycle is 8 hours a day and grid-base model users can submit requirement in 24 hour. Besides, we also assume the arrival of system events and the processing time of each node follow exponential distribution; the delay of internal operation process follows triangular distribution. The basic statistical unit of simulation is minutes; the length of simulation is one week.

3. Analysis of Simulation Results

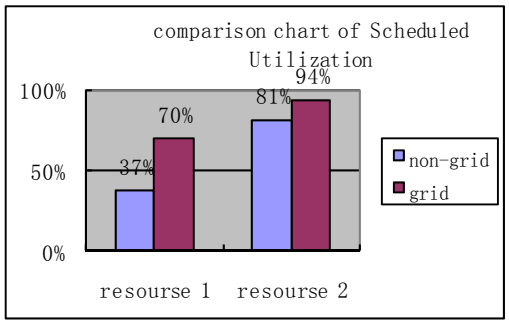
According to the simulation model and inputted data, using the Arena software for simulation operation. The system works 8 hours a day and 7 days each time, a .txt file will be generated after the simulation with all the statistic results in a report form. Finally, a serious of simulation results is obtained, as Fig. 7 stated.



(a)



(b)



(c)

Figure 7: Simulation results.

(1) Comparison of average waiting time

Waiting time indicates the period of time from the requirement is submitted to the time the requirement is processed. The services responsiveness and service congestion can be evaluated from the point of view of user and process service. In Figure (a), the average waiting time in non-grid mobile business process is more than 4 minutes, and there is almost no waiting time in the grid-based mobile business process model. It is obvious that grid-based mobile business process has faster response capability.

(2) Comparison of WIP

Average queue length means the total number of customers in the system (the number of customers waiting in line plus the number of customers who are receiving service and). The figure (b) demonstrates that the average queue of non-grid process is about three time of that of gird-based process.

(3) Comparison of resource utilization

The resource utilization includes Instantaneous Utilization and Scheduled Utilization. In the simulation result, they have the same indicators which referred to here as resource utilization. It can be seen from the figure (c) that grid-based process has higher resource utilization than non-grid based process.

In conclusion, grid-based model has great advantage over the non-gird model.

6 CONCLUSIONS

With the development of information technology, mobile business has entered into a service –oriented and process optimization focused stage. The main difficulties are information sharing, business collaboration and business process reengineering. There is no in-depth systematic analysis on this issue but only some ideas in theory. In this paper, combing the research result of grid management theory, mobile grid and Arena simulation technology, in the view point of system engineering, a grid-based mobile business process is built, paving the way for the research on mobile business process.

In this paper a grid-based mobile business process model is built on the basis of grid management theory. By comparing the service difference through constructing corresponding simulation models with related evaluation indicators, it is clear to see that grid-base process has incomparable advantage over that of non-grid process.

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