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Research on Intelligent Traffic Control Model and Simulation based on the Internet of Things and Cloud Platform

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Abstract: With the development of computer technology, the advantages of cloud computing, such as high scalability and high availability, provide a good solution to the problem of mass data in modern traffic management. In view of the problem of urban traffic area linkage control, this paper studies the decision analysis method based on the cloud computing model, and forms a systematic dynamic coordination of regional traffic and intersection signal control strategy. Considering the relationship between the adjacent green signal ratio and the traffic flow, the author try to optimize the traffic signal light timing scheme, then make construction of adaptive linkage control and strengthen the traffic control and guidance. Through the simulation and analysis of the strategy under different conditions, the experimental results show that the proposed scheme is superior in performance and has a good application prospects.

Keywords: Intelligent traffic, Internet of things, Traffic flow, Cloud computing

1. Introduction

With the rapid development of urban economy, the traffic volume of the road has increased dramatically, the energy and environment problems caused by traffic congestion have become more and more serious, which makes the importance of regional traffic planning and coordination become more and more important. In order to ensure the coordinated development of urban traffic, in order to speed up the construction of urban transportation infrastructure, it is more important to strengthen urban traffic management, especially the linkage between regional traffic management. The development and application of the urban traffic system is inseparable from the support of information technology and control technology, traffic management related decision-making methods and control theory only in the linkage of regional traffic to on traffic jams are effectively inhibit, and regional linkage control huge traffic detection data volume will increase the information center of communication, computation and storage pressure and its real-time and reliability of traffic management bring great challenges1. Cloud computing, as a new business model, with its highly extended and high availability advantages provides a good solution to solve the modern traffic management in the problem of massive data. Therefore, in recent years, with the development of computer technology, cloud computing technology is rapidly becoming a hot research topic in the field of transportation. At present, the development of cloud computing has been a large number of large enterprises to promote, typical of the Google App Engine, IBM's "blue cloud" computing platform, Amazon elastic computing cloud With the signing of Open Cloud Manifesto, a large number of IT firms gradually focused on mutual collaboration, to explore a new unified and open cloud computing standards, in order to facilitate users easier to understand and use the cloud environment2. However, the current cloud computing is still not formed a unified standard, business server many solutions from different vendors different, the cloud computing platform does not have interoperability directly affect the cloud mass market and commercial applications7. Especially in the transportation system, to achieve low cost, efficient, safe and easy to use cloud calculation platform is still facing many challenges, between different traffic management system need visits computing resources, to cloud computing interfaces need to establish a reasonable and efficient interaction protocol, makes different cloud computing service providers to cooperate with each other, so as to make better use of cloud computing in transportation system with strong service function3. Therefore, research on urban traffic regional linkage control of cloud strategy, forming system of traffic signal control and cloud computing to support a new generation of regional transportation linkage control scheme to promote cloud computing, the development of innovation theory and its application in the field of transportation industry, the intellectual power to traffic and transportation period of development to step onto a new stage.

In recent years, the traffic signal engineering and control theory has been the domestic and foreign government agencies, research institutes and technology companies, especially in the academic development of rapid4-5. Binghm research the intersection traffic fuzzy control parameters calculated by neural network, improved the traditional fuzzy control effect; Roozemond presents the agent for the control unit of the traffic control model, through actual traffic data is predicted value to improve the matching scheme6. Although the use of fuzzy control technology and intelligent technology in single intersection for traffic control has made some achievements, but the two methods do not have ability to learn, do not adapt to the variability of the modern traffic management traffic. In addition, using Q learning and BP neural network for single intersection mixed traffic signal control; Li use multi-step sarsa strengthen learning method combined with radial basis function network value function approximations for the traffic signal control of single intersection7-8. Through the study of the control method with learning function, the results show that the method is better than the fixed allocation scheme. In multi intersections signal control, Adler proposed conceptual model based on multi-agent system of road traffic distributed control; Wang using a combination of reinforcement learning and artificial neural network method to solve the multiple intersection traffic signal control problems; Li analyzes application of multi-agent technology of area traffic signal coordinated control were studied to establish a regional traffic intelligent control system9. From the above research results found that, although achieved some progress in the single junction and multi intersections signal control, but because in the actual intersection linkage control of real-time traffic state requirements higher, this precisely with the high volume of data detection and data processing contradict. Based on this point, this paper introduces the theory of cloud computing in regional traffic control to solve the problem of real-time access to traffic control information in massive traffic detection data.

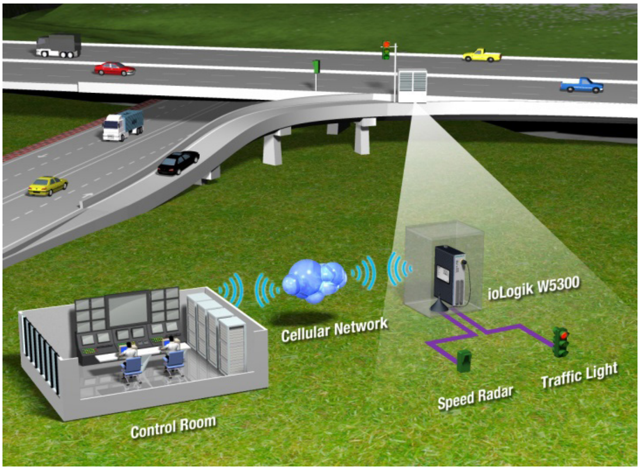

Figure 1 – Traffic control

2. Task scheduling model for cloud computing platform

2.1. Cloud computing platform architecture

The overall framework of the study of urban transportation regional linkage control cloud decision-making mainly consists of three parts, including traffic information collection, cloud decision support and control scheme. The status and function of each component in the overall structure of the system and the logical relations between them are shown in Figure 1.

1. traffic information collection to the underlying database mainly rely on networking platform provide acquisition and processing of traffic information, such as road conditions, traffic flow, traffic flow, road rate, front distance system required for the original data share. Through the data mining analysis, the formation of the attribute complementary type of traffic information database, for the development of the use of traffic control strategy module. The linkage of urban regional traffic control cloud decision research of traffic information comes mainly in two parts: a part for the real-time traffic information detection point (such as ring coil inspection measuring point, microwave detection, video detection point, etc.) will be road traffic data (such as traffic flow, traffic flow, road occupancy rate, the front distance, etc.) and vehicle data (such as vehicle, vehicle length, etc.) by transmission network for transmission to the cloud computing platform; another part of the data is integrated by intelligent transportation other subsystem to provide real-time traffic data (such as the floating car traffic information, traffic police corps other intelligent transportation system such as the traffic data collected by the traffic signal control system, bayonet system,

traffic incident detection system) and the open sharing of data by a transmission network access to cloud computing platform. The transmission of information is divided into two kinds of transmission modes, wired and wireless. Wire can be used in public security network connecting the internal traffic police corps, the Public Security Bureau and other units; to connect with Internet and other social information needs related units; using data lines and operators of the data center are connected; the front-end data acquisition and the information released can use 3G operators or 2. 5g wireless communication network, the traffic data are collected in real time and led traffic induced screen or variable message signs (VMS) of the traffic state information.

2. cloud decision support platform for regional traffic control linkage cloud computing strategy respectively based on the current traffic state estimation and prediction of the content of the two part of future traffic condition, the traffic condition prediction is traffic control information from the center data obtained after the treatment of each traffic node adjacent traffic lines, road traffic and traffic regulations, system generation of adjacent node adaptive linkage control strategy and released by the information; the other part is the current traffic state estimation, it is through the statistical traffic information, monitoring of the overall network traffic within the region to detect traffic conditions for emergency, priority control scheme of the artificial intervention, historical traffic data can also provide traffic management decision optimization according to the traffic management department.
3. the decision making scheme of traffic control is an important guarantee to ensure the smooth operation of the traffic, and is the important basis of traffic management and control, traffic guidance and so on. Regional coordinated

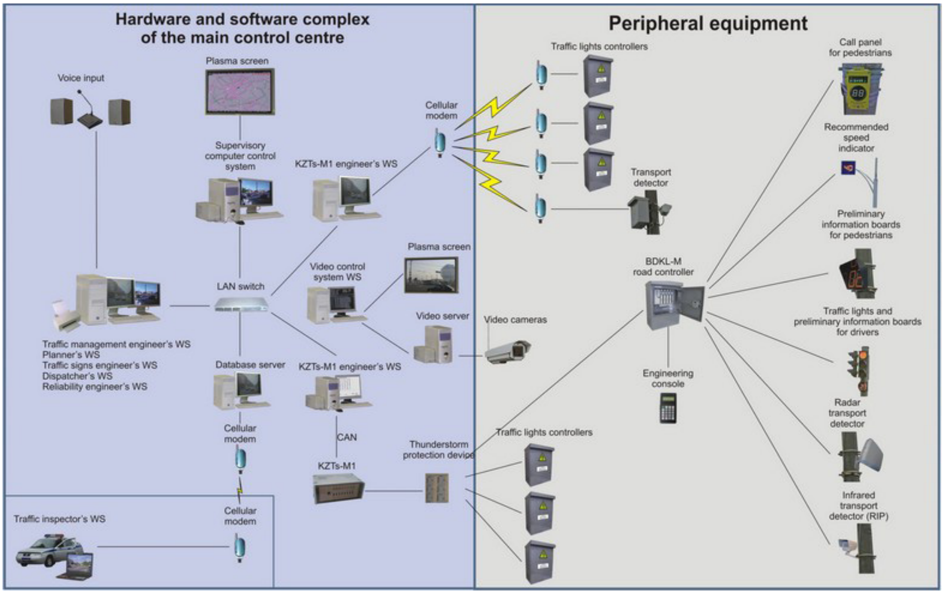

Figure 2 – Urban transportation regional linkage control cloud decision

traffic control strategy research is the extension of the single intersection traffic control, expect in the single intersection traffic control based on considering upstream and downstream traffic condition and adjacent traffic control nodes and help decision makers to improve decision quality and efficiency.

Based on the above discussion, cloud decision of the linkage of urban regional traffic control is mainly cloud decision model of research in the field of traffic application prospect and the core technology, to explore multiple traffic parameters of traffic linkage control decision scheme; according to the urban traffic area coordination control strategy application requirements determined regional traffic control strategy generation and release and optimization strategy, development of regional coordination control scheme.

2.2. Node control task scheduling model

Due to the vehicle arrived in a traffic signal lamp waiting time is uncertain, leading to joint control task arriving at the cloud computing platform is random, i.e., the control task arriving at the cloud computing platform interval follows a random distribution, such as negative exponential distribution and Poisson distribution, Erlang distribution. According to the characteristics of the demand for computing resources, the linkage control task can be divided into computation intensive, communication intensive, data intensive and I/O intensive, etc.. Different types of tasks to be processed in the form of data and the size of the problem is generally different. In order to facilitate the research, this paper will be a control system of a certain intersection in the regional traffic control system is called a control node, and it is assumed that the same type of control method is the same. Because of the autonomy of the linkage control system and the distribution of the region, there is no precedence constraint relation between the control tasks submitted by different nodes, that is, the control of any node is relatively independent.

Definition 1: assumes that said traffic control tasks to the cloud computing platform randomly into three tuple (T, R, W), among them:

a. T={ ti |1≤i≤m} means control set of task type, ti represents the class i control task, and there is ti∩ti =∅,Among them, 1≤i,j≤m.
b. R={ ri | 1≤i≤m} means average arrival rate set for a node control task, ri represents the average amount of time the ti class task unit is reached, If i≠j, ri≠rj, and1≤i,j≤m.
c. W = { wi | 1≤i≤m}means cloud computing platform faces the task of calculation, wi represents the computation of the ti class control task. Therefore, the i class computing task can be represented as(ti,ri,wi), among them, ti∈T,ri∈R,wi∈W.

Control tasks to the cloud computing platform average arrival rate of the platform of a large number of monitoring data analysis tasks arrive cloud computing platform interval random distribution, reference statistical methods, such as chi square test method to determine the task arrival interval, which is subject to the theoretical distribution, and to estimate the value of parameters.

Definition 2: The cloud computing platform in the control node task scheduling is represented as a six tuple:

a. $C = \{c_i | 1 \le i \le n\}$ represents a collection of control nodes in the cloud computing platform, where Ci represents the first i control node, and the n is the number of control nodes;

b. $P_{m\times n}^{busy} = \left\{ P_{m\times n}^{busy} \middle| 1 < i < m, 1 < j < m \right\}$ represents the execution power matrix of the control node.

c. $P^{idle} = \left\{ P_i^{idle} \middle| 1 < i < n \right\}$ represents a collection of idle power control nodes.

d. $P^{peak} = \left\{ P_i^{peak} \middle| 1 < i < n \right\}$ represents peak power control node set.

e. $U_{m\times n} = \left\{ u_{ij} \middle| 1 < i < m, 1 < j < m \right\}$ represents the average service rate matrix of the control nodes, and Uij represents the average service rate of the control node Ci.

f. $S = \left\{ s_{idle}, s_{busy} \right\}$ represents a collection of control node states, sidle indicates that the control node is running but is idle, and busy indicates that the control node is in a state of execution.

And control tasks on average to the cloud platform ratio method to obtain the same on the cloud computing platform for a large number of monitoring data random distribution analysis, can get different control node processing different types of task service rate matrix.

2.3. Multi node joint control of the cloud computing strategy

The demand for traffic control at different intersections is not the same, and some need to provide a three-dimensional cross road streaming service, and some of the pursuit of cross time service. In order to guarantee the quality of service (QoS) of the cloud platform, the traffic control signal must provide the appropriate intersection control strategy according to the actual traffic demand. At the same time, to play the overall efficiency of the control node in the cloud computing platform to achieve load balancing. In this paper, a method of multi control node coordination based on QoS is proposed, which can select the appropriate node control strategy based on priority to coordinate the traffic demands of different intersections. The following parameters are mainly considered.

a. Computing time: the time when the task arrives at the cloud computing platform from the start of execution to the end. The time required for system service is not predetermined, and can only be estimated on the basis of the system overhead, the estimated running time and the running time of the other ready services for the task. Task Wi expected completion time Tc.

$$T_c = Q_w = T_e + \sum_{k=1}^{QLD} T_{ke} \tag{1}$$

$$T_e = \frac{T_{ini} + \sum_{n=1}^{N} T_n}{N + 1} \tag{2}$$

In this formula: QLd represents the length of the task queue on the node Te, D represents the estimated running time of the task Wi. The estimated running time of task Tini is Wi, which is the average value of the previous run time of the task. N represents the number of tasks performed, and the Wi represents the running time of the Tn first n. Wi the number of completed, the more the value of the Te closer to the completion time of the task. The smaller the value of Te, the more quickly the task can be completed, to find the smallest Te node, and the node can be run to ensure that the task of real-time.

b. Cloud computing platform operating costs: Since cloud computing is to provide linkage control services for all control nodes, the control node needs to perform a task request according to the specific control requirements of the vehicle flow, and the total cost of CostWi is Wi.

$$\mathrm{Cos}tW_i = P_{cpu}C_{cpu/GHz} + P_{men}C_{men/MB} + P_{stor}C_{stor/MB} + P_{net/Mbs} \quad (3)$$

The service charge used in the implementation of the control task is mainly caused by the consumption of the network communication, computing, storage and other equipment. Among them, P said the price of each unit of equipment resources; C said the number of resources. In the specific cloud computing environment, the cost may be slightly different, for the convenience of the solution for the time being ignored.

c. System operation cost: Including the scheduling overhead and communication overhead of the cloud computing platform. Scheduling overhead refers to the task of real-time segmentation and according to the requirements of the implementation of resources generated by the cost of scheduling communication overhead refers to the resource scheduling or node and other nodes on the data communication overhead between the sum of the data. The total overhead of task Wi in the scheduling process as:

$$O_i = O_w + O_d \quad (4)$$

$$O_w = \frac{D_i}{C_d} D_{cij} \quad (5)$$

$$O_d = \sum_{v=0}^{n} \sum_{p=0}^{SN} \frac{D_{ip}}{C_v} DS_{dv} \quad (6)$$

d. Platform load balancing: If cloud computing platform in the control task of load exceeds the platform can withstand the maximum load limit, the overall performance will decrease, and cloud service quality is not guaranteed. Therefore, we should as possible to make task scheduling to load the node operation, in order to achieve load balancing, and for each control node set a denial of task critical value. The formula for calculating the critical value of a node is

$$TLV = \{TLV_{cpu}, TLV_{men}, TLV_{stor}, TLV_{net}\} \quad (7)$$

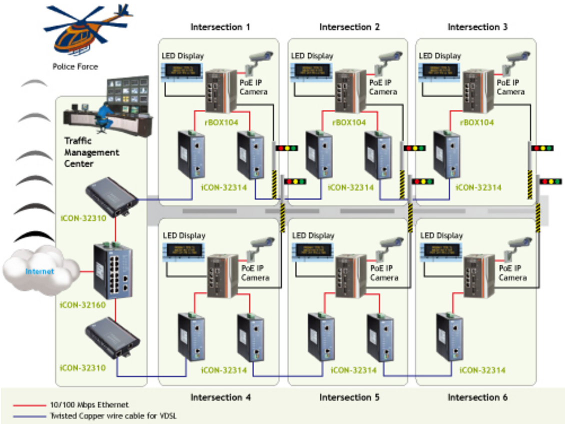

Figure 3 – Multi joint control

3. Simulation experiment and analysis

3.1. Experimental environment and parameter setting

In order to verify the effectiveness of the urban traffic control cloud strategy, this paper uses the discrete event simulation tool of MATLAB to carry out simulation experiment, the relevant parameters of the experimental environment and the range of values as shown in table 1.

parameter	Set up	Explain
m	8000	Total number of tasks to arrive at
ti	1≤i≤4	Number of task types
n	15	Number of control nodes in the platform
λi	[10,15]	Average arrival rate of class I tasks
uij	[1,5]	Control the average service rate of the node to the task
wi	[1, 10]	Calculation of Ti class tasks

Table 1 – Parameter settings for the simulation environment

3.2. Experiment and result analysis

When the control task of the node enters the cloud computing platform, the platform will record the task type and the time to enter the platform. In cloud computing platform of the task queue, any task waiting time is equal to the task queue in the previous task completion time minus the task arrival time, the task completion time is equal to the entry time and waiting time, service time and. Finally, the completion time of the task is subtracted from the time of entering the platform, which is the response time of the control task. Cloud computing platform for all tasks in the response time of the average value is the task in the platform of the average response time Timeavg. According to the implementation of the control node Cj task types and the number of the corresponding task, executive power and the service time, calculate the control node Cj task execute time Timebusyj and enforcement of energy consumption Energybusyj in Taichung. According to the previous analysis, we can know that in the control node Cj, the completion time of Timetotal for the last control task completion time minus the first task to enter the platform. Then, the idle time of the control node Cj can be expressed as:

$$Time_j^{idle} = Time_j^{total} - Time_j^{busy} \tag{8}$$

The idle energy consumption of the control node CJ is expressed as:

$$Energy_j^{idle} = Energy_j^{total} - Energy_j^{busy} \tag{9}$$

Therefore, the total energy consumption of the control node CJ can be expressed as:

$$Energy_j^{total} = Energy_j^{idle} + Energy_j^{busy} \tag{10}$$

The average power of the control node CJ is:

$$Power_j = \frac{Energy_j^{total}}{Time_j^{total}} \tag{11}$$

For the entire system, the completion time of all tasks is

$$\max\left\{Time_j^{total} \middle| 1 \le j \le n\right\} \tag{12}$$

The average power of the system is:

$$Power_{avg} = \frac{1}{n}\sum_{j=1}^{n} Power_j \tag{13}$$

Thus, the average power consumption of the control task of a single node in the cloud computing platform is:

$$Engergy_{avg} = Power_{avg} \times Time_{avg} \tag{14}$$

In order to further illustrate the effectiveness of the control strategy of cloud linkage control, this paper analyzes the average response time and average energy consumption of the cloud computing platform from two aspects. The simulation results are shown in Figure 4 and 5. From the experimental results, it is found that, with the increase of the number of control nodes, the average energy consumption of the cloud computing platform performs a linear decline. When the number of control nodes is 6 or 7, the average energy consumption of the platform is minimum, and the system has good scalability when the number of nodes is 6 or 7 under the condition of energy consumption. With the increase of the number of control nodes, the average energy consumption of the platform is increasing, and the average energy consumption is increasing:

When the control node a number from 1 to 6, cloud computing platform in control average task response time is exponential decrease (Figure 4), but the cloud platform, the average energy consumption growth momentum is basically stable (Figure 5), which leads to the platform to perform the tasks of average energy consumption is decreased gradually in the process, and, at this time because of cloud computing platform, the average power of the absolute value is small, so decreased linearly.

When the control node number from 7 to 15, the average task response time decreased trend gradually leveled off (Figure 4), but the cloud platform, the average power of the

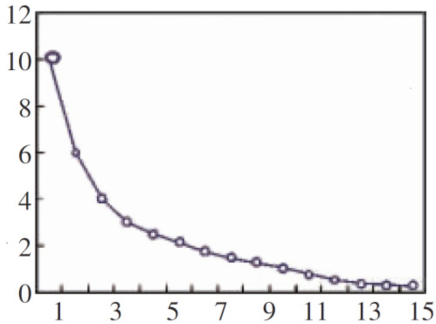

Figure 4 – Average response time of cloud computing platform

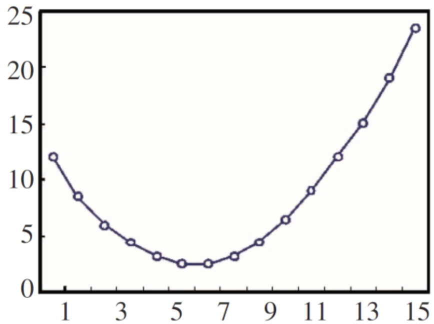

Figure 5 – Average energy consumption of cloud computing platform

momentum is the exponential increase (Figure 5), the task leads to the average energy consumption in the process is gradually increased, and because this time average power of absolute value larger, so the growth trend is exponential.

It can be seen that the system has the best scalability when the number of nodes is 6 or 7 under the condition of energy consumption. For the actual cloud computing platform, according to pan and run the system structure, task arrival rules determine cloud computing platform should be open or close linkage control traffic in the actual number of nodes, and open or closed what control nodes energy consumption optimization control, will serve as a further study of the content.

4. Conclusion

In view of the problem of urban traffic area linkage control, this paper studies the decision analysis method based on the cloud computing model, and forms a systematic dynamic coordination of regional traffic and intersection signal control strategy. Consider adjacent cross export green channel and traffic flow between the upstream and downstream of the relationship, traffic signal lamp with optimization scheme, support intersection adaptive control linkage, and strengthen traffic control and guidance function of informatization. Through the simulation and analysis of the strategy under different conditions, the experimental results show that the proposed scheme is superior in performance and good application prospects.

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