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Mobile Computing Clouds Interactive Model and Algorithm based on Multi-core Grids

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Abstract

Multi-core technology is the key technology of mobile cloud computing, with the boom development of cloud technology, the authors focus on the problem of how to make the target code computed by mobile cloud terminal multi-core compiler to use cloud multi-core system construction, to ensure synchronization of data cross-validation compilation, and propose the concept of end mobile cloud entity indirect synchronization and direct synchronization; use wave ormation energy conversion, give our a method to calculate indirect synchronization value and direct synchronization value according to the cross experience and cross time of compilation entity; construct function relative level algorithm with Hellinger distance, and give an algorithm method of comprehensive synchronization value. Through experiment statistics and analysis, take threshold limit value as the average, self-synchronization value as deviation, the update function of indirect synchronization value is constructed; an inter-domain multi-core synchronization flow chart is given; then inter-domain compilation data synchronization update experiment is carried out with more than 3000 end mobile cloud multi-core compilation environment. Through the analysis of data compilation operation process and results, the synchronization algorithm is proved to be reasonable and effective.

Keywords: *mobile cloud computing, multi-core technology, multi-core compilation, synchronous, cross validation*

1. Introduction

The development of cloud computing is not limited to the PC, with the mobile internet of booming development, based on a mobile terminal of the cloud computing services has emerged. Based on the definition of cloud computing, mobile computing clouds is through the mobile network with on-demand, easy to expand way to obtain the infrastructure, platform, software (or application) as well as a IT resources or (information) service delivery and use mode. Mobile cloud computing is cloud computing technology in mobile Internet application [1].

Multinuclear computing technology is the key technology of mobile computing clouds, The terminal entity of mobile cloud pool can be a mononuclear computer or multinuclear computer, the whole mobile cloud pool is a moving cloud computing terminal multinuclear platform [2-3]. "Mobile Me" rolled out by Apple, Inc. is a cloud based on mobile terminal multinuclear calculation and mobile cloud storage solutions. According to Apple's whole idea, the program lets mobile cloud terminal synergistic treatment E-mail, notepad project, communication book, photos and other files at the same time, users would do things to be automatic interaction, update to iMac, iPod, iPhone and all kinds of mobile terminal interface [4] by Apple Inc. An important link is multinuclear compiling of the mobile cloud multinuclear environment information interaction. The important goal of multinuclear compiling is the multinuclear of the synergistic interaction and multinuclear Credibility compiling.

The compiler credible goal is from the point of view of the operation of the system guarantee compiled the credibility of the software, He YanXiang professors and the team members to compile framework and part credible theoretical details of the system summary and define [1], the main including two meanings: on one hand we must ensure that the compiler itself is credible, the compiler itself credibility is mainly refers to the correctness of the translation process. First of all, the compiler function must be correct, that is the source code and compiled

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code on behavior equivalence with; Second, ensure that the compiler in the build process will not to bring any computer system security problems, prevent malicious attack by modifying the compiler, during compilation executive malicious code. On the other hand, we must ensure that the compiler compiled object code is credible, that is, through the compiler provide credibility to the guarantee system, must ensure that all through the compilation, testing and verification and the success of the generation of program code, in the system platform is running on a safe and reliable, at least, is scheduled to meet the requirements of the faithful. To meet the requirements of the above two aspects compiler called credible compiler.

Especially in the cloud technology the prosperous development of the background, the mobile terminal parallel compilation, moving clouds cloud compile necessary and mobile terminal distributed cloud terminal more nuclear compiler technology is widely fusion, more nuclear compiled and cloud computing will show the vitality of the special together. Compared with the traditional compiler, mobile cloud terminal to consider moving more nuclear program cloud terminal of the synchronization, mutually exclusive, data competition, the dead lock, load balance, etc, make the object code compiler out to make full use of mobile cloud much of the system structure, guarantee nuclear synchronize data consistency requirements [2] and make more under the environment of nuclear cloud credible compiled into a very valuable and the challenge of the subject.

Information compiled by the mobile cloud terminal credible multi-core cross-validation process essentially the same verification process and trusted computing grid information exchange, credible multicore compiled synchronous link mesh mobile cloud entities to work together, To the verification of interactive information [3-10]. In this paper, the emerging cloud technology distribution to verify the calculations, the trusted grid cross-validation calculation method is introduced into the mobile cloud terminal credible multi-core compile problem, Proposed and solve the problem of how to use history to compile experience to calculate a credible compiler synchronization value, the credibility of self-synchronization value, the agent indirectly trusted synchronization value function sets, Cross-validation process to form a mobile cloud terminal credible multi-core environment, thus achieving the key steps of the credibility of multicore synchronization compiled [11, 12].

2. Credible Compilation Interaction Model Description based on Multi-core Mobile Cloud

Cloud computing take virtualization technology to define and distinguish hardware and software mobile entities in the pool, mobile cloud entities have been defined from different perspectives, such as: Grid and unit. In the perspective of credible compilation, the bottom hardware platform of the cloud pool can be built based on trusted technology, all elements collected by software compilation in the mobile cloud pool is multi-core mobile cloud compilation mobile cloud entity, if the mobile cloud collection of entities need to be fully credible, the upper collaboration compilation should be credible, while the key point of mobile cloud entities should be compiled synchronous, the problem depends on the formulate of the mobile cloud entity interaction compile agreement and the verification of interactive information [13-16], the latter is also an important foundation of the former one.This paper of synchronous interaction validation of synchronization using the following definition model:

Synchronous (or not synchronous) is evaluation several mobile entity conducted jointly compiled a cloud the behavior of the objective possibility degree, the evaluation of the common behavior in compile monitor (or impossible to monitor the behavior) before and the compilation and behavior in its own influence behavior. Move the relationship between clouds entity synchronization can be divided into direct and indirect synchronization synchronous of two types: direct synchronization is a moving cloud entity according to the past each other's direct interaction and determine to compile experience of other mobile cloud entity synchronous degree; Indirect synchronization is a moving cloud based on past the compilation of the entity results and determine to recommend the other mobile cloud entity recommendations of the synchronization of information compiled experience level [17, 18].

A mobile cloud entity history synchronization of the cloud is moving entity a behavior compiled expectations, based on the expected in a specific time and many other nuclear environment for the mobile entity mobile clouds cloud entity in the past the behavior of the compiler observation. If mobile cloud entity a need to make sure to a direct interaction with no experience or in quite a long time no direct interaction experience mobile cloud the compilation

of the entity b synchronous degree, can according to indirect synchronous relationship more comprehensive other nuclear mobile cloud of mobile cloud entity b entity indirect synchronous information that cloud the history of mobile entity b synchronous value, and according to the history synchronous value to take a compiler behavior [19-20].

Interactive compilation experience can decide a compiler mobile cloud entity or more than a nuclear compiled the degree of regional synchronization. Synchronous value according to the interactive experience and can last from the interval when evaluating interaction by function $\mathrm{f}(\mathrm{x},\tau)$, One x represents experience, τ represents the time value.

One x represents experience, τ represents the time value. When moving a cloud with this much entity to nuclear domain mobile cloud entity interact b, mobile entity of a cloud based on previous synchronous evaluation function first of the storage of interactive experience and finally a and b interaction to the time now calculate to b directly synchronization of value $D_{ab} = t(x_{ab}, \tau_{ab})$

And then move to a more clouds cloud entity nuclear regional synchronous agent for inquires the history of the entity b mobile cloud synchronous value.

According to a recent synchronous agent for this domain S in the other mobile cloud entity and b interaction experience calculation $t_{ib} = t(x_{ib}, \tau_{ib})$ i ∈ S, Then the history of computing b synchronous value:

$$R_b = \sum_{i \in S} (\frac{r_i}{\sum_{i \in S} r_i} t_{ib}) = \frac{\sum_{i \in S} r_i t_{ib}}{\sum_{i \in S} r_i}$$

ri For synchronous agent is moving clouds of indirect synchronous value entity I. Synchronous agent will history synchronous value according to b use type update all recommended the indirect synchronous movement cloud entity value:

$$r_i^{'} = \begin{cases} \theta(Sub_i) r_i, & Sub_i < \sigma \\ r_i, & Sub_i = \sigma \\ \dfrac{r_i}{\eta(Sub_i)}, & Sub_i > \sigma \end{cases}$$

Among them is the updated synchronous agent for mobile cloud of indirect synchronous value entity I, $Sub_i = |R_b - t_{ib}|$, function θ (Sub) is exponential drab diminishing functions, function η (Sub) is exponential monotonous increasing function, σ as the accepted recommend data error threshold. Mobile cloud entity for a mobile cloud the history of the entity b after synchronous value will be used to calculate the type to b comprehensive synchronous value:

$T_{ab} = \alpha D_{ab} + (1-\alpha) R_b$, On behalf of a Tab to b of the comprehensive synchronous value, and alpha represents self synchronous value, the scope for [0, 1], by many nuclear mobile cloud the entity initially sure, and alpha in the value of a calculated decision comprehensive synchronous when direct experience and from other mobile cloud of indirect experience entity weight of the match. Mobile cloud entity according to the value of the Tab a will make the final decision to sync directly affects its in the translation process of interactive compilation behavior.

3. Wave Energy Information Theory, the Introduction and Analysis of Hellinger Distance

Literature [21, 22] of mobile cloud entity model analysis are given a kind when selected area calculation one mobile cloud entity is the influence of the sum function, defined as volatility information energy function; And at the same time in the area are the calculation of some local area has the influence and the proportion of the total influence calculation method, defined as fluctuations energy than information; And explain the function of mutual connection degree by functions related information said.

Theorem 1: for either a given function f (s), if it can be expressed as:

$$f(s)=\sum_{i=1}^{n} f(s_i)$$

Where $f(s_i)$. For continuous differentiable function, the function of the fluctuation of energy transformation for information:

$$E\left[f(s)\right]=\frac{\sum_{i=1}^{n}\left|f(s_i)g(s_i-s_{i-1})\right|^2}{2}$$

Wave energy than information for:

$$\lim_{n\to K} t\frac{E[F(S)]-\sum_{i=1}^{i=k}E[F(S_i)]}{E[F(S)]}=E_K$$

Theorem 2: set of a system for physical transfer function $W(S)$, the transfer function for identification $G(S)$, {S1, S2... Sn} for test samples, if:

$$E_{KSJ}>\left|\frac{G_{MP}(S_J)-W_{MP}(S_J)}{W_{MP}(S_J)}\right|=\delta_{MP}$$

Among them δ_M, δ_P as the fitting deviation ratio, Then:

$$\left|\frac{G_{MP}(S_J)-W_{MP}(S_J)}{W_{MP}(S_J)}\right|=\delta_{MP}>\left|\frac{\sum_{i=1}^{n}G_{MP}(S_i)-\sum_{i=1}^{n}W_{MP}(S_i)}{\sum_{i=1}^{n}W_{MP}(S_i)}\right|=\overline{\delta}_{MP}$$

Theorem 3

Function I (S) and M (S) of the correlated degree is $[I(S),M(S)]$; Function I (S) in M (S) under the conditions of the correlated degree is $[I(S)|M(S)]$, If M (S) is a multivalued function, said $[I(S)|\sum_{i=1}^{n}M_i(S)]$.

Theorem 4:

Hailin grid distance is able to reflect the two distributions between similarity metrics [4, 16]. Hypothesis in metric space $(\Theta,\ \lambda)$, P and Q represent respectively the corresponding parameters of two continuous distribution, so The two distribution between the Hellinger distance is defined as:

$$d_H(P,Q)=\sqrt{\int_{\alpha}(\sqrt{P}-\sqrt{Q})^2\,d\lambda}$$ Equivalent to $$d_H(P,Q)=\sqrt{2(1-\int\sqrt{PQ}\,d\lambda)}$$

For countable space, That is when the distribution is discrete, two distribution between the Hailin grid distance can be defined as:

$$d_H(P,Q)=\sqrt{\sum_{\varphi\in\Phi}(\sqrt{P(\varphi)}-\sqrt{Q(\varphi)})^2}$$

We can obtain the Hailin lattice distance has the following properties:

$$\begin{cases} 0 \leqslant d_{\mathrm{H}}(P, Q) \leqslant \sqrt{2} \\ d_{\mathrm{H}}(P, Q) = d_{\mathrm{H}}(Q, P) \end{cases}$$

Hellinger distance in the similarity of data sets than the Euclidean distance has the advantage on the form and meaning, Cieslak et al, [4] use it to design the corresponding design decision tree algorithm. [4] and analyzed and verified the effectiveness of the distance measure to select the appropriate features, Especially in the imbalanced data; Lee et al [5] to apply it on the Adjacent classifier.

4. Validation Model and Algorithm Design of Multi-core Compiled Synchronous Interaction within Domain

3.1. Indirect Update Function and Self Synchronous Value

According to the theory of fluctuations information energy we raise the following reasoning:

Reasoning.1: Suppose that move the mobile cloud entity A and mobile cloud entity B in the domain A to gain experience $\{x_1, x_2 \cdots x_n\}$ during the previous direct interaction, every interaction from the current calculation time, $\{\tau_1, \tau_2 \cdots \tau_n\}$, for the history of mobile cloud entity A mobile cloud entity B synchronization value $history(a,b) = \frac{\sum_{i=1}^{n} \left| \dot{f}(\tau_i)(x_i - x_{i-1}) \right|^2}{2}$.

Note: when you move within the region A cloud entity b b evaluation of mobile cloud entity a history of interactive experience in a, which is equivalent to b to apply excessive impact of a region the sum of. Every time interaction associated with the distance from the current time interval, with the further experience of interaction, the historical experience of the impact will decay, so f derivative function on behalf of the attenuation function can be compiled under the different multi-core environment setting. Reasoning, area A synchronization agent on the i-th mobile cloud entity b indirect synchronization error for an acceptable error Sub_i threshold for σ is self-synchronization value of alpha, the indirect synchronization update algorithm:

$$r_i' = \begin{cases} \frac{1}{\alpha\sqrt{2\pi}} \exp\left\{-\frac{(Sub_i - \sigma)^2}{2\alpha^2}\right\} r_i, \ Sub_i > \sigma \\ r_i, \ Sub_i = \sigma \\ \frac{1}{\alpha\sqrt{2\pi}} \exp\left\{\frac{(Sub_i - \sigma)^2}{2\alpha^2}\right\} r_i, \ Sub_i < \sigma \end{cases}$$

Description: When $Sub_i < \sigma$ or $Sub_i > \sigma$ will have the overall evaluation of the synchronization agent within mobile cloud entity b, higher than the agent's optimal expectations may be provided by the agent direct synchronization value is too low, are more likely to entities in the mobile cloud misjudgments or update to interact with b not timely Centre, which will indirectly affect the indirect simultaneous assessment of a to b; threshold for the two cases reflect the agency and the rest of the mobile cloud entities on the mobile cloud entity the final evaluation of b deviates from the optimal assessment. Deviation from the assessed value of the update of the impact of indirect synchronization value r_i' from the mobile cloud entity a self-synchronous value, to judge the impact of the size of error, so alpha can be expressed deviations in the normal distribution function, the update process.

When there is no threshold value constraint, we found in the experiment based on updating algorithm for indirect synchronization of the t distribution error is the larger value has

better convergence effect, can reflect the moving clouds of greater self-synchronization and the synchronization agent synchronization entities recommended role construct are as follows:

$$r`_i = \frac{\Gamma(\frac{\alpha+1}{2})}{\sqrt{\alpha\pi}\Gamma(\frac{\alpha}{2})}(1+\frac{Sub_i}{\alpha})^{-\frac{\alpha+1}{2}} r_i$$

Also find updates based on x^2 distribution function can be in error when smaller rapid response effect of self-synchronous synchronization error and recommended values, structure is as follows:

$$r_i`= \frac{1}{2^{\frac{\alpha}{2}}\Gamma(\frac{\alpha}{2})} Sub_i^{\frac{\alpha}{2}-1} e^{-\frac{Sub_i}{2}} r_i$$

Reasoning 3. If a and b represent two discrete point set space, its relevance $[A, B]$, with Hellinger (A,B) says.

Description: If function $I(S)$ and respectively $M(S)$ representative two a space discrete points set of range, s for defined domain, its related of with Hellinger distance calculation Shi, distance more large is related of more small, points set and itself of distance for zero and related of for is maximum; conditions related of can with two a points set of differences and which a points set of Hellinger distance than Shang two a points set Zhijian of Hellinger distance to calculation, Points set by reduction letter to Hellinger distance from the origin and the point set above and equal to the distance of the Hellinger distance between $I(S)$ and $M(S)$.

$$[I(S), M(S)] = Hellinger \quad [I(S), M(S)]$$

$$[I(S) | \sum_{i=1}^{n} M_i(S)] = \frac{Hellinger\ \{[I(S) - \sum_{i=1}^{n} M_i(S)], \sum_{i=1}^{n} M_i(S)\}}{Hellinger\ [I(S), \sum_{i=1}^{n} M_i(S)]}$$

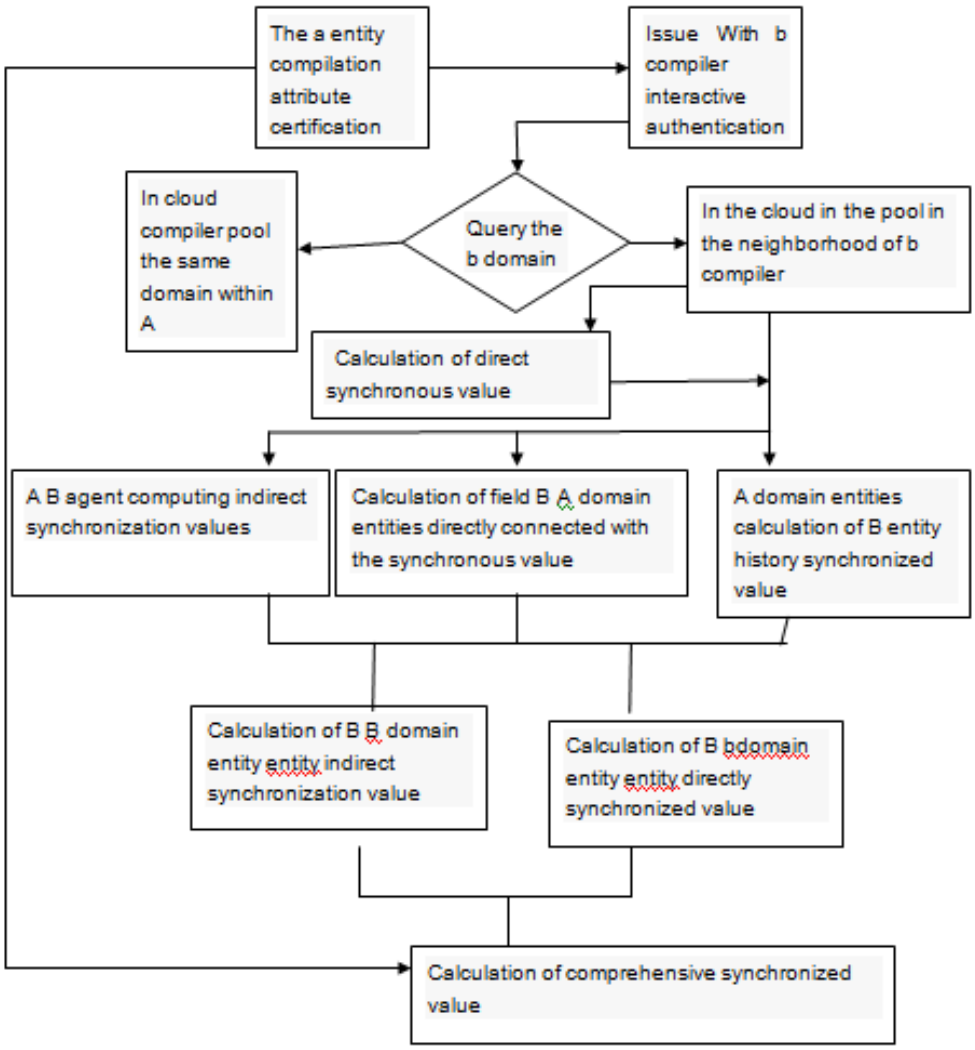
$$1 - [I(S) | \sum_{i=1}^{n} M_i(S)] = \frac{Hellinger\ \{O, \sum_{i=1}^{n} M_i(S)\}}{Hellinger\ [I(S), \sum_{i=1}^{n} M_i(S)]}$$

Reasoning 4. If domain A mobile cloud entity a direct synchronization within other mobile cloud entity value t_{ai}, other mobile cloud entities on the mobile cloud entity a direct synchronization value t_{ia}, the proxy directly to other mobile cloud entity synchronization value t_{mi}, of a self-synchronization value $[\sum t_{ai} | \sum t_{mi}]$.

Description: After simulation experiment, $[\sum t_{ai} | \sum t_{mi}]$ and $[\sum t_{ai} | \sum t_{ia}]$ Can be used as α in the initial calculation and real-time update algorithm. Here as $[\sum t_{ai} | \sum t_{mi}]$ an example, according to the Reasoning 3.

$$\alpha = [\sum_{i=1}^{n} t_{ai} | \sum_{i=1}^{n} t_{mi}] = \frac{\text{Hellinger}[\ (\sum_{i=1}^{n} t_{ai} - \sum_{i=1}^{n} t_{mi}), \sum_{i=1}^{n} t_{mi}]}{\text{Hellinger}(\ \sum_{i=1}^{n} t_{ai}, \sum_{i=1}^{n} t_{mi})}$$

3.2. Inter-domain Multi-core Compile Synchronous Cross-validation Model and Algorithm Process



5. Model parameter evaluation algorithm

Step1: Sets the error threshold value and interval for update functions, you can choose to set up self-synchronous (In long-term stability can be selected).

Step2：Set the time decay function, computing history and experience the difference, to be evaluating mobile cloud computing and history synchronization direct synchronization value value of the entity. Calculation results if you want one of the fourth step, or go to third step.

Step 3: collect the indirect synchronization synchronous agent value and each mobile cloud entity to move to evaluate the synchronous value directly cloud entity list, at the same time, apply for each mobile cloud of direct synchronization of entity value list. If self synchronous value has set the turn step 5, or turn step 4.

Step 4: according to the third step data calculation and set the self synchronous value, data normalization. Turn the third step.

Step 5: set of the values of the indirect synchronization update function (if the restraints on the limit attack can select different update function).

Step 6: calculation of the comprehensive synchronous values (and transfer to other decision-making function) update all mobile cloud of synchronous value and agency entity recommended value, turn the first step.

Data error threshold initialization	History update the data interval is set to 0.5 time units								
	The first round of updates		The second round of update		....		i = 850 round of	i = 851 round of	
Multi-core label	r1	t1	R2	T2	....	R850	T850	R851	T851
1	0.50000.53	0.5040	0.5080	0.5120	....	0.5239	0.5279	0.5319	0.5359
	980.57930.	0.5438	0.5478	0.5517		0.5636	0.5675	0.5714	0.5753
	61790.655	0.5832	0.5871	0.5910		0.6026	0.6064	0.6103	0.6141
	4 0.6915	0.6217	0.6255	0.6293		0.6406	0.6443	0.6480	0.6517
		0.6591	0.6628	0.6664		0.6772	0.6808	0.6844	0.6879
6	....	0.6950	0.6985	0.7019		0.7123	0.7157	0.7190	0.7224
....	0.98930.99	....	....	....		....	....	....	....
	18 0.99380								
2013	.99530.996	0.9896	0.9898	0.9901		0.9909	0.9911	0.9913	0.9916
	50.99740.9	0.9920	0.9922	0.9925		0.9931	0.9932	0.9934	0.9936
4005	981	0.9940	0.9941	0.9943		0.9948	0.9949	0.9951	0.9952
		0.9955	0.9956	0.9957		0.9961	0.9962	0.9963	0.9964
		0.9966	0.9967	0.9968		0.9971	0.9972	0.9973	0.9974
		0.9975	0.9976	0.9977		0.9979	0.9979	0.9980	0.9981
		0.9982	0.9982	0.9983		0.9985	0.9985	0.9986	0.9986
							....		
Subi	0.6950	0.0595	0.0555	0.0518	0.0484	0.0452		0.0422	0.0210
							....		
Ri	2.8784	2.8609	2.8453	2.8313	2.8187	2.8073		2.7969	2.7874

6. Applications of multi-core synchronous compile model

Setting simulation program: A domain nuclear compiled more than the number of 3000 mobile cloud entity, that is equivalent to having 3000 compiled with nuclear compiled; Data compiled error threshold initialization σ = 0.5500, synchronous recommend update based on the function of normal distribution constructor, $f(\tau) = \frac{1}{\tau}, \tau = 0.5(t)$.

Time unit is three times respectively set to $t = 1s, t = 1m, t = 1h$. Computing mobile cloud entity synchronization with another move in any cloud entity 2011 history value.

Reasoning one, history synchronization value results in the settings of the different time units. This time for the 0.7833, Direct and simultaneous value of 0.9896 (Space is limited empirical data, see Schedule); These two values as the first round of update synchronization initial value, as the above table t1 as shown in；4 too, based on reasoning, Self-synchronization value of 0.6950, set the initial value in order to speed up the update rate 0.7, updated in real time synchronization values, update Agent direct synchronization value for all mobile cloud entity first round of indirect synchronization values r1 and mobile cloud entity 2013 t1, Into the second round of calculations. Specific renewal process and the data shown in the above table, The unit of time is S, the current update to the 341.

Visible when Subi reduce hours of mobile agent cloud of indirect synchronous value entity 2013 increase gradually, indirect synchronous value in the update process and influence to mobile cloud 6 again and other mobile entity to the valuation of 2013 cloud entity value, based on the mobile cloud of direct experience value on entity 2013 mobile clouds in several rounds of updating entity with large synchronous value; At the same time can

See mobile cloud 6 to the valuation of 2013 entities and other mobile cloud of 2013 evaluation entity synchronous increase or decrease so at this moment, according to the reasoning 4 to mobile cloud 6 entity self synchronous value in the update process basic remains the same, in this more nuclear a compiled environment can be rough set to fixed value. Now the big adjustments to agency found the 2013 indirect value when the synchronization, mobile cloud 6 entity of self synchronous value is fluctuations, so strictly speaking should maintain self synchronous value of the real-time updates.

Data error threshold value initialization	The number of update intervals Historical data. Set to 0.5 time units							t=1s	α=0.7	0.3
Multi-core label	1	2	3	4	5	7	...	1997	1998	1999	2000
Tia	0.8303	0.8216	0.8215	0.7924	0.7583	0.7521	...	0.0232	0.0210	0.0185	0.0103
Tai	0.9306	0.9237	0.9179	0.8964	0.8883	0.8623	...	0.0356	0.0317	0.0294	0.0240
Tmi	0.7950	0.7895	0.7851	0.7818	0.7784	0.7752	...	0.0421	0.0410	0.0402	0.0387

7. Conclusion

So according to the fluctuation of energy of information theory set up by the synchronous calculation results meet the mobile cloud terminal multinucleated trusted compiler real time synchronization is needed, for in the traditional grid computing as a fixed value data (such as equivalent self confidence value) can also realize synchronous update so that the update process more accurate and perfect; at the same time can the classical mathematics in mature algorithms and more grid computing interactive algorithm into mobile cloud terminal multinucleated trusted compiler. The same we also see some limitations, such as is currently unable to find an effective transform data error threshold value update, and actually threshold should be constructed by fluctuation energy ratio, but in the experiment with other parameters matching, so did not discuss; we construct the indirect synchronization update function is based on a large number of simulation and experimental statistical results for different grid environment, select the appropriate update function relies on expert experience, future needs to establish a complete theoretical framework through derivation proves that.

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