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Proposing New Intelligence Algorithm for Suggesting Better Services to Cloud Users Based on Kalman Filtering

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Abstract Because of intrinsic characteristic of cloud computing, which made organizations and companies free from buying hardware and software infrastructures, lots of companies and industries decided to migrate to this network to be able to save more monies. For persuading organizations and institutes, about this facts of cloud computing, that in such network, cloud providers can address all of the user's needs, authors of this paper wants to propose and demonstrate new intelligence algorithm which is capable for smart servicing of the needs of users and also suggesting them more related software's and applications. The proposed algorithm is based on Kalman filtering and will use the log file of users and interests of them in different software's. Our proposed algorithm will use backgrounds information and present needs of users to estimate and predict the best software and applications to suggest them.

Keywords: *cloud computing, Kalman filtering, intelligence servicing*

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1. Introduction

One of the most important factors on how the information can processed in an organization is, how much does the processing costs? If we can decrease the whole costs, we can persuade owner of organizations and industries to augment the power of capacity and processing by investing on new technologies. Up to now, the technologies which existed and used by users and industries are so time and money consuming. Because they should pay lots of money for maintenance and operation of such resources – complete comparison between traditional systems and cloud computing will provide in sections 2 and 3 (Figure 1, illustrates basic needs diagram of your owned data centers).

In recent decade saving the costs of processing and communication can be done by using of cloud computing, it can progressed decentralization in different industries and companies, and help them in doing their works and processes with more agility and more optimum decision making structure, while it helps them simultaneously to keep the costs as low as possible. As a result, the owner of company or industry can invest their money in advancing the performance of the company. By decreasing the amount of money which should paid by organizations and industries for IT infrastructures, the owner of those companies can invest their monies in gathering more information about their projects or even buying more flexible and smart applications for their works. They can study about more intelligence and up to date software's which do their tasks and processes, based on it more easily. As an example, suppose a business company do most of their works by accounting and word processing software's. If we know their needs and amount of their data which they need to process, we can propose them more flexible and intelligence software to enable them to do their own projects more easily. By doing such help, we can ensure them about intelligence and flexibility of our network and also, we can rent them more valuable services. After that, when we rent our applications and software to them, we can improve the features of our applications according to their opinions and as a result we can servicing more flexible and up to date services. All of these suggestions and intelligences can be implemented by using of cloud computing. In cloud computing we can rent a platform from cloud providers and built our application on it, and rent it to cloud users. However, cloud providers can do the same actions - even as we told before - they can use log files of users to deliver them more related services according to their needs. The main goal of this paper is to introduce and demonstrate such intelligence algorithm.

This paper organized as such: the first section is the introduction, in which we gave general conception about cloud computing, and also we discuss a bit on the needs of intelligence servicing. Second section will be discuss about traditional systems and how they servicing to the users, also in this section we will debate on some weaknesses of such resources, and as a result in section three we will

present cloud computing as a solution to such problems and ever increasing demands. We will discuss on some remarkable potentials of cloud computing and we will also answer to this question that, why should organizations and industries migrate to cloud computing? In the fourth section we will discuss on our scheme; we will introduce Kalman filtering and we will tell why it's better to use Kalman filtering. We use this scheme as an intelligence estimator to be able to predict better software's and application for users to enable them to do their tasks more easily. The input of this algorithm will be the backgrounds of users about which software that they used and how much was the amount of their data and processes. The fifth section will be the conclusion and the last section is references.

2. Review on How Traditional Systems Servicing to the Users

Suppose you have an educational company and you delivering research and editing services to your customers. If you used traditional systems inside of your company, you should buy powerful server and systems to be able to install engineering and simulation software's. Also, each year because you will have an increase in number of your customers and staffs (and you want to record their information), and because of you wants to install up to date software's and applications you need to upgrade the hardware of your systems. Also, you need to hire at least one professional expert as an IT manager to remove the problems of your systems. Furthermore, if you will have complex simulation for one of your particular projects, and neither you, nor your staffs know how to do that simulation or with which software it is easier to do that simulation, what will you do in this case? You will call one of your research friends to introduce you, powerful software to be able to do your duty. But if your friend doesn't work on such research topic or didn't know applicable software for such problem, what will you do then? Also, because you have many computer systems and server, you should pay lots of money for your electrical bill each month. Although you may not have enough processes to busy your server and systems during their active time. Moreover, because your data and simulation files, stored in one particular server, what will you do, if your server is crashed?

Suppose you are in a trip and one of your friends ask you for a particular simulation that you know you do it previously and you have it in your hard drive of your system in company, but your friend is in a hurry now, and he need it for tomorrow, what will you do? Also, if you want to work on one project when you are in home, what will you do? Because of your server doesn't have worldwide coverage area you cannot use it from your home. If you want to up to dating one of your particular software's, you should do it manually and system by system. Moreover, lots of software's and applications need new licenses after updating, what will you do for this problem?

As you can see, using of traditional systems inside of your company has lots of problems and costs. By advents of cloud computing and by using of such technology inside of your company you wouldn't have any of such problems. In the next section of this paper we will tell some potentials and benefits of cloud computing and you will understand why we should migrate to this network and use it.

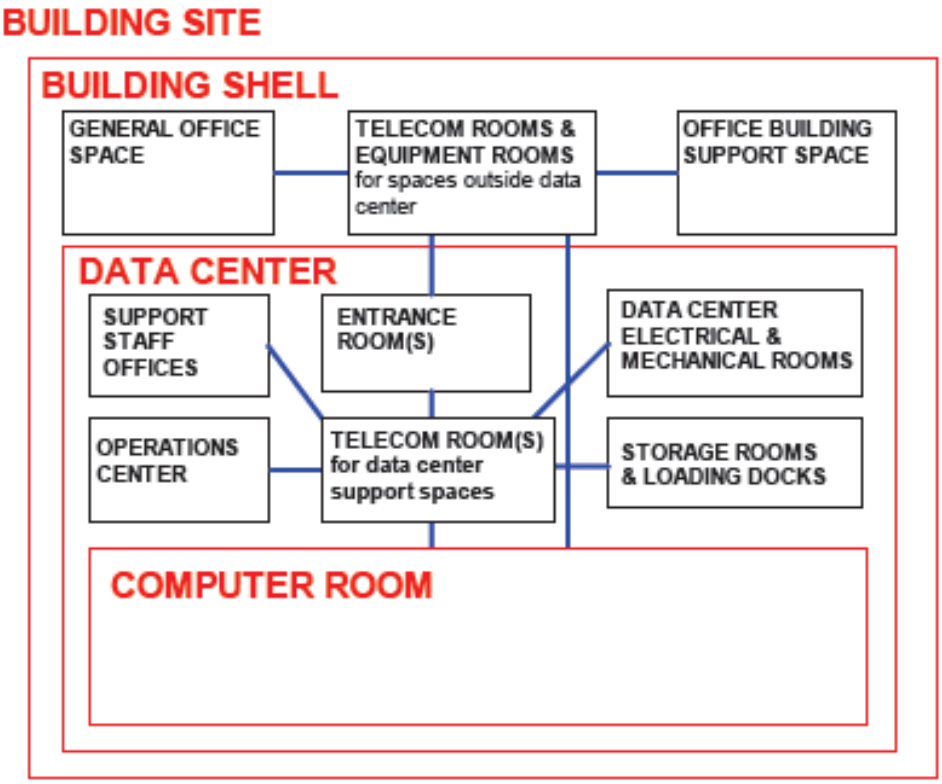

Figure 1. Basic needs diagram of your owned datacenters [16]

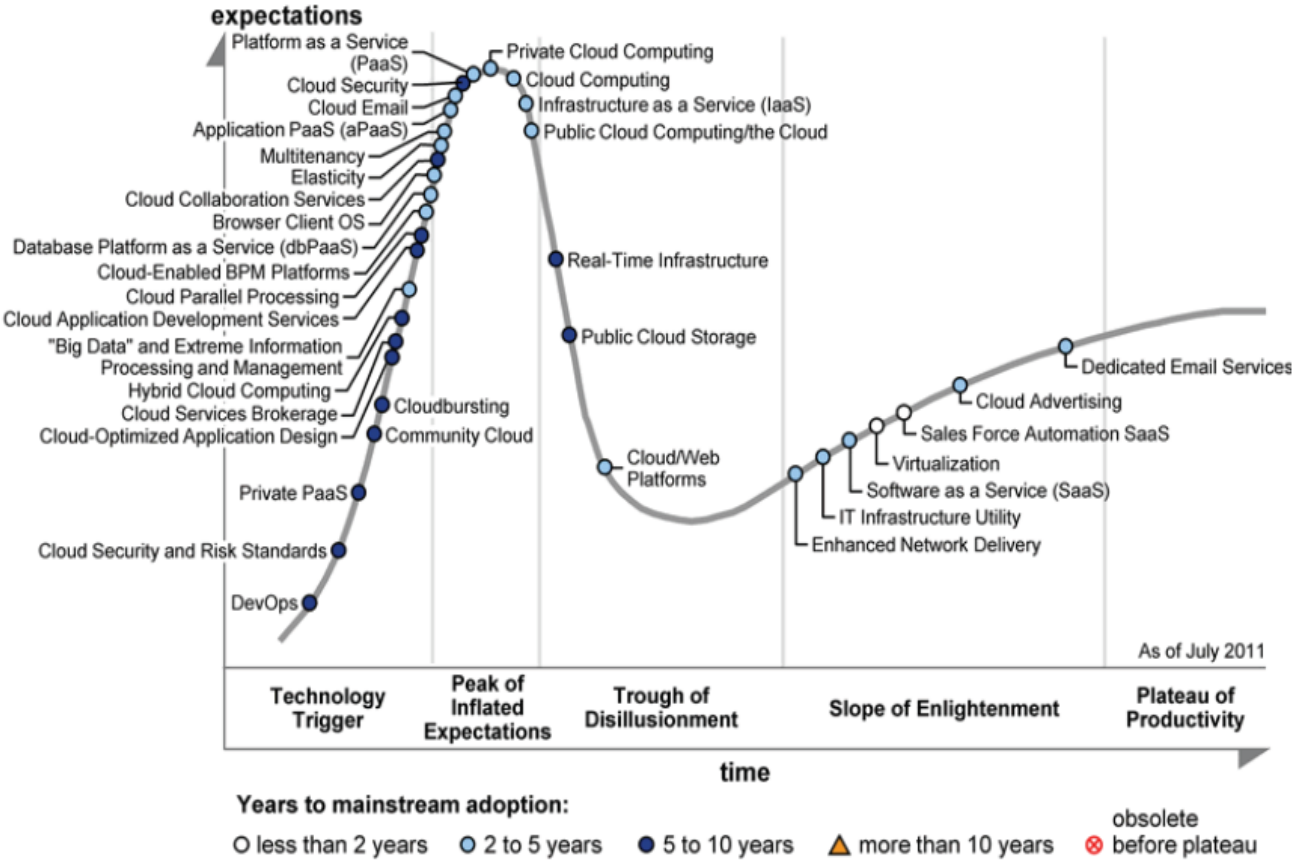

Figure 2. Hype graph for Cloud Computing (Garnder research 2011) [16]

3. Review on Cloud Potentials

From at least two decades ago, because of the advent of cloud computing, lots of the problems and needs from IT industry were addressed in such technology (Figure 2, illustrates hype graph for cloud computing [16]). As an example, we will consider some of the problems which pointed in previous section. Again, suppose you are a manager of an educational institute and you used cloud computing as the platform of your systems. You didn't need any more server or hubs and switches of the network, because in cloud computing, service providers gives you enough processing and storage capacity that you wouldn't need anymore of such instruments. Also, you can login to your account and do your duties as easy as possible and only with use of simple computer systems. When you want to install one engineering application in your system you do not need to upgrade your hardware and software specifications, because in cloud computing, cloud service providers will provide enough powers for you to be able to use the most complex applications and data. Furthermore, cloud service providers will gives you infinite storage capacity and processing power and you will not have any anxiety about the hardware or software specifications of your systems. For using of cloud computing, you and your staffs shouldn't have high expertise in computer engineering, every people can use it very easily. Another remarkable potential of this technology, is that if one of your customers send you an indiscriminate file, that you didn't know with which software you should run it, you can open it very easily in your cloud account. Cloud computing; supports all extensions of the files and software's. Also, because of the intrinsic potential of cloud computing, every time when you log in into your account you will use the latest versions of software's and applications. By using of cloud computing, you will save lots of money, that's because of you wouldn't have anymore computer server (and network hardware's); as a result you shouldn't pay lots of money for your electrical bill.

Furthermore, because your data stored in clouds with up to date firewalls and high security layers, you can login into your account and use your data or do your particular duty from everywhere that you exist. Another remarkable potential of such network is, it enables you for team working, which gives you and your staffs the ability to works on one project simultaneously. In cloud computing, you didn't need to buy any software or applications, you rent the latest versions of them only by nominal charges.

As you can see, you can improve your abilities and saves lots of money by using of cloud computing. But as we told before, a prominent obstacle in front of industries to migrate to cloud computing is they don't know enough about services and various applications which deliver through cloud computing. They habit to use their traditional servers and use their particular software. Even in some cases, we see that, if they migrate to cloud environment and use particular software which deliver through this network they can do their duties more easily, but unfortunately the owners of businesses didn't know enough about such potentials. The goal of this paper is to present new estimator which can suggest more optimum software's and applications to the users according to their needs. In the next section of this paper, we will introduce our new algorithm.

4. Proposed Algorithm

Our new algorithm is based on Kalman filtering and by use of this technique we're able to suggest more related software's in cloud computing. Before introducing our algorithm, we want to explain some basics of Kalman filtering. One of the best algorithms which attract lots of attentions in recent decades knows as statistical filtering. This remarkable and its ground-breaking usage comes from this truth that it used all accessible information of the system. I mean, statistical filtering will exploit the noise of the system and also the state of the system.

Weiner was introduced the filtering and statistical estimation in 1930's. His procedure and system analysis criteria's was developed by Kalman in about 1960's. He minimized the error in model of the estimation of the system by means of, covariance matrix in linear filter. The Kalman filter is class of statistical filter and used in being of uncorrelated white noise. By employing of Kalman filter, the classification issue is degraded into state estimation of dynamic system. Filter headway chase for linear case experiments which is pursued by its logical addition to the nonlinear case.

Identifying the Optimized Linear Filter:

The formulas for the state-space modeling of one dynamical system are:

$$\dot{\underline{x}} = \underline{f}\left(\underline{x}, \underline{u}, \underline{p}\right) + \underline{w} \tag{1}$$

$$\underline{z} = H\underline{x} + \underline{V}. \tag{2}$$

In these formulas linear relationship exist among state and output. For simplifying the noise factors $\underline{w}$ and $\underline{V}$ will removed. So, dynamic system equation is abridged to:

$$\dot{\underline{x}} = \underline{f}\left(\underline{x}, \underline{u}, \underline{p}\right) \tag{3}$$

$$\underline{z} = H\underline{x}. \tag{4}$$

Also, t is the time of estimation of accurate state. If we measure the parameters of the system several times, the values which acquired will approximate a Gaussian distribution. So, the finest state estimation of one system $\underline{\hat{x}}$:

$$\underline{\hat{x}} = \underline{\overline{x}} = \int_{-\infty}^{+\infty} \underline{x} P\left(\underline{x}|\underline{z}\right) d\underline{x}.$$

The following formula gives the amount of error in such estimation:

$$\underline{e} = \underline{\hat{x}} - \underline{x}.$$

And covariance matrix of such errors [1]:

$$E = \overline{\left(\underline{\hat{x}} - \underline{x}\right)\left(\underline{\hat{x}} - \underline{x}\right)^T} = \underline{\overline{e}\,\overline{e}}^T. \tag{5}$$

As you memorize from Gaussian distribution, the mean of $\underline{x}$ designates the climax of its PDF:

$$P\left(\underline{\overline{x}}\right) = \max[p\left(\underline{x}\right)].$$

So, finest procedure for specifying optimized estimation of $\underline{x}$ is through specifying the value of $\underline{x}$ which climaxing it's PDF. For particular random variable$y$, the standard form of Gaussian PDF is:

$$P(y) = \frac{1}{\sqrt{2\pi}\sigma} e^{\frac{-(y_0 - \overline{y})^2}{2\sigma^2}} \quad (-\infty \le y \le \infty).$$

For an unlimited system with n state parameters:

$$P\left(\underline{x}\right) = \frac{1}{(2\pi)^{\frac{n}{2}} E^{\frac{1}{2}}} e^{\frac{-(\underline{\hat{x}} - x)(\underline{\hat{x}} - x)^T}{2E}}.$$

In the above formula, E designates the variance. So the difficulty is to climaxing $P\left(\underline{x}\right)$, under the restrictions of measured output:

$$\underline{z} = H\underline{x}$$

$log[p\left(\underline{x}\right)]$ acquires the climax value for $\underline{x}$, so we can identify the difficulty with using of Lagrangian multipliers as follows:

$$F\left(\underline{x}\right) = \log\left[p\left(\underline{x}\right)\right] + \underline{\lambda}^{\mathrm{T}}\left(\underline{Z} - H\underline{x}\right)$$

$$= \log\left[\frac{1}{(2\pi)^{\frac{n}{2}} E^{\frac{1}{2}}}\right] - \frac{\left(\underline{\hat{x}} - \underline{x}\right)(\underline{\hat{x}} - \underline{x})^T}{2E + \underline{\lambda}^{\mathrm{T}}\left(\underline{Z} - H\underline{x}\right)}.$$

Derivation of $F\left(\underline{x}\right)$ by $\underline{x}$ is:

$$\frac{dF(\underline{x})}{d\underline{x}} = \left(\underline{\hat{x}} - \underline{x}\right)^T E^{-1} - \underline{\lambda}^{\mathrm{T}} H.$$

Maximization means:

$$\frac{dF(\underline{x})}{d\underline{x}} = 0 \rightarrow \left(\underline{\hat{x}} - \underline{x}\right)^T E^{-1} = \underline{\lambda}^{\mathrm{T}} H.$$

By taking transpose, we have:

$$\left(\underline{\hat{x}} - \underline{x}\right)(E^{-1})^T = \underline{\lambda} H^T$$

By using symmetry:

$$\left(\underline{\hat{x}} - \underline{x}\right)(E^{-1})^T = \underline{\lambda} H^T.$$

$$\underline{x} = \underline{\hat{x}} - \underline{\lambda} E H^T. \tag{6}$$

From measurement function, we will have:

$$\underline{z} = H\underline{x} = H(\underline{\hat{x}} - \underline{\lambda} E H^T).$$

Or:

$$\underline{\lambda} = \frac{(H\underline{\hat{x}} - \underline{z})}{HEH^T}. \tag{7}$$

By substituting (7) formula into (6) equation, we will have:

$$\underline{x} = \underline{\hat{x}} + EH^T\left[HEH^T\right]^{-1}(\underline{z} - H\underline{\hat{x}}). \tag{8}$$

This formula, will climaxing the PDF and also the optimized estimation of the system; also, if we enter (V) (measurement noise) in the (4) formula, then the state estimate will be:

$$\underline{\hat{x}}' = \underline{\hat{x}} + EH^T\left[HEH^T + R\right]^{-1}(\underline{z} - H\underline{\hat{x}}). \tag{9}$$

Where:

$$R = \overline{\left(\hat{\underline{V}} - \underline{V}\right)\left(\hat{\underline{V}} - \underline{V}\right)^T}. \quad (10)$$

For calculating new covariance matrix by using of (9) formula we will have:

$$E = \overline{\underline{e}\,\underline{e}^T}.$$

So,

$$E' = E - EH^T (H^T + R)^{-1} HE. \quad (11)$$

By doing some oversimplification on (9) and (11), we would have new factor k as the gain:

$$k = EH^T \left[HEH^T + R \right]^{-1}. \quad (12)$$

Make some lessening on (9) and (11):

$$\underline{\hat{x}}' = \underline{\hat{x}} + k(\underline{z} - H\underline{\hat{x}}) \quad (13)$$

$$E' = E - kHE. \quad (14)$$

So as stated former, we will have:

$$\dot{\underline{x}} = \underline{f}\left(\underline{x}, \underline{u}, \underline{p}\right) + \underline{w}$$

Optimized estimation for $\dot{\underline{x}}$:

$$\hat{\dot{\underline{x}}} = \underline{f}\left(\underline{\hat{x}}, \underline{u}, \underline{p}\right). \quad (15)$$

By hypothesis of process noise to be zero-mean the above formula can stated as:

$$\hat{\dot{\underline{x}}} = B\underline{\hat{x}}. \quad (16)$$

B is matrix of coefficients:

$$B = \frac{\partial \underline{f}\left(\underline{\hat{x}}, \underline{u}, \underline{p}\right)}{\partial \underline{x}}. \quad (17)$$

State estimation error can be measured as:

$$\dot{\underline{e}} = \hat{\dot{\underline{x}}} - \dot{\underline{x}} = B\underline{\hat{x}} - (B\underline{x} + \underline{w}).$$

So, the time derivation of the error covariance matrix is:

$$E = \frac{d}{dt}\left(\overline{\underline{e}\,\underline{e}^T}\right) = \overline{\dot{\underline{e}}\,\underline{e}^T} + \overline{\underline{e}\,\dot{\underline{e}}^T}.$$

In conclusion:

$$\dot{E} = BE + EB^T + (\overline{\underline{w}\underline{w}^T}).$$

The process noise covariance matrix is:

$$Q = \overline{\underline{w}\underline{w}^T}. \quad (18)$$

Time rate of variation of error covariance matrix can be introduced as:

$$\dot{E} = BE + EB^T + Q. \quad (19)$$

The above formula (19) is controlling equation in the shifting of covariance matrix together with the dimension function over time. By employing of (13), (14), (15) and (19) any kind of estimation problems can be expressed. Equation (13) will authenticate the optimized estimation, $\underline{\hat{x}'}$ of the state parameters at definite time. This will do by climaxing the model PDF by use of preceding estimation of the system $\underline{\hat{x}}$, and also the current measured output $\underline{z}$. By use of the (14) formula, we can find out error covariance matrix. (15) and (19) equations will update the error covariance and state matrices, respectively. Such norms are used to optimize the model and procedure estimations.

An essential factor in being able to model one dynamical system is to being able to model that system through sequence of differential formulas. To do this, various identifications and aspects of the specific system should be acknowledged, to be able to do accurate estimation and prediction. But in our experiment (cloud computing technology), we do not knowing anything about key criteria's and even layers of such network. So, we only define our algorithm.

Our proposed algorithm is based on Kalman filtering and the aim of this algorithm is to provide an intelligence estimator for software and application suggestion to the users. From section 4 explanations, we remember that Kalman filtering survey on past conditions and present state of the system in order to extract a mathematical formula between different variables of the system. So, for cloud computing by giving backgrounds information of the users, about which software that they used and amount of their processes and data, as an input to Kalman filter, and also by giving their present demands and interesting to the system, we can suggest more related software's and applications to them. And as a result we can persuade them more about cloud powers and also earn more monies by renting them more new software's.

The necessity of existing such intelligence suggesting system is, because all the users do not has enough knowledge and expertise about different services and software's and also most of the users do not capable to do fair comparison between different services and applications that provide by different service providers, or accidentally, when they search for better software or applications they may miss the best service provider. So, in these days, because of existence of different service providers and lots of different services we need an intelligence system that enables us in choosing the best applications. Our proposed system used Kalman filtering as an intelligence part of the system to suggest the users the best and reliable software's according to their needs. It surveys on the past usages logs of the users and extract a pattern for keen and eagerness of the users in facing with different software's and services. The system will update the pattern by more sampling from the user behaviors in the execution environment.

5. Conclusion

Changes in the costs of IT services can affect significantly in performances of organizations and industries. In recent decades this change is made by cloud computing, it delivers different processing and storage capacities only by nominal charges. According to authors opinion, the most prominent obstacle in migrating from traditional systems into cloud computing is that, the owners of companies and industries doesn't know enough

about cloud computing and its services. They are still doubtful about powers and abilities of this technology. They think that inside of cloud environment they can't used their particular software, or the main application which they used extensively in their systems, does not exist in cloud computing. In this paper, we introduce new intelligence algorithm for suggesting more applicable and up to date software's to the users based on their previous usages and their present needs. This intelligent algorithm will use Kalman filtering as a smart estimator to suggest better software and applications for persuading the user needs. This estimator will search in users log information, in order to extract a pattern about user behaviors in face of new software and applications, it searches about interests of user and most used software's in their system. After that, this algorithm will suggest better software and applications to the users based on their previous usages and their present needs. By employing this algorithm in cloud computing, we can improve the intelligence of the network and also suggest our new services and applications to the users and earn more money.

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