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Chapter 2

Measurement of the Communication Possibility of Service Requests for Multiservers in Parallel Connection in Cloud Computing Systems

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Additional information is available at the end of the chapter

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Abstract

Newly, growing amount of data-demanding applications arrangement with continuous fluctuating data substances, have been investigated by many researchers recently. In these applications, the underlying data management system must support new types of the space-time changing that indicates to the paths of the cloud computing system (CCS). The time-space changing causes change in the dimension of data and, consequently, in the CCS. One of the solutions regarding this case is suggesting an integrated cloud computing system (ICCS). In this effort, we introduce a new ICCS, based on fractional formal operators, taking into account the symmetrical delay in it. This model is useful for higher dimensional data, moving data, and chaos data. Moreover, we employ a fractional differential method to discover the paths (outcomes) of the system by minimizing the cost function. The proposed system delivers a sequence of paths that converge to the optimal path. The theoretical technique is supported by the applications.

Keywords: fractional calculus, fractional formal, fractional dynamical system, cloud computing

1. Introduction

Cloud computing system (CCS) is the technique industries and organizations use to do their trades. In that dynamically accessible and visualized resources are delivered as a service over the Internet. This system constructs a new type of chance for organizations. CCS is developing as one of the most important factors for the business industry: it can convert the traditional industrial business prototypical, aid it to support product improvement with business

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approach, and construct able manufacturing networks that reassure effective cooperation. Various categories of CCS adoptions in the industrial area have been studied with direct adoption utilizing technologies and manufacturing. CCS has been in some of the important parts of developed Information Technology (IT). In CCS, entirety is preserved as a service such as platform, infrastructure, and software. These services express a layered system assembly for CCS. There are different kinds of CCS: private (single-tenant setting), public (idea of sharing), hybrid (mixed internal and external clouds), and community (multitenant setting shared by numerous organizations) clouds. The integrated CCS may refer to one of them. These cloud services are permeating as a particular plug of access. Various types of placement simulations outfit various states. The main study in CCS is to minimize the cost of the cloud, keeping the good and stable quality with less time [1–5].

The cost assistance of accepting clouds in a characteristic developed prize can be manifold. The savings acquired from the exclusion of selected functions that were necessary in customary Information Technology (IT) can be important. With cloud paths (solutions), some applications may be distributed with the company's Information Technology (IT) region along CCS technologies. Thus, the Information Technology (IT) control can create the modification that occurs seamlessly to reduce the cost. scheming is significant for creating schedules and controlling decisions. Cost itemization analysis, finding the developed movement, adaptive cost scheming, clearness of feeding, and billings are imperative concerns. Virtualization states to the idea of rational resources from their fundamental physical features in order to progress and enhance flexibility and decrease cost. Integrated cloud computing system (ICCS) platform paths show a significant character in converting prize systems, funding to cost reduction [1, 6–9].

A diversity of smart phones and handheld computers prepared with a GPS and further sensory devices previously exists for clients. A collective sensor that can discover and report separate motivations plots a sequence of data arguments in a higher dimensional data (HDD) time-space (one time dimension and n data dimensions). Consequently, to improve a practical database application, one requires to examine the following categories: the nature, the presentation, the store, the management, the environment, and the support of data. The challenging phase of HDD organization is considerably more obvious in training, particularly when inadequate recognition, such as intervals, reduces the frequency of accelerators and GPS interval. The HDD is adopted to deal with partial capacity, highly dynamic clients, and partial scalability to larger data sets. Recently, numerous application path simulations have been presented. These models suggested the point-time and location of data in the information space. If the item transfers farther, it reports its new position and changes the inform threshold for the next apprise [10–14].

Fractional calculus is a field of various studies with applications not only in mathematics but also in other sciences, engineering, economics, and social presentations. It agrees with differential and integral operators, including random powers: real and complex [15, 16]. The essential benefit of the constructing technique of fractional differential equations (ordinary and partial) in methodical forming is their nonlocal property. It is standard that the normal derivative is a local, linear operator, while the derivative of arbitrary order is nonlocal and

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nonlinear. This proceeds that the successive recognized by a system is not only susceptible upon its present proper but also reliable upon all of its ancient formals. This additionally defined why fractional calculus has industrialized more and more extensively in mechanical, engineering, information theory, and industrial areas. Fractional calculus is received in information theory [17].

In this study, we impose a new ICCS, based on fractional formal operators, taking into account the symmetrical delay in it. This model is useful for higher dimensional data, moving data, and chaos data. Moreover, we employ a fractional differential method to discover the paths (outcomes) of the system by minimizing the cost function. The proposed system delivers a sequence of paths that converge to the optimal path. The theoretical technique is supported by applications.

2. Seeking

In this section, we illustrate the algorithm that we use to minimize the cost of the Information Technology (IT) in the cloud. Here, we suppose that the agents have nonhomogeneous options and pay the cost in order to translate from a position to another one in the state space $X \in [0, 1]$, where X is the level of utilizing Information Technology (IT) of the CCS. All agents have the common cost function Φ to have the request χ. Every user applies his optimal decision on the utility of the CCS by minimizing the cost function. Thus, the issue for each user is the minimized control function $U(t,X)$.

The method is based on a new fractional differential transform (FDT). It is well known that this method has solved many problems not only in mathematics but also in physics and engineering (see [18–20]). We need the following fractional formal: the Riemann-Liouville operators are defined by the formal

$$D_s^{\nu}\wp(t) = \frac{d}{ds}\int_0^t \frac{(t-\varsigma)^{-\nu}}{\Gamma(1-\nu)}\wp(\varsigma)d\varsigma, \tag{1}$$

which coincides with the fractional integral operator

$$I_a^{\nu}\wp(t) = \int_a^t \frac{(t-\varsigma)^{\nu-1}}{\Gamma(\nu)}\wp(\varsigma)d\varsigma, \tag{2}$$

such that $\nu \in (0, 1)$ and $\wp$ is a continuous function on $J = [0, T], T < \infty$. We use the notation $I_0^{\nu}\wp(t) = I^{\nu}\wp(t)$.

In this effort, we deal with the FCCS of the form minimize:

$$\frac{\partial}{\partial t}U(t,\chi) = \Phi(t,\chi(\tau_0 t), D^{\nu}\chi(\tau_1 t), D^{2\nu}\chi(\tau_2 t),\ldots,D^{n\nu}\chi(\tau_n t), I^{\nu}\phi(t)),$$
$$\text{Initial condition}: \quad (\chi_i(\tilde{t}) = y_i(\tilde{t})), \forall i = 1,\ldots,n, \tilde{t} < t \in J, \tag{3}$$

where

$$\phi(t) := \phi(t,\varsigma,\chi(\rho_0\varsigma), D^{\nu}\chi(\rho_1\varsigma), D^{2\nu}\chi(\rho_2\varsigma),\ldots,D^{n\nu}\chi(\rho_n\varsigma)), \quad t \geq 0, \varsigma \leq t, \tag{4}$$

is the objective function (we suggested integrable function in order to make the minimization of the cost function), $\chi = (\chi_1,\ldots,\chi_n)^T$ is the request function for $n-$ agent in the cloud, and Φ is the cost function of the cloud system. We aim for a given company a degree of CCS in its present operation, $X(\tilde{t}) = \chi(\tilde{t}) = y(\tilde{t}) \in [0,1]$. Therefore, $\chi = 0$ is represented to a company that is not yet translated to advanced position. Therefore, the dynamic of the company's position develops depending on Eq. (3). We proposed the system (3) in terms of the fractional formal operator to include the delay in the CCS. The objective function deals with optimal state of the usage of the Information Technology (IT) in the cloud system depending on the cost.

CCS influences notions from utility computing to deliver elements the services used. Such elements are at the fundamental of the public cloud paid-per-use representations. Moreover, measured services are a critical part of the reactive loop in autonomic computing, agreeing services to scale on-demand and to achieve automatic disappointment recovery. Also, CCS delivers the tools and technologies to measure data/compute demanding parallel applications with much more reasonable prices compared to traditional computing system techniques. Our aim is to minimize (3). Therefore, we proceed to introduce a solution for the system (3). In this section, we introduce a numerical solution for Eq. (3) by using a new technique based on the fractional formal concept. The CCS (3) is equivalent to the problem

$$\Phi(t,\chi(\tau_0 t), D^{\nu}\chi(\tau_1 t), D^{2\nu}\chi(\tau_2 t),\ldots,D^{n\nu}\chi(\tau_n t), I^{\nu}\phi(t)) = 0. \tag{5}$$

An arbitrary function $\chi(t)$ can be formulated in terms of fractional Taylor series (see [21]) about the point t_0

$$\begin{aligned}\chi(t) &= \sum_{\kappa=0}^{\infty}\frac{(t-t_0)^{\kappa\nu}}{(\nu\kappa)!}[D^{\kappa\nu}\chi(t)]_{t=t_0} \\ &:= \sum_{\kappa=0}^{\infty}(t-t_0)^{\kappa\nu}\Lambda_{\nu}(\kappa),\end{aligned} \tag{6}$$

where $(\nu\kappa)! = \Gamma(\nu\kappa + 1)$, $D^{\kappa\nu}\chi(t) = (D^{\nu}...D^{\nu})_{\kappa - times}\chi(t)$ and

$$\Lambda_{\nu}(\kappa) = \frac{[D^{\nu\kappa}\chi(t)]_{t=t_0}}{(\nu\kappa)!}, \nu \in (0,1], \tag{7}$$

is FDT of $\chi(t)$.

Equation (3) represents various types of fractional and integer control systems such as the Hamilton Jacobi Bellman equation, Euler equation, Fokker-Planck equation, and Hybrid systems. The major important advantage of FCCS is their nonlocal property. The CCS (integer case) is a local, linear system, while the FCCS is a nonlocal, nonlinear system. Therefore, the subsequent formal of a system is simulated by its current and previous positions (this asset is beneficial in CC). Thus, fractional formal has developed progressively into practical and manufacturing areas. A virtuous consequence is attained in FCCS by minimizing the time of utility function ($\chi(t)$) and the cost function (Φ) of the cloud. The change in the quality of the cloud may calculate the difference in the promised quality (Q_p) and the recent quality (Q_r)

$$\Delta Q = Q_p - Q_r. \tag{8}$$

We accept that cost, request, profit, and income functions are continuous and different with respect to time. The request is dwindling in the cost for the service and growing in quality delivered. The CCS is expected to determine its request for Information Technology (IT) services for any assumed value and quality. The base flat of quality essential to function the system is zero, and the base flat of request is at zero quality and cost. The request of the internal customer is such that at a satisfactorily high cost, there will be no feeding the services. Therefore, the quantity of the CCS can be expended as a function of the amount and quality.

We have the following properties:

Proposition 2.1. Suppose that $\Theta(\kappa)$ and $\Lambda(\kappa)$ are FDTs of $\theta(t)$ and $\chi(t)$, respectively, then

1. If $\theta(t) = \chi(\rho t)$, then $\Theta_{\nu}(\kappa) = \rho^{\kappa}\Lambda_{\nu}(\kappa)$.

2. If $\theta(t) = D^{m\nu}\chi(\rho t)$, then $\Theta_{\nu}(\kappa) = \frac{(\nu(m+\kappa))!}{(\nu\kappa)!}\rho^{m+\kappa}\Lambda_{\nu}(m+\kappa), m \in \mathbb{N}$.

3. If $\theta(t) = I^{\nu}\chi(\rho t)$, then $\Theta_{\nu}(\kappa) = \frac{(\nu(\kappa-1))!}{(\nu\kappa)!}\rho^{\kappa-1}\Lambda_{\nu}(\kappa-1)$.

for $\rho \in (0,1)$

Proof: From Eq. (7), we have

$$D^{\nu\kappa}\theta(t) = D^{\nu\kappa}\chi(\rho t) = \rho^{\kappa}D^{\nu\kappa}\chi(\rho t); \tag{9}$$

therefore, we get

$$D^{\nu\kappa}\theta(t)|_{t=t_0} = \rho^{\kappa} D^{\nu\kappa}\chi(\rho t)|_{t=t_0} = \rho^{\kappa}(\nu\kappa)!\Lambda_{\nu}(\kappa); \tag{10}$$

thus, we obtain

$$\Theta_{\nu}(\kappa) = \frac{[D^{\nu\kappa}\theta(t)]_{t=t_0}}{(\nu\kappa)!} = \rho^{\kappa}\Lambda_{\nu}(\kappa). \tag{11}$$

This proves the first part. By using the first part, we conclude that

$$D^{\nu\kappa}\theta(t)|_{t=t_0} = D^{\nu\kappa}(D^{m\nu}\chi(\rho t))|_{t=t_0} = D^{\nu(m+\kappa)}\chi(\rho t))|_{t=t_0}, \text{ and} \tag{12}$$

consequently, we receive

$$D^{\nu\kappa}\theta(t)|_{t=t_0} = (\nu(m+\kappa))!\rho^{m+\kappa}\Lambda_{\nu}(m+\kappa). \tag{13}$$

Hence, we arrive at the part two,

$$\Theta_{\nu}(\kappa) = \frac{(\nu(m+\kappa))!}{(\nu\kappa)!}\rho^{m+\kappa}\Lambda_{\nu}(m+\kappa). \tag{14}$$

Finally, to prove the last part,

$$\begin{aligned} D^{\nu\kappa}\theta(t)|_{t=t_0} &= D^{\nu\kappa}(I^{\nu}\chi(\rho t))|_{t=t_0} = D^{\nu(\kappa-1)}\chi(\rho t))|_{t=t_0} \\ &= \frac{(\nu(\kappa-1))!}{(\nu\kappa)!}\rho^{\kappa-1}\Lambda_{\nu}(\kappa-1) \\ &= \Theta_{\nu}(\kappa). \end{aligned} \tag{15}$$

This completes the proof.

Proposition 2.2. Consider that $\Theta_{\nu}(\kappa)$, $\Lambda_{\nu}(\kappa)$ and $\Omega_{\nu}(\kappa)$ are the FDT of the functions $\theta(t)$, $\chi(t)$ and $\omega(t)$, respectively, then

1. If $\theta(t) = \chi(t) \pm \omega(t)$, then $\Theta_{\nu}(\kappa) = \Lambda_{\nu}(\kappa) \pm \Omega_{\nu}(\kappa)$.
2. If $\theta(t) = \delta\chi(t)$, then $\Theta_{\nu}(\kappa) = \delta\Lambda_{\nu}(\kappa)$.

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Proof: By applying Eq. (7) in the first part, we obtain

$$\begin{aligned}\Theta_\nu(\kappa) &= \frac{[D^{\nu\kappa}\theta(t)]_{t=t_0}}{(\nu\kappa)!} = \frac{[D^{\nu\kappa}(\chi(t)\pm\omega(t))]_{t=t_0}}{(\nu\kappa)!} \\ &= \frac{[D^{\nu\kappa}\chi(t)]_{t=t_0}}{(\nu\kappa)!} \pm \frac{[D^{\nu\kappa}\omega(t)]_{t=t_0}}{(\nu\kappa)!} \\ &= \Lambda_\nu(\kappa)\pm\Omega_\nu(\kappa).\end{aligned} \tag{16}$$

Similarly, for the second part, we have

$$\Theta_\nu(\kappa) = \frac{[D^{\nu\kappa}\theta(t)]_{t=t_0}}{(\nu\kappa)!} = \frac{[D^{\nu\kappa}\delta\chi(t)]_{t=t_0}}{(\nu\kappa)!} = \delta\Lambda_\nu(\kappa). \tag{17}$$

The procedure of CCS as a contribution to the Information Technology (IT) section can be observed as a resource chain. The Information Technology (IT) section improves the cost of the external part of CCS and deliveries such improved services to the inner consuming parts. Therefore, there are correspondences and there are parts of differences between the traditional resource chain techniques [22] and the suggested one that introduced in this effort (see **Figure 1**). The proposed CCS model shows dual relegation under the incomes because the Information Technology (IT) section scripts the cost of the incoming cloud system. Nevertheless, the cost reports double relegation by posing Information Technology (IT) services at no control. Moreover, apart from the differing reasons of the numerous objects, information irregularity is an additional problem in resource chain coordination, which causes the bullwhip result.

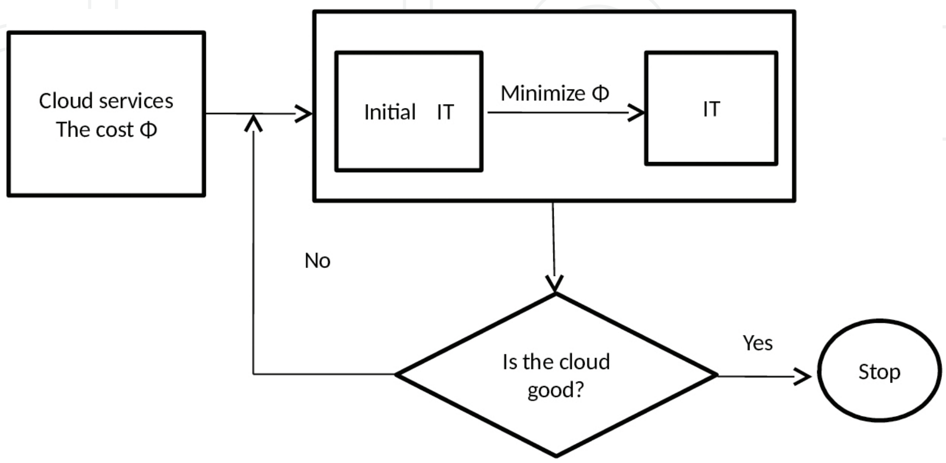

Figure 1. The proposed method of FCCS.

The proposed FCCS model theoretically looks like a resource chain construction. However, there are significant parts of the changes. We contain the stability and convergence of the system to the optimal solution by using the FDT, which implies the authority to inflict the operating organizational arrangement. The optimizing owns benefit discretely, or the models optimize the cost. The ICCS model, in the recent studies in Information Technology (IT) services, does not meet the resource problems for physical properties such as stock-outs or excess record. Moreover, we take into account the quality of Information Technology (IT) services under the ICCS model. Value development under CCS is expected to formulate a stationary price component and a quality-related minimal cost component. This is the new ICCS model that fixed the cost organization and increased the variable labor cost. Under this seeking, higher internal Information Technology (IT) value stages need a suitably high level of value from the ICCS because the price of a considerable value development is gross.

3. Applications

In this section, we illustrate some prototype applications to explain the accuracy of the FCCS.

3.1. System 1

Assume the following cost function:

$$\begin{aligned} \Phi(t,\chi) &= D^{\nu}\chi(t) - \chi(t) \\ &= 0 \\ &\text{Initial condition}: \chi(0) = 1, \chi'(0) = 1. \end{aligned} \tag{18}$$

In view of Proposition 2.1, we obtain the fractional differential transform type of Eq. (18) as follows:

$$\begin{aligned} &\frac{(\nu(1+\kappa))!}{(\nu\kappa)!}\Lambda_{\nu}(1+\kappa) - \Lambda_{\nu}(\kappa) = 0 \\ &\text{Initial condition}: \Lambda_{\nu}(0) = \Lambda_{\nu}(1) = 1, \end{aligned} \tag{19}$$

where Λ_{ν} is the fractional differential transform of $\chi(t)$, which is read in Eq. (7). By utilizing Eq. (19), we obtain the following system:

$$\begin{aligned}
&\frac{(2\nu)!}{\nu!}\Lambda_\nu(2)-1=0,\\
&\frac{(3\nu)!}{(2\nu)!}\Lambda_\nu(3)-\Lambda_\nu(2)=0,\\
&\frac{(4\nu)!}{(3\nu)!}\Lambda_\nu(4)-\Lambda_\nu(3)=0,\\
&\frac{(5\nu)!}{(4\nu)!}\Lambda_\nu(5)-\Lambda_\nu(4)=0.
\end{aligned} \tag{20}$$

Solving the above system, we obtain the following outcome:

$$\Lambda_\nu(t)\approx 1+t+\frac{1}{\Gamma(2\nu+1)}t^2+\frac{1}{\Gamma(3\nu+1)}t^3+\frac{1}{\Gamma(4\nu+1)}t^4+\frac{1}{\Gamma(5\nu+1)}t^5. \tag{21}$$

In general, we attain to the solution

$$\Lambda_\nu(t)\approx E_{\nu,1}(t), \tag{22}$$

where $E_{\nu,1}$ is the Mittag-Leffler function defined by the series:

$$E_{\nu,\mu}(t)=\sum_{\kappa=0}^{\infty}\frac{t^\kappa}{\Gamma(\nu\kappa+\mu)}. \tag{23}$$

3.2. System 2

Assume the following cost function:

$$\begin{aligned}
&\frac{(\nu(1+\kappa))!}{(\nu\kappa)!}\Lambda_\nu(1+\kappa)-\frac{1}{2}\Lambda_\nu(\kappa)-\frac{1}{2}\frac{(\nu(\kappa-1))!}{(\nu\kappa)!}\Lambda_\nu(\kappa-1)=0\\
&\text{Initial condition}:\Lambda_\nu(0)=\Lambda_\nu(1)=\frac{1}{2},
\end{aligned} \tag{24}$$

In view of Proposition 2.1, we get the fractional differential transform of Eq. (24) as follows:

$$\begin{aligned}&\frac{(\nu(1+\kappa))!}{(\nu\kappa)!}\Lambda_\nu(1+\kappa)-\frac{1}{2}\Lambda_\nu(\kappa)-\frac{1}{2}\frac{(\nu(\kappa-1))!}{(\nu\kappa)!}\Lambda_\nu(\kappa-1)=0\\&\text{Initial condition}:\Lambda_\nu(0)=\Lambda_\nu(1)=\frac{1}{2},\end{aligned}\tag{25}$$

where Λ_ν is the fractional differential transform of $\chi(t)$, which is given in Eq. (7). By utilizing Eq. (25), we obtain the following system:

$$\begin{aligned}&\frac{(2\nu)!}{\nu!}\Lambda_\nu(2)-\frac{1}{2}\Lambda_\nu(1)-\frac{1}{2}\frac{1}{\nu!}\Lambda_\nu(0)=0,\\&\frac{(3\nu)!}{(2\nu)!}\Lambda_\nu(3)-\frac{1}{2}\Lambda_\nu(2)-\frac{1}{2}\frac{\nu!}{(2\nu)!}\Lambda_\nu(1)=0,\\&\frac{(4\nu)!}{(3\nu)!}\Lambda_\nu(4)-\frac{1}{2}\Lambda_\nu(3)-\frac{1}{2}\frac{(2\nu)!}{(3\nu)!}\Lambda_\nu(2)=0,\\&\frac{(5\nu)!}{(4\nu)!}\Lambda_\nu(5)-\frac{1}{2}\Lambda_\nu(4)-\frac{1}{2}\frac{(3\nu)!}{(4\nu)!}\Lambda_\nu(3)=0.\end{aligned}\tag{26}$$

Solving the above system, we obtain the following outcome for $\nu \in (0,1]$:

$$\Lambda_\nu(t)\approx\frac{1}{2}\left[1+t+\frac{1}{\Gamma(2\nu+1)}t^2+\frac{1}{\Gamma(3\nu+1)}t^3+\frac{1}{\Gamma(4\nu+1)}t^4+\frac{1}{\Gamma(5\nu+1)}t^5\right].\tag{27}$$

In general, we attain the solution

$$\Lambda_\nu(t)\approx\frac{1}{2}E_{\nu,1}(t).\tag{28}$$

3.3. System 3

Suppose the following cost function:

$$\begin{aligned}\Phi(t,\chi)\;&=D^{2\nu}\chi(t)+D^{\nu}\chi(t)-\chi(t)+I^{\nu}\chi(t)\\&=0\\&\text{Initial condition}:\chi(0)=1,\chi'(0)=-1.\end{aligned}\tag{29}$$

In view of Proposition 2.1, we have the fractional differential transform of Eq. (29) as follows:

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$$\frac{(\nu(2+\kappa))!}{(\nu\kappa)!}\Lambda_\nu(2+\kappa)+\frac{(\nu(1+\kappa))!}{(\nu\kappa)!}\Lambda_\nu(1+\kappa)-\Lambda_\nu(\kappa)+\frac{(\nu(\kappa-1))!}{(\nu\kappa)!}\Lambda_\nu(\kappa-1)=0$$
$$\text{Initial condition}: \Lambda_\nu(0)=1, \Lambda_\nu(1)=-1, \tag{30}$$

where Λ_ν is the fractional differential transform of $\chi(t)$, which is given in Eq. (7). By utilizing Eq. (25), we obtain the following system:

$$\begin{aligned}
&\frac{(3\nu)!}{\nu!}\Lambda_\nu(3)+\frac{(2\nu)!}{\nu!}\Lambda_\nu(2)-\Lambda_\nu(1)+\frac{1}{\nu!}\Lambda_\nu(0)=0,\\
&\frac{(4\nu)!}{(2\nu)!}\Lambda_\nu(4)+\frac{(3\nu)!}{(2\nu)!}\Lambda_\nu(3)-\Lambda_\nu(2)+\frac{\nu!}{(2\nu)!}\Lambda_\nu(1)=0,\\
&\frac{(5\nu)!}{(3\nu)!}\Lambda_\nu(5)+\frac{(4\nu)!}{(3\nu)!}\Lambda_\nu(4)-\Lambda_\nu(3)+\frac{(2\nu)!}{(3\nu)!}\Lambda_\nu(2)=0,\\
&\frac{(6\nu)!}{(4\nu)!}\Lambda_\nu(6)+\frac{(5\nu)!}{(4\nu)!}\Lambda_\nu(5)-\Lambda_\nu(4)+\frac{(3\nu)!}{(4\nu)!}\Lambda_\nu(3)=0.
\end{aligned} \tag{31}$$

Solving the above system, we get the following outcome for $\nu \in (0,1)$:

$$\Lambda_\nu(t)\approx \left[1-t+\frac{1}{\Gamma(2\nu+1)}t^2-\frac{1}{\Gamma(3\nu+1)}t^3+\frac{1}{\Gamma(4\nu+1)}t^4-\frac{1}{\Gamma(5\nu+1)}t^5\right]. \tag{32}$$

In general, we attain the solution

$$\Lambda_\nu(t)\approx E_{\nu,1}(-t). \tag{33}$$

From above examples, we conclude that the solution of a fractional system, taking the formal (3), has the following general formula:

$$\chi(t)=(\chi(0))E_\nu(\lambda t^\nu). \tag{34}$$

4. Results and discussion

For the extra model improvement, it is essential to form some model considerations that come across the demand of applicability and to study major information and price styles.

- Every worker has a computer linked to the internet. Therefore, the price of acquiring and the price of the network (switches, routers, and network security) are not recognized to the CCS.
- The effort of the analysis deceits in the price evaluation of different CCS and service structures. As a consequence, the price for servers is reflected in the mathematical model.
- The price (cost) construction and empathy of cost styles have been initially formed in the source of the CCS.

The cost function is suggested and studied by many researchers in various methods [23–25]. For example, the authors used the form

$$\text{Total Cost} = \text{Expenditure of time} = \text{Total time* The cost per hour.} \tag{35}$$

Most of these methods do not request the quality of the CCS. Our technique requested the quality and integrated it. **Table 1** shows the experimental results, the proposed method, and comparison with the usual method for calculating the cost of CCS. It is well known that E_ν satisfies the following asymptotic behavior (see [26]; Theorem 1):

$$E_\nu(t) \sim \frac{1}{\nu} e^{t^{1/\nu}}, \quad \nu \neq 0. \tag{36}$$

Hence, we have the solution

$$\chi(t) \approx \frac{\lambda}{\nu} e^{t(\Delta Q)^{1/\nu}}, \tag{37}$$

where ΔQ is the difference in the quality of the CCS, which is suggested in $[0, 1]$ and $\lambda = \chi(0)$ is the initial cost of the cloud. In this effort, based on the above discussion, we impose the following formal of the total cost

$$\text{Total Cost} = \text{Total time* The cost per hour} * \chi(t), \tag{38}$$

where $\chi(t)$ is given in Eq. (37).

Obviously, the quality of the cloud plays an important role in the cost. Increasing the quality leads to higher cost. At the level $\Delta Q = \nu = 0.1$ (high quality, low fractional value), we see that the cost is minimized to the quarter, while the level $\Delta Q = \nu = 0.5$ (the quality is less and higher fractional power), we obtain no much minimization for the cost. Moreover, in the case $\Delta Q = 0.1, = \nu = 0.75$, we have a minimum up to the half. Hence, we conclude that the fractional

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power of the cloud system also plays an important role to minimize the cost. The fractional power of the system may be realized as the rate of the gain of the FCCS.

Time	[23–25]	FCCS	[Eq. (38)]			
		$\Delta Q = \nu = 0.1$	$\Delta Q = \nu = 0.25$	$\Delta Q = \nu = 0.4$	$\Delta Q = \nu = 0.5$	$\Delta Q = 0.1, \nu = 0.75$
10	\$112.0	\$246.6	\$560	\$896	\$1131.1	\$896
12	\$134.4	\$295.68	\$672	\$1075.2	\$1357.44	\$1075.2
14	\$156.8	\$344.96	\$784	\$1254.4	\$1583.66	\$1254.4
16	\$179.2	\$394.24	\$896	\$1433.6	\$1809.92	\$1433.6
18	\$201.6	\$433.5	\$1008	\$1612.8	\$2036.16	\$1612.8
20	\$224.0	\$492.8	\$1120	\$1792	\$2262.4	\$1792

Table 1. The cost of FCCS with initial cost $= \$112$.

5. Conclusion

The cloud computing system moves the manner activities (business, economy, and industries) and deals with their plans. The cloud computing system uses a new method to improve the economy, industries, and businesses, that is, everything is supposed as a service, be a service you demand or a service you deliver. We employed the concept of fractional formal calculus to impose a mathematical model of the cloud computing system. This system is obligated to various factors such as the controller, the utility of the cloud, structure for the Information Technology (IT) unit, and the cost taking into account the gain of the producers. Although the model has created simplifying conditions, it yielded a selection of outcomes that enhance the literature and have management suggestions. Obviously, any concept that is essential for a dynamic system is restricted in its ability to internment the complexity of Information Technology (IT) control. The proposed system may be viewed as a hybrid system, integrated system, as well as a perturbed system. It included various types of well-known systems (see [22, 27]). Also, the suggested system is addressed with huge number of data (time and space). Our goal was to introduce a method to minimize the cost function of the cloud. The anticipated framework is comprehensive in that the coverage contains the conceptual model, quantitative computation, logical representation, straddling both the theory and the applications of the problem. The results in **Table 1** show the performance of the method, by using fractional formal calculus. The obtainable method raises the quality of the system as well as minimizes the cost in the cloud computing system.

6. Competing interests

The author declares that there are no competing interests.

7. Author's contributions

There is no conflict of interests regarding the publication of this article.

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