The comparison of decentralized and centralized structure of network communication in different application fields

Zeyu Xi
Nankai University, Tianjin,700000, China
Corresponding author's e-mail: angela@cas-harbour.org

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Abstract. Since P2P is hypothetical expected to be a distributed network, in most cases the mode needs centralization through a set of servers. According to Vocal (2015), the P2P mode is an integral component in defining decentralized and centralized architectures with the two approaches offering varying services in the network infrastructure[12]. A single database plan makes the centralized system more manageable and highly reliable for enhanced consistency, rationality, and data soundness. A key feature of the centralized architecture is that index servers are usually utilized in preserving shared files directory as stowed across a network [7]. Such a design makes it easier to search into the centralized directory when seeking for the desired item. Due to the ability of the decentralized architecture to offer secure transactions and safer exchange of health information, such a system has proven essential in promoting telemedicine.

1. Introduction

Earlier, the model of gossip-oriented algorithms were hosted as a way of propagating data in large-scale disseminated frameworks. However, as their strength, efficiency, and simplicity began stirring immense recognition, the algorithms changed and started being used beyond data dissemination alone. Currently, the thought of gossip-based algorithms are being used extensively in an array of functionalities including data accumulation as well as overlay maintenance, a factor that has offered tremendous gossiping solutions in the network architectural landscape. With the advanced development of network technology, network transmission has assumed a dual though entirely varied research directions including a highly centralized client-server model and the P2P framework keenly based on the gossip algorithm. In the network space, decentralized and centralized architectures are integral in the P2P network infrastructure. Therefore, the purpose of this paper is to explore whether decentralized or centralized structure is more suitable for the development of future social structure in the process of future social structure development by comparing various aspects of data.

2. Decentralized and Centralized Architecture Based on the P2P Mode

It is crucial to understand that there is a form of a pseudo P2P mode linking the two architectures (decentralized and centralized), which is to select randomly one of the clients as the server. Ideally, according to Rahimian (2014), P2P is usually not considered a "pure" centralized architecture since the data exchange can be done even without a well-defined server framework[8]. Since P2P is hypothetical expected to be a distributed network, in most cases the mode needs centralization through a set of servers. According to Vocal (2015), the P2P mode is an integral component in defining decentralized and centralized architectures with the two approaches offering varying services in the network infrastructure[12]. However, while the decentralized architecture prioritizes robustness, the centralized one prioritizes more on efficiency.

3. Decentralized and Centralized Architecture

3.1 Decentralized Architecture

Decentralized structures are P2P systems whereby all the involved peers communicate proportionally in equal functionalities. In this system, each node in the P2P framework makes its own decision and the overall behavior of the architecture is gauged based on the cumulative decisions made by an individual P2P node. It is, however, important to note that no individual entity is present to either accept or answer to the request in decentralized architectures. According to Poonpakdee, Koiwanit, and Yuangyai (2017), all nodes in this infrastructure are peers to one another and no form of supremacy is exercised in such systems[7]. Again, decentralized infrastructure lacks a central server making the peers flexible when it comes to exchanging information between each other[7]. Decentralized architecture is popular for fault tolerance and extensibility in that it can permit any number of nodes to create files in a system while still going offline without any significant effect on the system.

3.2 Centralized Architecture

Centralized architecture is one of the most popular topologies in network systems. Unlike in the decentralized architecture whereby each client node is responsible for making its own decision, in centralized architecture, at least one node is directly linked to a central server[11]. The structure of a centralized architecture is normally identical to that of the client/server whereby all functionalities and information are centralized. In a network infrastructure, the server consolidates all the information received from clients by directly creating a common hub among them. Once connected, the clients share resources at their disposal through conveying and getting information to a server[7]. With the presence of a centralized architecture, it becomes easier to send relayed information to the system, a factor that is made convenient by the availability of single database design. A single database plan makes the centralized system more manageable and highly reliable for enhanced consistency, rationality, and data soundness. A key feature of the centralized architecture is that index servers are usually utilized in preserving shared files directory as stowed across a network[7]. Such a design makes it easier to search into the centralized directory when seeking for the desired item. However, this system tends to be highly susceptible to attacks and more likely to be subjected to legal disputes.

4. Decentralized and Centralized Architecture and Banking Systems

One key factor that defines effectiveness in banking institutions is the ability to store and access clients' information conveniently and safely, provision of operational security, and accruing passive income. Such an infrastructure would enhance banking operations including maintaining reliable database systems and the ability to communicate effectively across banking institutions situated in different locations. With the introduction of decentralized and centralized architectures, banking effectiveness can be achieved, although, to some extent, banking efficiency can be compromised.

4.1 Centralized Architecture and Banking Systems

Applying a centralized algorithm is one of the primary features that define banking frameworks in contemporary digital space. In the banking space, centralization architecture allows client information to be stored in a bank's central server rather than being kept away in a branch server. In addition, data is accurately availed, thus minimizing the risks of poor data utilization and loss. According to Sesame (2018), this form of an infrastructure fosters a CORE (Centralized Online Real-time Exchange) banking solution, a centralized system that integrates diverse banking functions and processes and connects such activities across banking branches[9]. A centralized banking system enables banks to facilitate customer on-boarding, accounts management, smooth payment processing, and improving on activities concerning loan disbursements. Other likely benefits of centralized infrastructure in banking institutions include easier data administration, cost friendliness during setup, and high chances of maintaining data integrity due to the presence of a

central data record. Centralized architecture plays an important role in the maintenance of banking functions since it enables such institutions to grow and expand their operations and profit base considerably.

Centralized infrastructure faces several serious limitations that compromise its effectiveness in banking circles. First, centralized databases are considerably reliant on network connectivity, which makes it inefficient during access to databases, especially during network lags. Such a factor can drag banking operations leading to customer dissatisfaction in addition to being time-consuming. According to De Filippi & McCarthy (2012), centralized databases can pose significant risks towards data loss[4]. Mainly, centralized infrastructure fails to utilize a fault-tolerant plan and can promote loss of banking data especially during hardware failure. The main limitation of centralized architecture in the banking space, however, is its inability to retrieve lost data. In most cases, when data is lost, the centralized system would push the firm to use manual means of data retrieval due to the system's incapacity to support data redundancy. Despite the architectural drawbacks of the centralized architecture, the system remains an important infrastructure in the banking space due to its immense contribution towards efficient banking modes and operations.

4.2 Decentralized Architecture and Banking Systems

Decentralized architecture presents another key factor in banking systems. As earlier described, a decentralized infrastructure uses an approach whereby data is stored on many locations rather than on a single location as is seen in centralized architectures. In the modern business landscape, decentralized algorithms are increasingly becoming popular due to their immense capacity in the application to real-world business scenarios. According to Hamal (2018), decentralization is fast becoming a crucial component in the development of cryptocurrencies and at the heart of the understanding of the mechanisms of decentralized networks [5]. Cryptocurrencies such as bitcoin and blockchain technology that has been advanced through the idea of decentralization have tremendously impacted the banking sector[1]. Compared to centralized architecture, areas where substantial differences have been found in the decentralized framework remains in safety and convenience. As previously noted in centralized architecture, such systems create safety concerns in banking circles due to susceptibility to safety especially through hackers and inconveniences during network breakdowns. A centralized server poses considerable risks when it comes to safe transactions, unlike the P2P digital currencies through decentralized architecture that guarantees more safety and expediency.

Decentralization architecture differs from the centralization system in several important ways as seen in fault tolerance, attack resistance, and collusion resistance. A decentralization architecture in the banking space is beneficial since it promotes fault tolerance, minimizes attack resistance, and averts collusion assistance[3]. A banking institution utilizing a decentralized architecture is more likely to benefit from fault tolerance. Fault tolerance would assist in cushioning a bank to accidental failures due to the reliance on numerous separate components that lacks in centralized systems[3]. Again, attack resistance is more achievable due to the lack of delicate central points that malicious hackers can exploit to attack a banking system[3]. Centralized systems usually lack this capacity due to central servers that once attacked spell severe implications towards the integrity bank data. Collusion resistance, However, discourages likely acts of exploiting the banking system for profit gain due to the presence of stringent protocols that shuts such loopholes[3]. However, the decentralization system also has several serious drawbacks. The communication framework in such an architecture is sophisticated and costly in decentralized processing configurations and faces numerous obstacles when it comes to coordinating those systems. Other possible limitations include complexity in managing numerous networks and machines and issues originating from technicalities of interfaces and validation procedures. Perhaps, the most serious disadvantage of decentralized architecture is that it is complicated to set up, update, and maintain, a factor that makes it challenging for the majority of institutions such as banks to utilize its framework.

5. Decentralized interaction and centralized management in both Real-time communications and military science, Taking the gossip algorithm for example

Real-time communication is one of the most crucial components of numerous interactive multimedia uses on internet platforms. As such, a gossip algorithm offers more benefits when conducting structural-oriented communication protocols and greater performances especially in currency storage and video-audio communication. According to Luk, Wong, Lea, and Ouyang (2013), in gossip protocols, a gossip-oriented super-node infrastructure presents a fundamental architecture crucial in conducting routing and queries during the relay of communication[6]. Recently, real-time systems have been migrated from centralized architectures to a decentralized one, a factor that shows the high efficiency of such infrastructures towards the realization of real-time services. The decentralization architecture as seen through real-time communication can be illustrated briefly through video audio communication scenarios as developed through advanced multimedia services. The decentralized structure supports high bandwidth that comes with real-time video and audio communication and mechanical resources such as that of the CPU. With a decentralized architecture, multi-video conferencing is highly achievable compared to earlier single-communication channels that relied on texts and hindered by numerous online-based communication restrictions.

Decentralization architecture greatly favors currency storage through technologies such as that of blockchain and cryptocurrency. The digital innovations have promoted currency storage technology, which has high scores on safety and reliability. Decentralized architecture's capacity to utilize nodes that do not rely on a single server makes it easier to customize it and integrate more adaptive and flexible network configurations that can support even advanced technologies such as ones of cryptocurrencies and blockchain.

Decentralized architecture is no longer confined in real-time communication and cryptocurrencies but is also becoming increasingly adopted in military agencies. A space firm such as NSA in conjunction with other corporations has expressed keen interest in exploring blockchain technology, a move that has raised hope of further advancement of the space industry[2]. The appropriateness of using decentralized architecture in infrastructures such as that of blockchain is made possible by the presence of numerous autonomous interconnecting nodes that possess high connectivity capacity, a factor that makes the blockchain framework sturdier.

6. Conclusion

To sum up, the decentralized model seems a better fit for the future advancement of the societal structure. The centralized and decentralized architecture differ not only in their physical characteristics but also in the way they are applied in different settings. As the paper reveals, the decentralized architecture is more versatile as seen in its capacity to be applied in numerous environments. The decentralized structure is instrumental in promoting cryptocurrencies, inspiring space science, improving currency storage, and enhancing the field of telemedicine. The centralized system seems to be compromised by its shallowness, an instance that makes it incapable of utilization in advanced large-scale networks. Ideally, this paper greatly contributes to the existing knowledge of gossip algorithms by offering a diversified view of architectural models (centralized and decentralized) and their application in modern-day financial, scientific, and healthcare settings. The knowledge derived can serve as a foundation for future studies and a resourceful reference point on gossip algorithm frameworks.

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