A Survey And Analysis Of Content Centric Networking Approaches

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Abstract: Content-centric networking (CCN) is a new network paradigm for information centric approach of modelling the Internet applications to meet the regard of contents with high interest from the peoples' perspectives. The internet service providers focus on utilizing the efficient CCN techniques to ensure content push to reduce redundant contents and increase advertisements to the users with high probability of reading them. This paper presents a survey of recent researches on CCN developed for improving the content availability to the users through accurate content access and delivery.

Index Terms: Content-centric networking, content push, social networks, internet applications, accurate content access.

1. INTRODUCTION
The rapid development of internet applications and social media networks like Twitter, Facebook, YouTube, etc. have transformed the volume and nature of human interaction data. The fast spread of information has led to data overload problem. The service providers recommend all types of contents to the users and push similar advertisements to millions of users without considering the users’ ability and browsing interests. In most cases, the delivered contents are useless and the network load is wasted; thus causing plummeting profits to the providers. To address this issue, content push is required to map the real-time users’ context and provide personalized recommendation to increase the probability of utilizing the delivered contents. The CCN has emerged as the new network architecture to encounter today’s requirement for content access and delivery [1]. CCN highlights content by creating it directly addressable and routable. Endpoints interconnect based on named data instead of IP addresses. CCN is regarded as the basic interchange of content request messages called Interests and content return messages called Content Objects. It is considered an information-centric networking (ICN) architecture. The goals of CCN are to provide a more safe, flexible and accessible network for secure content delivery on a enormous scale to a different set of users. Many concepts and techniques of CCN have been developed in the recent years for personalized recommendation especially in social networks [2]. This work highlights some of the prominent CCN research works and analyses their characteristics and performances.

2. CONTENT-CENTRIC NETWORKING TECHNIQUES
Many recent researches have been focused on CCN techniques. Some of the most prominent works are discussed in this section. Tang et al. [3] proposed a smart caching mechanism for improving the user experience in mobile multimedia in CCN. This proposed mechanism utilized edge Internet of Things equipment-assisted caching and location prediction method based on machine learning to detect user interests. The location prediction is done based on historical traces using recurrent neural network (RNN) model. This mechanism improves the cache hit ratio, optimize the data acquisition time, and improve the efficiency. The experimental results showed that the proposed scheme significantly reduced the data access time and improved the data acquisition efficiency. However, the access time is considerably higher than other real-time computing environments. Badshah et al. [4] presented an improved caching method Software Defined Network (SDN)-based Information Centric Networking. This caching method is based on joint optimization of multiple parameters like closeness centrality, betweenness centrality, path-stretch values and load balancing. Initially, the location and number of servers are determined using network topology information and then the controller installs the flow rule switches to forward the content requests. The controller computes the path optimally to provide the copy of requested content with high efficiency. The experimental results showed that this approach reduces traffic overhead and average end-to-end delay significantly. The only known limitation of this model is the slightly higher computation time.

Liu et al. [5] introduced an analytical framework for resolving the problem of content propagation among users in leveraging location-based social networks. This framework employed the dissemination of popular contents by modelling it into combinatorial optimization problem. Then the propagation effectiveness quantitative model is introduced to determine the distance between users and their interests. Then the simulated annealing algorithm is used to select the content holders to relay based on propagation effectiveness quantitative model. The experimental results are conducted Foursquare datasets showed that the proposed approach improved the effects by 25.4%–65.6%, and the faster contents dissemination by about 24.6%–57.8%. However, there are some malicious attackers in the network, and the content can be dropped and attacked by malicious attackers. Noh and Song [6] presented a progressive caching system for video streaming services over CCN. This system determines the caching range of video data to minimize the required peak bandwidth for each link. Initially, a metafile is created for the CCN to provide the cached chunk priority. Then, a caching information exchanging protocol is designed to deliver the caching information among CCN nodes. This system provided high content push with better video streaming services and reduced network stress. Feng et al. [7] presented a big data supported online learning approach for ensuring accurate content push for CCN social networks. This technique has modelled the content push issue as a contextual multi-armed bandit based Monte Carlo tree search problem. This problem is resolved using the big data approach based on low cost and energy efficiency features of CCN. The experimental results were conducted on an offline collected dataset showed that the accuracy and
convergence speed of the content push has been increased by the big data approach. However, the issue with this approach is that the energy efficiency is not quite improved. Arshad et al. [8] presented a hierarchical and flat-based hybrid naming scheme for improving the performance of CCN based IoT networks. This hybrid scheme incorporated both hierarchical and flat ICN naming schemes and also used a sub part in the content name to support both pull and push style communication. Experimental results showed that this approach has high success rate and number of transmissions of Interest packets, latency, number of hops and interest aggregation. But, the content access time is slightly higher. Augé et al. [9] presented MAP-Me, an anchor-less solution to manage micro-mobility of content producers in CCN. This model is a layer-2 agnostic approach operating at forwarding plane using leveraging planes. The reported results showed that MAP-Me optimally offloads the infrastructure from communications that are local with high accuracy. However, the computation time is higher than other approaches. Appel et al. [10] introduced Chimera which is a shared factorization model that can simultaneously account for graph links, content, and temporal analysis. This model extracts the latent semantic structure of the network in multidimensional form with the temporal continuity to model the content based on the users’ interests. This method also predicts the future communities from embedding over snapshots. Experiments also showed that the prediction is efficient in using embedding to predict near future communities. Wahid et al. [11] presented big data analytics for mitigating broadcast storm in Vehicular CCN. This approach developed a routing protocol that ensures the maximum content packet successfully receives at the consumer. It also enhances selection of forwarding node with content knowledge. The experiments conducted on RUFS provided that the proposed approach has better performance metrics. The only limitation is the performance trade-off in high average delay in a highway scenario. Jmal and Fourati [12] introduced OpenFlow architecture for managing content-centric-network using popularity caching strategy. This hybrid architecture utilized name-based routing and name-based caching and integrated SDN programmability and OpenFlow controller for optimized caching. The experimental results conducted using Mininet environment showed that the proposed strategy increased the cache hit ratio and maximized the caching efficiency. This strategy has the disadvantage of not supporting real traffic beyond a certain level. Wang et al. [13] introduced Crowdsourcing-based content-centric network model for improving the contentpush in information centric paradigms. This network model combines the mobile participants and a server cloud and designed a complementary social-enhanced communication strategy for improving the performance. Experimental results showed that the Crowdsourcing-based CCN improved the cache hit ratio by 30%. However, there are many open issues in reliability, security and task privacy that are needed to be addressed. Wu et al. [14] developed FCSS-Fog computing based content-aware filtering approach for security services in information centric social networks. This approach resolves the major security problems in CCN using assessment and content-matching schemes. Experimental results showed that the accuracy of this approach is improved at any number of nodes initialized. However, the security enhancement has also reduced the computation speed. Hajimirsadeghi et al. [15] proposed joint caching and pricing strategies for popular content in CCN using the generalized Zipf distribution for modelling the content popularity. This approach employed the Nash strategies for a non-cooperative game using a probabilistic model by assuming that access requests to detect the contents. This approach provides better pricing and high content push; but the multiple content providers are not supported in this model. Wang et al. [16] proposed the mobility-aware caching scheme for CCN. In this scheme, the key properties of user mobility patterns that are useful for content caching will be firstly recognized and then suitable methodology will be utilized. This approach provided higher advantages and improved cache hit ratio. But the privacy issues are major drawbacks of this approach. Zhou et al. [17] introduced stochastic content-centric multicast scheduling to jointly minimize the average network delay and power costs under a multiple access constraint. This approach modelled the stochastic optimization problem as an infinite horizon average cost Markov decision process. Using relative value iteration, this problem is minimized and the scheduling is optimally designed. Experimental results showed that this approach has less complexity and highly efficient in minimizing the average network delay and power costs. However, the lack of interference management can reduce the performance. Karami and Guerrero-Zapata [18] proposed a fuzzy anomaly detection system based on hybrid PSO-Kmeans algorithm in CCN. This system overcomes the drawbacks of the clustering algorithms by incorporating the CCN concepts for high clustering accuracy. Mean Square error is used to determine the data points and their cluster centroids for local cluster optimization. Experiments conducted in MATLAB over UCI datasets showed this approach has better anomaly detection with high accuracy and less computation time. But the false positive rate is slightly higher in this approach. Bazmi and Keshhtgary [19] developed a neural network based congestion control algorithm for CCN. This algorithm is implemented in each router to predict adaptively the existence of the congestion on link given the current status of the network. The experimental results showed that this algorithm can effectively improve throughput by 85.53%. Bernardini et al. [20] proposed Most Popularity-based caching (MPC) strategy for CCN. This MPC caches less than CCN default strategy but still improves in-network caching performance while -at the same time- decreases resource consumption. However, the content delivery process still needs more improvement. Carofiglio et al. [21] proposed joint hop-by-hop and receiver-driven interest control protocol for CCN to regulate user requests either at the receiver or at intermediate nodes via Interest shaping. Experimental results showed that this approach has better benefits of reducing delay, congestion and improving accuracy of content push but the content delivery is very less. Lee et al. [22] developed Proxy-based mobility management scheme in mobile CCN using the proxy nodes. Experiments conducted in CCN showed that the proxy based mobility model has reduced the errors significantly. But the limitation of this model is the dynamic modelling is less adequate. From the literature, it can be inferred that the CCN
techniques are mainly focussed on providing content based caching of servers and ensure the delivery of highly usable content to the users. To ensure this objective, many techniques utilized their own unique way of determining the content based on users’ interests and direct those contents towards similar users. Apart from the larger advantages, these techniques also face minor limitations like high computation time, security, reliability and high traffic. Considering these limitations in the future researches will be helpful in developing highly efficient techniques than the existing ones.

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ISSN 2277-8616
3. CONCLUSION

This paper has presented a survey of recent techniques utilizing the CCN paradigms. This survey is intended to provide understanding about the CCN features, performance, practical usages and analyse their advantages and disadvantages. The final objective is to utilize these analysis results in the future researches to design and develop more advanced models of CCN with sufficient concepts to outperform these limitations.

REFERENCES


