new network features. The proposed architecture acknowledges and guarantees quality of service and mobility support. An advanced network functions, applications and services is sustained and developed due to the centralised and strengthened network control. Simplify network management: The scalability of the proposed architecture is unrivalled and it manages assorted services in the MNGs. This is possible because of the programmability and the reconfigurability of the network devices and new management policies can be assigned by administrators using the controllers. This enables a more efficient simplified network management. Improve resource utilization: Efficient cooperation amongst mobile nodes in the MNGs is improved to facilitate a flexible resource scheduling because of the adoption of global-aware controllers. Based on individual demand, the available recourses are allocated. These resources are allocated to various mobile nodes based on their requirements and capacity. Resource utilisation in the proposed architecture is improved.

5. A Key Issue in the Proposed Architecture

The proposed 5G-SDMN experiences challenges in MNG networking and this challenge is addressed by utilizing the UPnP. The UPnP characterises a rather intelligent peer-to-peer network where devices are configured automatically upon discovery. It is unique with its features since it does not depend on any operating system, programming language or any other platform whatsoever. This technology boosts interoperability of various network technologies, end devices and management policies and this is facilitated by a flexible and open network connectivity. Also, the UPnP depicts how information are exchanged by network devices in a transparent manner to the users. This can be very useful in MNGs in data sharing amongst mobile nodes. Recently the UPnP has been popular in ad hoc networks as it has been used as a robust and simple standard. This successful achievement is the reason why this technology has been adopted for the MNG networking in 5G-SDMN. The UPnP technology comes with two key components which have been adopted here as the mobile nodes and the MEC servers, these key components are the controlled devices and the control points. In the MNG networking, the novel benefit of the UPnP lies in the PnP concept. For the proposed architecture, the moment a target mobile node is approved for a MNG, the UPnP protocol configures the network connection setting automatically for that mobile node. If there is need, any available resources of the newly joined member are scheduled within the VNG for other members. Relevant VNG networking operations like content exchange, service discovery and member selection are facilitated by UPnP and this is achieved by the highly-efficient coordination and automatic discovery that this technology supports. One of the protocols that supports a simple standardised mechanism is the simple service discovery protocol (SSDP). Therefore, processes of discovery, event detection, and control is based on the UPnP in the VNG networking. These illustrations could be described as follows: a mobile node *mni* can request to setup a new MNG. There would be various services that the mobile node can subscribe to and this could be noted as, *Servicei* = {*S1, S2, …, Sn*}. The sociality flow is forwarded to a control point by the mobile node which is the closest MEC server. The MEC server deals with this request by comparing the requesting mobile node with existing MNG to ensure fitting requirements. There is also an existing *MNGj* with services = {*W1, W2,..., Wn*}. Whenever a mobile node requires to join a group, it compares its intended services with services that each group offers. *mni* joins *MNGj* and the probability is calculated by

$$P\frac{j}{i} = \frac{\parallel service_i \cap service^j \parallel}{\parallel service_i \parallel}$$

||service|| returns the services provided and ∩ is an operation to select the common services between the two services. With the obvious common service subscription, the mobile nodes are willing to become a member of the recommended MNG. In a case where there are no available or suitable MNGs, the MEC server authorises the mobile node to establish a new MNG. When the authorisation is approved, the mobile node forwards the sociality flow on the new MNG to mobile nodes nearby. The MEC server pays attention to its surroundings for a new MNG. Upon discovery of a suitable mobile node, the MEC server notifies a specified mobile node to form the new MNG to forward the sociality flow. When this is done, the mobile node makes the decision whether to join the MNG corresponding to the probability in the equation above. Upon making a decision to join, the mobile node uploads its response to the MEC server and this increases the packet size. At the point when the size attains the upper bound, that ends the MNG networking. For the existing and the established MNG, the description files for registered members is made known in other to facilitate the services of the MNG. The basic sets of standards and the policies for outlining the services and devices is defined by the UPnP. All the files show a general information of the mobile nodes. The MEC server gathers the description files for all the members in the MNGs to monitor the state changes of the MNG as a control point. This enables the MEC server to take a real-time decision for the services provided in the MNGs. Upon detection of a mobile node requesting for interested content, the MEC server locates the target mobile node conforming to the details in the description files. The target mobile node upon instruction from the MEC server, transfers its content to the requesting mobile node. This is done according to the transmission path which is optimised taking into account the dynamic topology of the MNG.

A. Case Study

This case study here draws attention to the advantages of the proposed 5G-SDMN. The scenarios adopted here is that of a multicast cloud computing in 5G-SDMN, which is set up amongst a group of cooperating mobile nodes nearby each other. The network resources are dynamically allocated to authorised mobile nodes in other to avoid idle resources. Previously, multicast cloud computing have been set up without optimised control and real-time control. For instance, because of the dynamic mobility of mobile nodes, it has created a challenge with topology estimation and real-time member update and this is common when a mobile node that is requesting to join a multicast cloud group acts as a group leader. In 5G-SDMN, when a mobile node in a MNG sends a request to the local MEC server to establish a cloud multicast, the MEC server would acquire necessary information on the mobile node and more mobile nodes can be elected in other to establish the multicast cloud. This election and selection process is achieved by considering available resources, proximity and workload of the mobile node. Also, the UPnP and the MEC server monitors the various events and operations of the multicast cloud in real-time. Consequently, this is used to improve the overall performance of the multicast could by the optimisation of resource scheduling, and task allocation. These improvements are illustrated in the performance indexes in table 1.

Table 1. Performance index of a multicast cloud computing.

Performance Index
Capacity
Efficiency
Stability
Reliability
Consumptions

Stable construction: The MEC server constructs a stable multicast cloud by selecting the mobile nodes with various similarities and proximity.

Extended capacity: The constructed stable cloud multicast can be increased or extended by adding more suitable mobile nodes.

Reliable resource provision: Due to the selection criteria of the MNG, the event pattern of the members is similar, and this ensures reliable resource provision.

Real-time scheduling: The features and capabilities of MEC which is ubiquitous communications, increased computing capabilities and decision making is useful as this is done in real-time and is sent to the mobile nodes swiftly to accomplish real-time scheduling.

Low communication overheads: High energy consumption is avoided, and communication overhead is reduced because event detection is moved from the request mobile node.

Efficient resource utilization: In other to improve resource utilisation from a global viewpoint, mobile node resource cooperation is under the centralised control.

Research Challenges in 5G-SDMN

The proposed 5G-SDMN exploits the SDN and MEC technology to manage the MNGs for improved QoS. This has also exposed some key research challenges that needs attention. These challenges are discussed below:

A. MNG Management

Figure Labels: Use 8-point Times New Roman for Figure labels. Use words rather than symbols or abbreviations when writing Figure axis labels to avoid confusing the reader. As an example, write the quantity "Magnetization", or "Magnetization, *M*", not just "*M*". If including units in the label, present them within parentheses. Do not label axes only with units. In the example, write "Magnetization (A/m)" or "Magnetization *{A[m(1)]}*", not just "*A/m*". Do not label axes with a ratio of quantities and units. For example, write "Temperature (K)", not "Temperature/K" As a result of the increased number of connected mobile device, MNG management presents new challenges in 5G-SDMN. This article takes into account the size of a MNG because a large sized MNG is advantageous to improved services on the MNG. This could be in the form of new content being shared although, this would result in high management overhead. Whereas, with a smaller size, the available resources are limited, and the shared content too is also limited, and this will affect user satisfaction and hamper normal services. This text considers that the size of each MNG is determined based on different condition. Also, intercommunication between different MNGs could as well be considered. A single mobile node can be a member of multiple MNGs and this would foster interaction among different MNGs.

B. Resource Allocation

In terms of resource allocation, the integration ofemerging technologies in the proposed 5G-SDMN, approach for resource allocation tends to be inclusive. This could be seen in a case where two mobile nodes are within a proximal distance to each other, for communication they adopt device-to-device (D2D) to communicate with each other to improve high-rate content delivery. This improves spectral reuse, enhances system capacity and acquiring hop gains. One of the challenges of D2D communication is interference in cellular communication and this is due to the reuse of user's cellular spectrum [6-8]. This challenge has been addressed in a few literatures that shows improved spectrum optimisation and efficient resource allocation [9, 10]. These solutions that have earlier been proposed can be combined with the resource allocation for D2D communication and depending on the conditions relating to decision making, the control plane can choose an optimal solution or strategy in making its decision.

C. Privacy Preservation

It is crucial to protect the information of mobile nodes in 5G-SDMN because some of this information could have sensitive value, commercial value etc. This information could be, which MNG to join, which mobile node joins which group, or files that have been uploaded to the controllers etc. Some of these security and privacy issues have been addressed in existing networks, although, these schemes, in order to efficiently work in the control plane would need to be explored.

6. Conclusion

This article explores mobile edge computing in 5G-enabled software defined multicast networks and in order to ensure the benefits, there is need for efficient management of the MNG. This led to the proposal of the 5G-SDMN by exploiting SDN to manage the MNGs with flexibility and scalability in 5G networks. To enable 5G-SDMN, the architecture was designed with MEC and a network separated into control plane, social plane and data plane. The proposed architecture offers a programmable and flexible MNG networking and data transmission. The integration of SDN and MEC signifies a strengthened control plane which offers improved controllability for the proposed 5G-SDMN; hence, the architecture provides a simplified network management which improves resource utilisation and promotes a sustainable network development. UPnP is exploited for the MNG and this article used a case study to outline the advantages of the 5G-SDMN with some research challenges.

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