System and Method for Mapping a Service-Level Topology to a Service-Specific Data Plane Logical Topology

This application claims the benefit of U.S. Non Provisional Application Serial No. 14/297,269, titled, "System and Method for Mapping a Service-Level Topology to a Service-Specific Data Plane Logical Topology," filed on June 5, 2014, which claims benefit to U.S. Provisional Application No. 61/831,786, titled "Framework for Software Defined Content or Traffic Delivery," filed on June 6, 2013, which application is hereby incorporated herein by reference.

TECHNICAL FIELD

The present invention relates generally to a software defined topology (SDT) and, in particular embodiments, to a system and method for mapping a service-level topology to a service-specific data plane logical topology.

BACKGROUND

Driven largely by smart phones, tablets, and video streaming, the amount of wireless data handled by wireless networks has risen markedly and is expected to continue to rise by orders of magnitude over the next ten years. In addition to the sheer volume of data, the number of devices is expected to continue to grow exponentially, possibly reaching into the billions of devices, along with radically higher data rates. Different applications will place different requirements on the performance of future wireless networks. Future wireless networks are expected to be highly flexible, highly efficient, open, and customizable for customers and consumers.

SUMMARY OF THE INVENTION

In an~~A n~~ embodiment of a first aspect of the present invention, there is provided a method of mapping a service-level topology for a service to a service-specific data plane logical topology for a network having a plurality of physical network nodes includes receiving service parameters for the service. Logical network nodes for the service-specific data plane logical topology are then located at respective physical network nodes among the plurality of physical network nodes. The locating is done according to the service parameters, the service-level topology, and a physical infrastructure of the plurality of physical network nodes. Connections among the logical network nodes are defined according to the service parameters, the service-level topology, and the physical infrastructure. Respective connections for a plurality of UEs to at least one of the logical network nodes are defined according to the service parameters, the service-level topology, and the physical infrastructure. The method also includes defining respective functionalities for the logical network nodes.

An In an embodiment of a second aspect of the present invention, there is provided a communication system that includes a data plane and a control plane. The data plane is configured to transport network traffic for a service among a plurality of physical network nodes that compose a physical infrastructure. The control plane includes a software defined topology (SDT) module. The SDT module is configured to receive service parameters for the service. The SDT module is further configured to locate logical network nodes for a service-specific data plane logical topology at respective physical network nodes among the plurality of physical network nodes according to the service parameters, a service-level topology for the service, and the physical infrastructure. The SDT module is further configured to define connections among the logical network nodes according to the service parameters, the service-level topology, and the physical infrastructure, and define respective connections for a plurality of UEs to at least one of the logical network nodes according to the service parameters, the service-level topology, and the physical infrastructure. The SDT module is further configured to define respective functionalities for the logical network nodes.

BRIEF DESCRIPTION OF THE DRAWINGS

For a more complete understanding of the present invention, and the advantages thereof, reference is now made to the following descriptions taken in conjunction with the accompanying drawings, in which:

Figure 1 is a block diagram of one embodiment of a logical functional architecture 100 for a wireless network;

Figure 2 is a block diagram of one embodiment of a hierarchical SDT architecture;

Figure 3 is a flow diagram of one embodiment of a method of defining a service-specific data plane logical topology for a network;

Figure 4 is a block diagram of one embodiment of a computing system;

Figure 5 is a block diagram of one embodiment of a control plane;

Figure 6 is an illustration of one embodiment of a SDT for machine-to-machine communication;

Figure 7 is an illustration of one embodiment of a SDT for virtual network migration;

Figure 8 is an illustration of one embodiment of a SDT for content dissemination into a network;

Figure 9 is an illustration of one embodiment of a SDT for content delivery to a consumer;

WHAT IS CLAIMED IS:

1. A method of mapping a service-level topology for a service to a service-specific data plane logical topology for a network having a plurality of physical network nodes, comprising:

receiving service parameters for the service;

locating logical network nodes for the service-specific data plane logical topology at respective physical network nodes among the plurality of physical network nodes according to the service parameters, the service-level topology, and a physical infrastructure of the plurality of physical network nodes, wherein the logical network nodes comprise respective software defined entities;

defining connections among the logical network nodes according to the service parameters, the service-level topology, and the physical infrastructure;

defining respective connections for a plurality of user equipments (UEs) to at least one of the logical network nodes according to the service parameters, the service-level topology, and the physical infrastructure; and

defining respective functionalities for the logical network nodes.

2. The method of Claim 1 wherein the receiving the service parameters includes receiving service requirements from a customer for the service.

3. The method of Claim 1 wherein the receiving service parameters includes receiving service requirements from at least one provider of the service.

4. The method of Claim 1 wherein the defining connections among the logical network nodes includes defining respective data rates for each logical connection.

5. The method of Claim 1 further comprising providing the service-specific data plane logical topology to a software defined network (SDN) module for physical resource mapping.

6. The method of Claim 1 further comprising providing the respective functionalities to a software defined protocol (SDP) module for configuring the logical network nodes.

7. The method of Claim 1 wherein the logical network nodes comprise at least one service-specific virtual serving gateway (v-s-SGW) and the locating comprises defining the at least one v-s-SGW for the service within the service-specific data plane logical topology according to the physical infrastructure, the service-level topology, and the service parameters, wherein the service includes machine-to-machine communication.

8. The method of Claim 7 wherein the logical network nodes comprise at least one service-specific virtual server for the service within the service-specific data plane logical topology according to the physical infrastructure, the service-level topology, a distribution of the UEs, and the service parameters, wherein the UEs comprise customers of the service.

9. The method of Claim 7 wherein the machine-to-machine communication comprises communication between at least two UEs from the plurality of UEs.

10. The method of Claim 1 wherein the logical network nodes comprise logical content container nodes and the locating includes defining the logical content container nodes for content dissemination into the network according to the service parameters and the service-level topology, wherein the service parameters include quality of service (QoS) requirements, traffic statistics, and content request statistics.

11. The method of Claim 10 wherein the locating includes selecting source nodes from the logical content container nodes for content delivery to at least one UE among the plurality of UEs according to a requested content and the at least one UE.

12. The method of Claim 1 wherein the logical network nodes comprise a first user-specific virtual serving gateway (v-u-SGW) and the locating includes defining the first v-u-SGW for a UE among the plurality of UEs according to the physical infrastructure, the service parameters, and the service-level topology, wherein the service parameters include service quality of experience (QoE) requirements and location and mobility of the UE.

13. The method of Claim 12 wherein the locating further comprises defining a second v-u-SGW for the UE when the UE moves to a new location.

14. The method of Claim 1 further comprising:

identifying service traffic flows from the connections among the logical network nodes that need a rate adjustment;

determining respective adapted rates for the service traffic flows according to respective location and mobility of the plurality of UEs and network congestion; and

determining a link capacity requirement according to the respective adapted rates and a quality of experience (QoE) for the service.

15. The method of Claim 1 further comprising:

activating compression for at least one connection from the connections among the

logical network nodes and the respective connections for the plurality of UEs;

identifying service traffic flows over the at least one connection that need compression according to network congestion; and

selecting a compression scheme for the service traffic flows.

16. The method of Claim 1 wherein the respective functionalities include message aggregation.

17. A communication system, comprising:

a data plane configured to transport network traffic for a service among a plurality of physical network nodes that compose a physical infrastructure; and

a control plane having a software defined topology (SDT) module configured to:

receive service parameters for the service,

locate logical network nodes for a service-specific data plane logical topology at respective physical network nodes among the plurality of physical network nodes according to the service parameters, a service-level topology for the service, and the physical infrastructure,

define connections among the logical network nodes according to the service parameters, the service-level topology, and the physical infrastructure,

define respective connections for a plurality of user equipments (UEs) to at least one of the logical network nodes according to the service parameters, the service-level topology, and the physical infrastructure, and

define respective functionalities for the logical network nodes.

18. The communication system of Claim 17 wherein the control plane comprises a computing system having at least one processing unit configured to receive the service parameters, locate the logical network nodes, define the connections, define the respective connections, and define the respective functionalities.

19. The communication system of Claim 17 wherein the service parameters include at least one of quality of experience (QoE) requirements, UE capabilities, service traffic characteristics, and network traffic load predictions.

20. The communication system of Claim 17 wherein the control plane comprises a top-level SDT module configured to control and manage a plurality of lower-level SDT modules.

21. The communication system of Claim 20 wherein the plurality of lower-level SDT modules are allocated according to the physical infrastructure.

22. The communication system of Claim 17 wherein the SDT module is configured to receive the service parameters from a customer for the service.

23. The communication system of Claim 17 wherein the control plane further comprises a software define network (SDN) module and a software defined protocol (SDP) module, wherein both the SDN module and the SDP module are coupled to the SDT module.

24. The communication system of Claim 23 wherein the SDT module is further configured to provide the service-specific data plane logical topology to the SDN module for physical resource mapping.

25. The communication system of Claim 23 wherein the SDT module is further configured to provide the functionalities to the SDP module for configuring the logical network nodes.

WHAT IS CLAIMED IS:

1. A method of mapping a service-level topology for a service to a service-specific data plane logical topology for a network having a plurality of physical network nodes, comprising:

receiving service parameters for the service;

locating logical network nodes for the service-specific data plane logical topology at respective physical network nodes among the plurality of physical network nodes according to the service parameters, the service-level topology, and a physical infrastructure of the plurality of physical network nodes, wherein the logical network nodes comprise respective software defined entities;

defining connections among the logical network nodes according to the service parameters, the service-level topology, and the physical infrastructure;

defining respective connections for a plurality of user equipments, UEs, to at least one of the logical network nodes according to the service parameters, the service-level topology, and the physical infrastructure; and

defining respective functionalities for the logical network nodes.

2. The method of Claim 1 wherein the receiving the service parameters includes receiving service requirements from one of at least one of a customer for the service and a provider of the service.

3. The method of Claim 1 wherein the defining connections among the logical network nodes includes defining respective data rates for each logical connection.

4. The method of Claim 1 further comprising providing the service-specific data plane logical topology to a software defined network, SDN, module for physical resource mapping.

5. The method of Claim 1 further comprising providing the respective functionalities to a software defined protocol, SDP, module for configuring the logical network nodes.

6. The method of Claim 1 wherein the logical network nodes comprise at least one service-specific virtual serving gateway, v-s-SGW and the locating comprises defining the at least one v-s-SGW for the service within the service-specific data plane logical topology according to the physical infrastructure, the service-level topology, and the service parameters, wherein the service includes machine-to-machine communication wherein the machine-to-machine communications optionally comprises communication between at least two UEs from the plurality of UEs.

7. The method of Claim 6 wherein the logical network nodes comprise at least one service-specific virtual server for the service within the service-specific data plane logical topology according to the physical infrastructure, the service-level topology, a distribution of the UEs, and the service parameters, wherein the UEs comprise customers of the service.

8. The method of Claim 1 wherein the logical network nodes comprise at least one of:

logical content container nodes and the locating includes defining the logical content container nodes for content dissemination into the network according to the service parameters and the service-level topology, wherein the service parameters include quality of service (QoS) requirements, traffic statistics, and content request statistics; and

comprise a first user-specific virtual serving gateway, v-u-SGW, and the locating includes defining the first v-u-SGW for a UE among the plurality of UEs according to the physical infrastructure, the service parameters, and the service-level topology, wherein the service parameters include service quality of experience (QoE) requirements and location and mobility of the UE

9. The method of Claim 8 wherein the locating includes selecting source nodes from the logical content container nodes for content delivery to at least one UE among the plurality of UEs according to a requested content and the at least one UE.

10. The method of Claim 8 wherein the locating further comprises defining a second v-u-SGW for the UE when the UE moves to a new location.

11. The method of Claim 1 further comprising:

identifying service traffic flows from the connections among the logical network nodes that need a rate adjustment;

determining respective adapted rates for the service traffic flows according to respective location and mobility of the plurality of UEs and network congestion; and

determining a link capacity requirement according to the respective adapted rates and a quality of experience (QoE) for the service.

12. The method of Claim 1 further comprising:

activating compression for at least one connection from the connections among the logical network nodes and the respective connections for the plurality of UEs;

identifying service traffic flows over the at least one connection that need compression

according to network congestion; and

selecting a compression scheme for the service traffic flows.

13. The method of Claim 1 wherein the respective functionalities include message aggregation.

14. A communication system, comprising:

a data plane configured to transport network traffic for a service among a plurality of physical network nodes that compose a physical infrastructure; and

a control plane having a software defined topology (SDT) module configured to:

receive service parameters for the service,

locate logical network nodes for a service-specific data plane logical topology at respective physical network nodes among the plurality of physical network nodes according to the service parameters, a service-level topology for the service, and the physical infrastructure,

define connections among the logical network nodes according to the service parameters, the service-level topology, and the physical infrastructure,

define respective connections for a plurality of user equipments (UEs) to at least one of the logical network nodes according to the service parameters, the service-level topology, and the physical infrastructure, and

define respective functionalities for the logical network nodes.

15. The communication system of Claim 14 wherein the control plane comprises a computing system having at least one processing unit configured to receive the service parameters, locate the logical network nodes, define the connections, define the respective connections, and define the respective functionalities.

16. The communication system of Claim 14 wherein the service parameters include at least one of quality of experience (QoE) requirements, UE capabilities, service traffic characteristics, and network traffic load predictions.

17. The communication system of Claim 14 wherein the control plane comprises a top-level SDT module configured to control and manage a plurality of lower-level SDT modules.

18. The communication system of Claim 17 wherein the plurality of lower-level SDT modules are allocated according to the physical infrastructure.

19. The communication system of Claim 14 wherein the SDT module is configured to perform at least one of:

receiving the service parameters from a customer for the service

providing the service-specific data plane logical topology to an SDN module for physical resource mapping; and

providing the functionalities to an SDP module for configuring the logical network nodes.