

NETWORK MANAGEMENT

FIELD OF INVENTION

[0001] The present invention relates to the field of network management, such as for example management of a communication network with virtualized functions.

BACKGROUND OF INVENTION

[0002] Communication networks, such as for example cellular communication networks, are comprised of network nodes. The network nodes of a network may be subdivided into different node types, for example, a cellular communication network may comprise base stations, base station controllers, switches, gateways and application functions. An internet protocol, IP, network may comprise routers and gateways.

[0003] When designing a network, planners may estimate loading situations in a coverage area of the network. For example, in busy sections of cities it may be estimated that communication occurs more often, and at a higher intensity, than in outlying areas. Therefore, in the case of a cellular network, cells in busier areas may be made smaller, and base stations assigned to control these smaller cells may be furnished with sufficient data processing capability to handle high peak loads. For example, the base stations may be equipped with several data processing cards. Likewise, network nodes tasked with conveying data to and from base stations with high anticipated peak loads may be dimensioned to be capable of handling these high loads.

[0004] When network nodes dimensioned to handle high loads experience lower loads, for example at night, their instantaneous load factors may be low. On the other hand, in case usage patterns of a network change, for example, if an area that previously experienced only low usage becomes more highly loaded, capacity may be added to base stations and, possibly, to other nodes serving that area of the network. Such adding may involve installing more data processing cards and/or transceivers into base stations to cope with the load. Peak loads may increase in previously lightly loaded areas as cities or other areas develop. For example, the opening of a new airport, train station or simply the construction of a new apartment building may modify usage patterns of communication networks that are active in the area.

[0005] Virtualization of network functions may be employed to simplify network maintenance. In a network where functions have been, at least in part, virtualized, virtualized

network functions may be run as software entities on commodity server computers, which may be located in a datacentre, for example.

SUMMARY OF THE INVENTION

[0006] Aspects of the invention are defined by the features of the independent claims. Some specific embodiments are defined in the dependent claims.

[0007] According to a first aspect of the present invention, there is provided a system comprising a memory configured to store information characterizing network management actions that have occurred in the past, and at least one processing core configured to predictively initiate a pre-emptive network management action based at least in part on the stored information, the network management action involving at least one virtualized network function, wherein the information characterizing network management actions that have occurred in the past comprises at least one propensity score associating a network management action with a network operating condition, and wherein the at least one processing core is configured to initiate the network management action jointly based on the at least one propensity score and the network operating condition.

[0008] Various embodiments of the first aspect may comprise at least one feature from the following bulleted list:

- the network management action comprises at least one of the following: increasing resources allocated to a virtualized network function, decreasing resources allocated to a virtualized network function, starting a virtualized network function instance, and terminating a virtualized network function instance
- the information characterizing network management actions that have occurred in the past comprises at least one of the following: information identifying when past network management actions have occurred, at least one pattern identified in past network management actions
- the at least one virtualized network function comprises at least one of the following: a virtualized base station function, a virtualized call session control function, CSCF, a virtualized switching centre, a virtualized mobility management entity, a virtualized home subscriber server, a virtualized equipment identity register and a virtualized gateway function

- the system is configured to override a first network management action request based at least in part on the stored information
- the first network management action request comprises a request to terminate a first virtualized network function and the stored information indicates that increased loading is likely in the near future
- the first network management action request comprises a request to increase resources allocated to a first virtual network function, and the at least one processing core is configured to, based at least in part on the stored information, increase resources allocated to a second virtualized network function and leave resources of the first virtualized network function unmodified
- the memory and the at least one processing core are comprised in a virtualized cellular communication network management device and the system further comprises a network functions virtualization orchestrator function configured to, responsive to a trigger from the virtualized cellular communication network management device, cause the network management action to be implemented
- the system comprises a first node configured to determine, based on the information identifying when past network management actions have occurred, at least one of the at least one pattern and the at least one propensity score
- the first node comprises the virtualized cellular communication network management device

[0009] According to a second aspect of the present invention, there is provided a method comprising storing information characterizing network management actions that have occurred in the past, and predictively initiating a pre-emptive network management action based at least in part on the stored information, the network management action involving at least one virtualized network function, wherein the information characterizing network management actions that have occurred in the past comprises at least one propensity score associating a network management action with a network operating condition, and wherein the network management action is initiated jointly based on at least one propensity score and the network operating condition.

[0010] Various embodiments of the second aspect may comprise at least one feature corresponding to a feature comprised in the preceding bulleted list laid out in connection with the first aspect.

[0011] In an embodiment of the present invention, the above system comprises a database or big data storage comprising a memory configured to store the information characterizing network management actions involving at least one virtualized network function that have occurred in the past, and at least one pattern characterizing the information.

[0012] According to a third aspect of the present invention, there is provided an apparatus comprising at least one processing core and at least one memory including computer program code, the at least one memory and the computer program code being configured to, with the at least one processing core, cause the apparatus at least to store information characterizing network management actions that have occurred in the past, and predictively initiate a pre-emptive network management action based at least in part on the stored information, the network management action involving at least one virtualized network function, wherein the information characterizing network management actions that have occurred in the past comprises at least one propensity score associating a network management action with a network operating condition, and wherein the at least one processing core is configured to initiate the network management action jointly based on the at least one propensity score and the network operating condition.

[0013] According to a fourth aspect of the present invention, there is provided an apparatus comprising means for storing information characterizing network management actions that have occurred in the past, and means for predictively initiating a pre-emptive network management action based at least in part on the stored information, the network management action involving at least one virtualized network function, wherein the information characterizing network management actions that have occurred in the past comprises at least one propensity score associating a network management action with a network operating condition, and wherein the network management action is initiated jointly based on at least one propensity score and the network operating condition.

[0014] Disclosed herein is a non-transitory computer readable medium having stored thereon a set of computer readable instructions that, when executed by at least one processor, cause an apparatus to at least store information characterizing network management actions that have occurred in the past, and initiate a network management action based at least in part

on the stored information, the network management action involving at least one virtualized network function.

[0015] According to an embodiment of the present invention, the above method comprises predictively triggering, from a predictive entity, a network management action relating to a virtualized network function, responsive to the triggering, requesting implementation of the network management action by transmitting an instruction from a network function virtualization orchestrator function to a virtual infrastructure manager function, and responsive to a message from the virtual infrastructure manager function, requesting configuration relating to the network management action by transmitting a message from the network function virtualization orchestrator function to a virtualized network function manager function.

[0016] Various embodiments may comprise at least one of the following two features:

- the configuration is caused by causing at least one message to be transmitted from the virtualized network function manager to the virtualized network function
- responsive to the triggering, querying by the network function virtualization orchestrator function from the virtualized network function manager function what resources are needed for implementing the network management action, and wherein the implementation is requested based at least in part on a response to the query.

[0017] According to fifth aspect of the present invention, there is provided a computer program configured to cause the method in accordance with the second aspect to be performed when executed on a computer.

[0017a] According to sixth aspect of the present invention, there is provided a non-transitory computer readable medium carrying the program.

Industrial Applicability

[0018] At least some embodiments of the present invention find industrial application in network management and use optimization.

BRIEF DESCRIPTION OF THE DRAWINGS

CLAIMS:

1. A system comprising:

a memory configured to store information characterizing network management actions that have occurred in the past, and

at least one processing core configured to predictively initiate a pre-emptive network management action based at least in part on the stored information, the network management action involving at least one virtualized network function, wherein the information characterizing network management actions that have occurred in the past comprises at least one propensity score associating a network management action with a network operating condition, and wherein the at least one processing core is configured to initiate the network management action jointly based on the at least one propensity score and the network operating condition.

2. The system according to claim 1, wherein the network management action comprises at least one of the following: increasing resources allocated to a virtualized network function, decreasing resources allocated to a virtualized network function, starting a virtualized network function instance, and terminating a virtualized network function instance.

3. The system according to claim 1 or 2, wherein the information characterizing network management actions that have occurred in the past comprises at least one of the following: information identifying when past network management actions have occurred, at least one pattern identified in past network management actions.

4. The system according to any of claims 1 - 3, wherein the at least one virtualized network function comprises at least one of the following: a virtualized base station function, a virtualized call session control function, CSCF, a virtualized switching centre, a virtualized mobility management entity, a virtualized home subscriber server, a virtualized equipment identity register and a virtualized gateway function.

5. The system according to any of claims 1 - 4, wherein the system is configured to override a first network management action request based at least in part on the stored information.

6. The system according to claim 5, wherein the first network management action request comprises a request to terminate a first virtualized network function and the stored information indicates that increased loading is likely in the near future.

7. The system according to claim 5, wherein the first network management action request comprises a request to increase resources allocated to a first virtual network function, and the at least one processing core is configured to, based at least in part on the stored information, increase resources allocated to a second virtualized network function and leave resources of the first virtualized network function unmodified.

8. The system according to any of claims 1 - 7, wherein the memory and the at least one processing core are comprised in a virtualized cellular communication network management device and the system further comprises a network functions virtualization orchestrator function configured to, responsive to a trigger from the virtualized cellular communication network management device, cause the network management action to be implemented.

9. The system according to any of claims 1 - 8, wherein the system comprises a first node configured to determine, based on the information identifying when past network management actions have occurred, at least one of the at least one pattern and the at least one propensity score.

10. The system according to claim 9, wherein the first node comprises the virtualized cellular communication network management device.

11. A method comprising:

storing information characterizing network management actions that have occurred in the past, and

predictively initiating a pre-emptive network management action based at least in part on the stored information, the network management action involving at least one virtualized network function, wherein the information characterizing network management actions that have occurred in the past comprises at least one propensity score associating a network management action with a network operating condition, and wherein the network management action is initiated jointly based on at least one propensity score and the network operating condition.

12. The method according to claim 11, wherein the network management action comprises at least one of the following: increasing resources allocated to a virtualized network function, decreasing resources allocated to a virtualized network function, starting a virtualized network function instance, and terminating a virtualized network function instance.

13. The method according to claim 11 or 12, wherein the information characterizing network management actions that have occurred in the past comprises at least one of the following: information identifying when past network management actions have occurred, at least one pattern identified in past network management actions.

14. The method according to any of claims 11 - 13, wherein the at least one virtualized network function comprises at least one of the following: a virtualized base station function, a virtualized call session control function, CSCF, a virtualized switching centre, a virtualized mobility management entity, a virtualized home subscriber server, a virtualized equipment identity register and a virtualized gateway function.

15. The method according to any of claims 10 - 12, further comprising overriding a first network management action request based at least in part on the stored information.

16. The method according to claim 15, wherein the first network management action request comprises a request to terminate a first virtualized network function and the stored information indicates that increased loading is likely in the near future.

17. The method according to claim 15, wherein the first network management action request comprises a request to increase resources allocated to a first virtual network function, and the method comprises, based at least in part on the stored information, increasing resources allocated to a second virtualized network function and leaving resources of the first virtualized network function unmodified.

18. The method according to any of claims 11 - 17, wherein the method is performed in a virtualized cellular communication network management device, the method further comprising receiving, in a network functions virtualization orchestrator function, a trigger from the virtualized cellular communication network management device, and responsively causing the network management action to be implemented.

19. The method according to any of claims 11 - 18, further comprising determining, based on the information identifying when past network management actions have occurred, at least one of the at least one pattern and the at least one propensity score.

20. The system of any one of claims 1 – 10, comprising a database or big data storage comprising a memory configured to store:

the information characterizing network management actions involving at least one virtualized network function that have occurred in the past, and at least one pattern characterizing the information.

21. The system of claim 20, wherein the at least one pattern characterizes at least one trend in time concerning the network management actions that have occurred in the past.

22. An apparatus comprising at least one processing core and at least one memory including computer program code, the at least one memory and the computer program code being configured to, with the at least one processing core, cause the apparatus at least to:

store information characterizing network management actions that have occurred in the past, and

predictively initiate a pre-emptive network management action based at least in part on the stored information, the network management action involving at least one virtualized network function, wherein the information characterizing network management actions that have occurred in the past comprises at least one propensity score associating a network management action with a network operating condition, and wherein the at least one processing core is configured to initiate the network management action jointly based on the at least one propensity score and the network operating condition.

23. An apparatus comprising:

means for storing information characterizing network management actions that have occurred in the past, and

means for predictively initiating a pre-emptive network management action based at least in part on the stored information, the network management action involving at least one virtualized network function, wherein the information characterizing network management actions that have occurred in the past comprises

at least one propensity score associating a network management action with a network operating condition, and wherein the network management action is initiated jointly based on at least one propensity score and the network operating condition.

24. The method of any one of claims 11-19, comprising:

predictively triggering, from a predictive entity, a network management action relating to a virtualized network function;

responsive to the triggering, requesting implementation of the network management action by transmitting an instruction from a network function virtualization orchestrator function to a virtual infrastructure manager function, and

responsive to a message from the virtual infrastructure manager function, requesting configuration relating to the network management action by transmitting a message from the network function virtualization orchestrator function to a virtualized network function manager function.

25. The method according to claim 24, wherein the configuration is caused by causing at least one message to be transmitted from the virtualized network function manager to the virtualized network function.

26. The method according to claim 24 or 25, further comprising, responsive to the triggering, querying by the network function virtualization orchestrator function from the virtualized network function manager function what resources are needed for implementing the network management action, and wherein the implementation is requested based at least in part on a response to the query.

27. A computer program configured to cause a method in accordance with at least one of claims 11 - 19 or 24 - 26 to be performed when executed on a computer.

28. A non-transitory computer readable medium carrying the program of claim 27.