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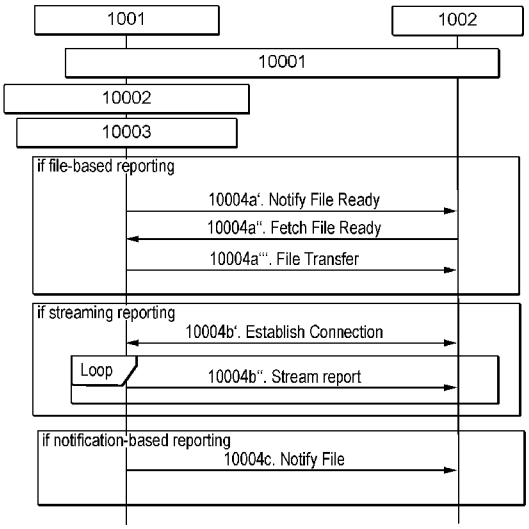

FIG. 10

(57) Abstract: There is provided an apparatus, method and computer program for causing an apparatus for an analytics producer to perform: receiving a request for performing an analytics reporting control from an analytics consumer using information object class signalling, the request comprising an indication of determined parameters; performing at least part of the analytics reporting control to produce output results; forming an analytics report comprising the output results; and signalling the analytics report to the analytics consumer.

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ANALYTICS REPORTING CONTROL

Field

[0001] The present disclosure relates to apparatus, methods, and computer programs, and in particular but not exclusively to apparatus, methods and computer programs for network apparatuses.

Background

[0002] A communication system can be seen as a facility that enables communication sessions between two or more entities such as user terminals, access nodes and/or other nodes by providing carriers between the various entities involved in the communications path. A communication system can be provided for example by means of a communication network and one or more compatible communication devices. The communication sessions may comprise, for example, communication of data for carrying communications such as voice, electronic mail (email), text message, multimedia and/or content data and so on. Content may be multicast or uni-cast to communication devices.

[0003] A user can access the communication system by means of an appropriate communication device or terminal. A communication device of a user is often referred to as user equipment (UE) or user device. The communication device may access a carrier provided by an access node and transmit and/or receive communications on the carrier.

[0004] The communication system and associated devices typically operate in accordance with a required standard or specification which sets out what the various entities associated with the system are permitted to do and how that should be achieved. Communication protocols and/or parameters which shall be used for the connection are also typically defined. One example of a communications system is UTRAN (3G radio). Another example of an architecture that is known is the long-term evolution (LTE) or the Universal Mobile Telecommunications System (UMTS) radio-access technology. Another example communication system is so called 5G system that allows user equipment (UE) or user device to contact a 5G core via e.g. new radio (NR) access technology or via other access technology such as Untrusted access to 5GC or wireline access technology.

Summary

[0005] According to a first aspect, there is provided an apparatus for an analytics producer, the apparatus comprising means for: receiving a request for performing an analytics reporting control from an analytics consumer using information object class signalling, the request comprising an indication of determined parameters; performing at least part of the analytics reporting control to produce output results; forming an analytics report comprising the output results; and signalling the analytics report to the analytics consumer.

[0006] The indication may be a request to subscribe to an existing analytics reporting control.

[0007] The apparatus may comprise means for modifying the existing analytics reporting control to perform both the requested analytics reporting control and the reporting control performed by the existing analytics reporting control prior to modification, and the means for performing at least part of the analytics reporting control may comprise means for performing the modified existing analytics reporting control to produce output results.

[0008] The indication may be a request to instantiate the analytics reporting control at the analytics producer.

[0009] The request may comprise a plurality of parameters for instantiating the analytics reporting control, the plurality of parameters comprising agnostic information related to a computational model for performing the analytics reporting control, specific information relating to the computation model in relation to a specific use case, and context information relating to the specific use case.

[0010] The request may comprise an identifier of an analytics service being requested.

[0011] The request may comprise parameters indicating at least one of: a frequency, and/or duration, and/or period and/or mechanism by which the analytics producer should signal the analytics report.

[0012] The request may comprise an indication that the analytics report is to be signalled by one of: a notification-based mechanism, a streaming-based mechanism, and by a file request mechanism.

[0013] The request may comprise a value for a time within which the analytics consumer is to receive the analytics report.

[0014] The analytics report may comprise at least one of: an indication of an analytics result; an indication that the analytics result is at least one of a numeric result, a recommendation, and/or a root cause result; a description of the analytics result being provided; a length of the result; and/or a degree of confidence in the analytics result.

[0015] The indication of an analytics result may indicate whether the analytics result is based on statistics using historic data and/or predictions of future data.

[0016] The request may comprise an indication of at least one of an analytics performance input and/or a granularity for collecting measurements for performing the analytics reporting control.

[0017] The request may comprise at least one of a location of and/or an identification of at least one object for performing the analytics reporting control.

[0018] According to a second aspect, there is provided an apparatus for an analytics consumer, the apparatus comprising means for: determining parameters for requesting an analytics reporting control to be performed; signalling a request for performing the analytics reporting control to an analytics producer using information object class signalling, the request comprising an indication of the determined parameters; and receiving an analytics report from the analytics producer that is based on the signalled request.

[0019] The indication may be a request to subscribe to an existing analytics reporting control.

[0020] The indication may be a request to instantiate the analytics reporting control at the analytics producer.

[0021] The request may comprise a plurality of parameters for instantiating the analytics reporting control, the plurality of parameters comprising agnostic information related to a computational model for performing the analytics reporting control, specific information relating to the computation model in relation to a specific use case, and context information relating to the specific use case.

[0022] The request may comprise an identifier of an analytics service being requested.

[0023] The request may comprise parameters indicating at least one of: a frequency, and/or duration, and/or period and/or mechanism by which the analytics producer should signal the analytics report.

[0024] The request may comprise an indication that the analytics report is to be signalled by one of: a notification-based mechanism, a streaming-based mechanism, and by a file request mechanism.

[0025] The request may comprise a value for a time within which the analytics consumer is to receive the analytics report.

[0026] The analytics report may comprise at least one of: an indication of an analytics result; an indication that the analytics result is at least one of a numeric result, a recommendation, and/or a root cause result; a description of the analytics result being provided; a length of the result; and/or a degree of confidence in the analytics result.

[0027] The indication of an analytics result may indicate whether the analytics result is based on statistics using historic data and/or predictions of future data.

[0028] The request may comprise an indication of at least one of an analytics performance input and/or a granularity for collecting measurements for performing the analytics reporting control.

[0029] The request may comprise at least one of a location of and/or an identification of at least one object for performing the analytics reporting control.

[0030] According to a third aspect, there is provided an apparatus for an analytics producer, the apparatus comprising: at least one processor; and at least one memory comprising code that, when executed by the at least one processor, causes the apparatus to: receive a request for performing an analytics reporting control from an analytics consumer using information object class signalling, the request comprising an indication of determined parameters; perform at least part of the analytics reporting control to produce output results; form an analytics report comprising the output results; and signal the analytics report to the analytics consumer.

[0031] The indication may be a request to subscribe to an existing analytics reporting control.

[0032] The apparatus may be caused to modify the existing analytics reporting control to perform both the requested analytics reporting control and the reporting control performed by the existing analytics reporting control prior to modification, and perform at least part of the analytics reporting control may comprise performing the modified existing analytics reporting control to produce output results.

[0033] The indication may be a request to instantiate the analytics reporting control at the analytics producer.

[0034] The request may comprise a plurality of parameters for instantiating the analytics reporting control, the plurality of parameters comprising agnostic information related to a computational model for performing the analytics reporting control, specific information relating to the computation model in relation to a specific use case, and context information relating to the specific use case.

[0035] The request may comprise an identifier of an analytics service being requested.

[0036] The request may comprise parameters indicating at least one of: a frequency, and/or duration, and/or period and/or mechanism by which the analytics producer should signal the analytics report.

[0037] The request may comprise an indication that the analytics report is to be signalled by one of: a notification-based mechanism, a streaming-based mechanism, and by a file request mechanism.

[0038] The request may comprise a value for a time within which the analytics consumer is to receive the analytics report.

[0039] The analytics report may comprise at least one of: an indication of an analytics result; an indication that the analytics result is at least one of a numeric result, a recommendation, and/or a root cause result; a description of the analytics result being provided; a length of the result; and/or a degree of confidence in the analytics result.

[0040] The indication of an analytics result may indicate whether the analytics result is based on statistics using historic data and/or predictions of future data.

[0041] The request may comprise an indication of at least one of an analytics performance input and/or a granularity for collecting measurements for performing the analytics reporting control.

[0042] The request may comprise at least one of a location of and/or an identification of at least one object for performing the analytics reporting control.

[0043] According to a fourth aspect, there is provided an apparatus for an analytics consumer, the apparatus comprising: at least one processor; and at least one memory comprising code that, when executed by the at least one processor, causes the apparatus to: determine parameters for requesting an analytics reporting control to be performed; signal a request for performing the analytics reporting control to an analytics producer using information object class signalling, the request comprising an

indication of the determined parameters; and receive an analytics report from the analytics producer that is based on the signalled request.

[0044] The indication may be a request to subscribe to an existing analytics reporting control.

[0045] The indication may be a request to instantiate the analytics reporting control at the analytics producer.

[0046] The request may comprise a plurality of parameters for instantiating the analytics reporting control, the plurality of parameters comprising agnostic information related to a computational model for performing the analytics reporting control, specific information relating to the computation model in relation to a specific use case, and context information relating to the specific use case.

[0047] The request may comprise an identifier of an analytics service being requested.

[0048] The request may comprise parameters indicating at least one of: a frequency, and/or duration, and/or period and/or mechanism by which the analytics producer should signal the analytics report.

[0049] The request may comprise an indication that the analytics report is to be signalled by one of: a notification-based mechanism, a streaming-based mechanism, and by a file request mechanism.

[0050] The request may comprise a value for a time within which the analytics consumer is to receive the analytics report.

[0051] The analytics report may comprise at least one of: an indication of an analytics result; an indication that the analytics result is at least one of a numeric result, a recommendation, and/or a root cause result; a description of the analytics result being provided; a length of the result; and/or a degree of confidence in the analytics result.

[0052] The indication of an analytics result may indicate whether the analytics result is based on statistics using historic data and/or predictions of future data.

[0053] The request may comprise an indication of at least one of an analytics performance input and/or a granularity for collecting measurements for performing the analytics reporting control.

[0054] The request may comprise at least one of a location of and/or an identification of at least one object for performing the analytics reporting control.

[0055] According to a fifth aspect, there is provided a method for an apparatus for an analytics producer, the method comprising: receiving a request for performing an analytics reporting control from an analytics consumer using information object class signalling, the request comprising an indication of determined parameters; performing at least part of the analytics reporting control to produce output results; forming an analytics report comprising the output results; and signalling the analytics report to the analytics consumer.

[0056] The indication may be a request to subscribe to an existing analytics reporting control.

[0057] The method may comprise modifying the existing analytics reporting control to perform both the requested analytics reporting control and the reporting control performed by the existing analytics reporting control prior to modification, and the performing at least part of the analytics reporting control may comprise performing the modified existing analytics reporting control to produce output results.

[0058] The indication may be a request to instantiate the analytics reporting control at the analytics producer.

[0059] The request may comprise a plurality of parameters for instantiating the analytics reporting control, the plurality of parameters comprising agnostic information related to a computational model for performing the analytics reporting control, specific information relating to the computation model in relation to a specific use case, and context information relating to the specific use case.

[0060] The request may comprise an identifier of an analytics service being requested.

[0061] The request may comprise parameters indicating at least one of: a frequency, and/or duration, and/or period and/or mechanism by which the analytics producer should signal the analytics report.

[0062] The request may comprise an indication that the analytics report is to be signalled by one of: a notification-based mechanism, a streaming-based mechanism, and by a file request mechanism.

[0063] The request may comprise a value for a time within which the analytics consumer is to receive the analytics report.

[0064] The analytics report may comprise at least one of: an indication of an analytics result; an indication that the analytics result is at least one of a numeric result, a recommendation, and/or a root cause result; a description of the analytics

result being provided; a length of the result; and/or a degree of confidence in the analytics result.

[0065] The indication of an analytics result may indicate whether the analytics result is based on statistics using historic data and/or predictions of future data.

[0066] The request may comprise an indication of at least one of an analytics performance input and/or a granularity for collecting measurements for performing the analytics reporting control.

[0067] The request may comprise at least one of a location of and/or an identification of at least one object for performing the analytics reporting control.

[0068] According to a sixth aspect, there is provided a method for an apparatus for an analytics consumer, the method comprising: determining parameters for requesting an analytics reporting control to be performed; signalling a request for performing the analytics reporting control to an analytics producer using information object class signalling, the request comprising an indication of the determined parameters; and receiving an analytics report from the analytics producer that is based on the signalled request.

[0069] The indication may be a request to subscribe to an existing analytics reporting control.

[0070] The indication may be a request to instantiate the analytics reporting control at the analytics producer.

[0071] The request may comprise a plurality of parameters for instantiating the analytics reporting control, the plurality of parameters comprising agnostic information related to a computational model for performing the analytics reporting control, specific information relating to the computation model in relation to a specific use case, and context information relating to the specific use case.

[0072] The request may comprise an identifier of an analytics service being requested.

[0073] The request may comprise parameters indicating at least one of: a frequency, and/or duration, and/or period and/or mechanism by which the analytics producer should signal the analytics report.

[0074] The request may comprise an indication that the analytics report is to be signalled by one of: a notification-based mechanism, a streaming-based mechanism, and by a file request mechanism.

[0075] The request may comprise a value for a time within which the analytics consumer is to receive the analytics report.

[0076] The analytics report may comprise at least one of: an indication of an analytics result; an indication that the analytics result is at least one of a numeric result, a recommendation, and/or a root cause result; a description of the analytics result being provided; a length of the result; and/or a degree of confidence in the analytics result.

[0077] The indication of an analytics result may indicate whether the analytics result is based on statistics using historic data and/or predictions of future data.

[0078] The request may comprise an indication of at least one of an analytics performance input and/or a granularity for collecting measurements for performing the analytics reporting control.

[0079] The request may comprise at least one of a location of and/or an identification of at least one object for performing the analytics reporting control.

[0080] According to a seventh aspect, there is provided an apparatus for an analytics producer, the apparatus comprising: receiving circuitry for receiving a request for performing an analytics reporting control from an analytics consumer using information object class signalling, the request comprising an indication of determined parameters; performing circuitry for performing at least part of the analytics reporting control to produce output results; forming circuitry for forming an analytics report comprising the output results; and signalling circuitry for signalling the analytics report to the analytics consumer.

[0081] The indication may be a request to subscribe to an existing analytics reporting control.

[0082] The apparatus may comprise modifying circuitry for modifying the existing analytics reporting control to perform both the requested analytics reporting control and the reporting control performed by the existing analytics reporting control prior to modification, and the performing circuitry for performing at least part of the analytics reporting control may comprise performing circuitry for performing the modified existing analytics reporting control to produce output results.

[0083] The indication may be a request to instantiate the analytics reporting control at the analytics producer.

[0084] The request may comprise a plurality of parameters for instantiating the analytics reporting control, the plurality of parameters comprising agnostic

information related to a computational model for performing the analytics reporting control, specific information relating to the computation model in relation to a specific use case, and context information relating to the specific use case.

[0085] The request may comprise an identifier of an analytics service being requested.

[0086] The request may comprise parameters indicating at least one of: a frequency, and/or duration, and/or period and/or mechanism by which the analytics producer should signal the analytics report.

[0087] The request may comprise an indication that the analytics report is to be signalled by one of: a notification-based mechanism, a streaming-based mechanism, and by a file request mechanism.

[0088] The request may comprise a value for a time within which the analytics consumer is to receive the analytics report.

[0089] The analytics report may comprise at least one of: an indication of an analytics result; an indication that the analytics result is at least one of a numeric result, a recommendation, and/or a root cause result; a description of the analytics result being provided; a length of the result; and/or a degree of confidence in the analytics result.

[0090] The indication of an analytics result may indicate whether the analytics result is based on statistics using historic data and/or predictions of future data.

[0091] The request may comprise an indication of at least one of an analytics performance input and/or a granularity for collecting measurements for performing the analytics reporting control.

[0092] The request may comprise at least one of a location of and/or an identification of at least one object for performing the analytics reporting control.

[0093] According to an eighth aspect, there is provided an apparatus for an analytics consumer, the apparatus comprising: determining circuitry for determining parameters for requesting an analytics reporting control to be performed; signalling circuitry for signalling a request for performing the analytics reporting control to an analytics producer using information object class signalling, the request comprising an indication of the determined parameters; and receiving circuitry for receiving an analytics report from the analytics producer that is based on the signalled request.

[0094] The indication may be a request to subscribe to an existing analytics reporting control.

[0095] The indication may be a request to instantiate the analytics reporting control at the analytics producer.

[0096] The request may comprise a plurality of parameters for instantiating the analytics reporting control, the plurality of parameters comprising agnostic information related to a computational model for performing the analytics reporting control, specific information relating to the computation model in relation to a specific use case, and context information relating to the specific use case.

[0097] The request may comprise an identifier of an analytics service being requested.

[0098] The request may comprise parameters indicating at least one of: a frequency, and/or duration, and/or period and/or mechanism by which the analytics producer should signal the analytics report.

[0099] The request may comprise an indication that the analytics report is to be signalled by one of: a notification-based mechanism, a streaming-based mechanism, and by a file request mechanism.

[0100] The request may comprise a value for a time within which the analytics consumer is to receive the analytics report.

[0101] The analytics report may comprise at least one of: an indication of an analytics result; an indication that the analytics result is at least one of a numeric result, a recommendation, and/or a root cause result; a description of the analytics result being provided; a length of the result; and/or a degree of confidence in the analytics result.

[0102] The indication of an analytics result may indicate whether the analytics result is based on statistics using historic data and/or predictions of future data.

[0103] The request may comprise an indication of at least one of an analytics performance input and/or a granularity for collecting measurements for performing the analytics reporting control.

[0104] The request may comprise at least one of a location of and/or an identification of at least one object for performing the analytics reporting control.

[0105] According to a ninth aspect, there is provided non-transitory computer readable medium comprising program instructions for causing an apparatus for an analytics producer to perform at least the following: receive a request for performing an analytics reporting control from an analytics consumer using information object class signalling, the request comprising an indication of determined parameters; perform at least part

of the analytics reporting control to produce output results; form an analytics report comprising the output results; and signal the analytics report to the analytics consumer.

[0106] The indication may be a request to subscribe to an existing analytics reporting control.

[0107] The apparatus may be caused to modify the existing analytics reporting control to perform both the requested analytics reporting control and the reporting control performed by the existing analytics reporting control prior to modification, and perform at least part of the analytics reporting control may comprise performing the modified existing analytics reporting control to produce output results.

[0108] The indication may be a request to instantiate the analytics reporting control at the analytics producer.

[0109] The request may comprise a plurality of parameters for instantiating the analytics reporting control, the plurality of parameters comprising agnostic information related to a computational model for performing the analytics reporting control, specific information relating to the computation model in relation to a specific use case, and context information relating to the specific use case.

[0110] The request may comprise an identifier of an analytics service being requested.

[0111] The request may comprise parameters indicating at least one of: a frequency, and/or duration, and/or period and/or mechanism by which the analytics producer should signal the analytics report.

[0112] The request may comprise an indication that the analytics report is to be signalled by one of: a notification-based mechanism, a streaming-based mechanism, and by a file request mechanism.

[0113] The request may comprise a value for a time within which the analytics consumer is to receive the analytics report.

[0114] The analytics report may comprise at least one of: an indication of an analytics result; an indication that the analytics result is at least one of a numeric result, a recommendation, and/or a root cause result; a description of the analytics result being provided; a length of the result; and/or a degree of confidence in the analytics result.

[0115] The indication of an analytics result may indicate whether the analytics result is based on statistics using historic data and/or predictions of future data.

[0116] The request may comprise an indication of at least one of an analytics performance input and/or a granularity for collecting measurements for performing the analytics reporting control.

[0117] The request may comprise at least one of a location of and/or an identification of at least one object for performing the analytics reporting control.

[0118] According to a tenth aspect, there is provided non-transitory computer readable medium comprising program instructions for causing an apparatus for an analytics consumer to perform at least the following: determine parameters for requesting an analytics reporting control to be performed; signal a request for performing the analytics reporting control to an analytics producer using information object class signalling, the request comprising an indication of the determined parameters; and receive an analytics report from the analytics producer that is based on the signalled request.

[0119] The indication may be a request to subscribe to an existing analytics reporting control.

[0120] The indication may be a request to instantiate the analytics reporting control at the analytics producer.

[0121] The request may comprise a plurality of parameters for instantiating the analytics reporting control, the plurality of parameters comprising agnostic information related to a computational model for performing the analytics reporting control, specific information relating to the computation model in relation to a specific use case, and context information relating to the specific use case.

[0122] The request may comprise an identifier of an analytics service being requested.

[0123] The request may comprise parameters indicating at least one of: a frequency, and/or duration, and/or period and/or mechanism by which the analytics producer should signal the analytics report.

[0124] The request may comprise an indication that the analytics report is to be signalled by one of: a notification-based mechanism, a streaming-based mechanism, and by a file request mechanism.

[0125] The request may comprise a value for a time within which the analytics consumer is to receive the analytics report.

[0126] The analytics report may comprise at least one of: an indication of an analytics result; an indication that the analytics result is at least one of a numeric

result, a recommendation, and/or a root cause result; a description of the analytics result being provided; a length of the result; and/or a degree of confidence in the analytics result.

[0127] The indication of an analytics result may indicate whether the analytics result is based on statistics using historic data and/or predictions of future data.

[0128] The request may comprise an indication of at least one of an analytics performance input and/or a granularity for collecting measurements for performing the analytics reporting control.

[0129] The request may comprise at least one of a location of and/or an identification of at least one object for performing the analytics reporting control.

[0130] According to an eleventh aspect, there is provided a computer program comprising program instructions for causing a computer to perform any method as described above.

[0131] According to a twelfth aspect, there is provided a computer program product stored on a medium that may cause an apparatus to perform any method as described herein.

[0132] According to a thirteenth aspect, there is provided an electronic device that may comprise apparatus as described herein.

[0133] According to a fourteenth aspect, there is provided a chipset that may comprise an apparatus as described herein.

Brief description of Figures

[0134] Examples will now be described, by way of example only, with reference to the accompanying Figures in which:

[0135] Figures 1A and 1B show a schematic representation of a 5G system;

[0136] Figure 2 shows a schematic representation of a network apparatus;

[0137] Figure 3 shows a schematic representation of a user equipment;

[0138] Figure 4 shows a schematic representation of a non-volatile memory medium storing instructions which when executed by a processor allow a processor to perform one or more of the steps of the methods of some examples;

[0139] Figure 5 shows a schematic representation of a network;

[0140] Figure 6 shows a schematic representation of operations performed by an analytics producer;

[0141] Figure 7 shows a schematic representation of an analytics producer interacting with a plurality of analytics consumers;

[0142] Figure 8 shows example signalling between an analytics producer and an analytics consumer;

[0143] Figure 9 shows a schematic representation of a fragment;

[0144] Figure 10 illustrates example signalling between an analytics producer and an analytics consumer; and

[0145] Figures 11 and 12 are example flow charts illustrating operations performed by, respectively, and analytics producer and an analytics consumer.

Detailed description

[0146] In the following, certain aspects are explained with reference to mobile communication devices capable of communication via a wireless cellular system and mobile communication systems serving such mobile communication devices. For brevity and clarity, the following describes such aspects with reference to a 5G wireless communication system. However, it is understood that such aspects are not limited to 5G wireless communication systems, and may, for example, be applied to other wireless communication systems with analogous components (for example, current 6G proposals).

[0147] Before explaining in detail the exemplifying embodiments, certain general principles of a 5G wireless communication system are briefly explained with reference to Figures 1A and 1B.

[0148] Figure 1A shows a schematic representation of a 5G system (5GS) 100. The 5GS may comprise a user equipment (UE) 102 (which may also be referred to as a communication device or a terminal), a 5G access network (AN) (which may be a 5G Radio Access Network (RAN) or any other type of 5G AN such as a Non-3GPP Interworking Function (N3IWF) /a Trusted Non3GPP Gateway Function (TNGF) for Untrusted / Trusted Non-3GPP access or Wireline Access Gateway Function (W-AGF) for Wireline access) 104, a 5G core (5GC) 106, one or more application functions (AF) 108 and one or more data networks (DN) 110.

[0149] The 5G RAN may comprise one or more gNodeB (gNB) distributed unit functions connected to one or more gNodeB (gNB) unit functions. The RAN may comprise one or more access nodes.

[0150] The 5GC 106 may comprise one or more Access Management Functions (AMF) 112, one or more Session Management Functions (SMF) 114, one or more authentication server functions (AUSF) 116, one or more unified data management (UDM) functions 118, one or more user plane functions (UPF) 120, one or more unified data repository (UDR) functions 122, one or more network repository functions (NRF) 128, and/or one or more network exposure functions (NEF) 124. Although NRF 128 is not depicted with its interfaces, it is understood that this is for clarity reasons and that NRF 128 may have a plurality of interfaces with other network functions.

[0151] The 5GC 106 also comprises a network data analytics function (NWDAF) 126. The NWDAF is responsible for providing network analytics information upon request from one or more network functions or apparatus within the network. Network functions can also subscribe to the NWDAF 126 to receive information therefrom. Accordingly, the NWDAF 126 is also configured to receive and store network information from one or more network functions or apparatus within the network. The data collection by the NWDAF 126 may be performed based on at least one subscription to the events provided by the at least one network function.

[0152] Figure 1B shows a schematic representation of a 5GC 106' represented in current 3GPP specifications.

[0153] Figure 1B shows a UPF 120' connected to an SMF 114' over an N4 interface. The SMF 114' is connected to each of a UDR 122', an NEF 124', an NWDAF 126', an AF 108', a Policy Control Function (PCF) 130', and an AMF 112' over an interconnect medium that also connects these network functions to each other. The PCF 130' is connected to an online charging system (OCS) 132' over an N28 interface.

[0154] 3GPP refers to a group of organizations that develop and release different standardized communication protocols. 3GPP is currently developing and publishing documents related to Release 16, relating to 5G technology, with Release 17 currently being scheduled for 2022.

[0155] 3GPP is standardizing a Management Data Analytics Service (MDAS) and the related Management Data Analytics Function (MDAF). MDAF or MDAS producer or MDA MnS producer are entities that may be producers of analytics in the management plane. It is understood that references below to an analytics producer will apply to any of these entities, and that examples using a specific one of these terms are not limited to only that entity. The MDAF is an entity that holds a set of functions / Agents that provides statistics, and/or prediction analytics or recommendation options or route

cause analysis result based on Management Data. The MDAF may optionally include the functions that compute the analytics too. Management Data Analytics Service (MDAS) and the related Management Data Analytics Function (MDAF) are intended to be responsible for providing analytics for a number of different use cases, including Service Level Specification (SLS) assurance, alarm and fault management, resource management, Self-Organized Networks (SON), security and network maintenance, as described in 3GPP TR 28.809.

[0156] As 3GPP communication networks have become more of a service-based architecture, 3GPP became more concerned with the concept of providing analytics within a network from an analytics producer and an analytics consumer in order to better provide a service and/or otherwise control network operations with the aim of optimizing network resources.

[0157] Analytics is the concept of, or the area of work on, computing analysis on data to produce at least one insight that helps improve the quality of a hypothesis. For example, analytics may determine an optimum gNB in a communication network to which to handover a UE to while considering the effects such a handover would have on multiple entities accessing the communication network. The insight/analysis may be applied to multiple analytics use cases, where an analytics use case is a specific problem for which a hypothesis that can be generated and thus for which analysis may be undertaken. The producer of analytics may be a process, which is referred to herein as an analytics job. The process/analytics job is also be referred to as MDA reporting control or “analytics reporting control”, and these terms are used interchangeably throughout the following. Thus, in the following, the term “analytics job” refers to the process(es) related to producing at least one analytics report for a specific use case. The analytics job may also comprise the processes to format, control and compile an analytics report for reporting the results of the analytics job to the analytics consumer.

[0158] In order to perform an analytics operation, an analytics computation model is used. The analytics computation model is a set of algorithms and/or functions used to compute analytics. The set may comprise one. The set may comprise more than one. The set may comprise, for example, at least one of a mathematical function, an artificial intelligence (AI) and/or machine learning (ML) function, and/or some other rule-based procedure. The analytics computation model produces an output. The output may be, for example, at least one of a statistic or prediction result, recommendation option(s), and/or root cause analysis result(s), where a root cause

analysis result is a systematic process for identifying “root causes” of problems or events and an approach for responding to them.

[0159] Analytics also defines an Analytics Report Instance (ARI). An ARI refers to a capability of an entity to produce analytics for a given use case. The ARI is associated with at least one analytics computation model. The ARI is associated with a set of parameters (also referred to herein as an ARI Context Set of analytics parameters). This set of parameters may comprise time scheduling, filtering, analytics model, etc. An analytics report instance may support different analytics jobs that each have their own distinct context.

[0160] Once the analytics job is completed, the analytics producer compiles a report for providing to the analytics consumer. This report may be labelled as a Management Data Analytics Service (MDAS) report or MDA report, and comprise the outcome of the analytics job. The outcome produced by the MDAS producer using an analytics job and reported in an MDAS report may be comparable to a Performance Measurement (PM) or Key Performance Indicator (KPI) report defined in 3GPP specifications.

[0161] Figure 6 schematically illustrates the above concepts.

[0162] Figure 6 shows a plurality of management data analytics functions 601, one of which comprises a plurality of analytics computation models 602a-602c. One of the management data analytics function is part of (e.g. nestled within) the other management data analytics function. Each of the plurality of analytics computation models 602a-602c are associated with a respective analytics job 603a-603c in the other management data analytics function 601. The analytics job 603a is shown as providing an analytics report instance 604 to an MDAS 605.

[0163] Figures 7 and 8 illustrate relationships between multiple Management Data Analytics (MDA) consumers or MDA Management Service (MnS) consumers requesting and receiving analytics from an MDAS producer.

[0164] Figure 7 shows an MDAS producer 701 that receives respective analytic requests from each of a plurality of MDA consumers 702. In response to receipt of a request, the MDAS producer 701 responds to the requesting MDA consumer with a report comprising the requested analytics (or, alternatively, a failure message).

[0165] The analytics related interaction may be grouped into at least 4 steps. These are illustrated with respect to Figure 8, which shows an MDAS producer 801 and an MDA consumer 802. The steps include operations 8001 to 8004.

[0166] At 8001, the MDA consumer 802 discovers analytics are available from an MDAS producer 801. This may be discovered between the MDA consumer 802 and the MDAS producer 801.

[0167] At 8002, the MDA consumer 802 requests analytics from the MDAS producer 801.

[0168] At 8003, the MDAS producer 801 processes the received request of 8002 and compiles the requested analytics (when available).

[0169] At 8004, the MDAS producer 801 provides the requested analytics to the MDAS consumer 802. Usefully, the requested analytics are provided in a report having a standardized format.

[0170] There are different kinds of analytics that can be computed from distinctive Performance Measurements (PMs), configuration management and fault management data, trace data, Quality of Experience data, alarms, and/or Key Performance Indicators (KPIs). These analytics may concentrate on network objects such as, for example: Network Function (NFs), gNBs, cell and UEs; network processes such as mobility optimization, energy efficiency and/or load balancing; faults and alarm incidents as well as analytics on user behaviour and traffic characteristics.

[0171] An MDAS producer may provide statistics and/or prediction insights and/or recommendation options and/or root cause analysis results for assisting an MDAS consumer to take a decision or any combination of these. An MDA consumer may be interested in receiving different insights of such analytics with distinct levels of reporting granularity. However, the reporting mechanisms described in 3GPP provides reporting mechanisms irrespective of consumer needs. But for example, this shall not be the case in 3GPP TR 28.809, which describes use case for specific analytics information, which may potentially be used for MDA reporting.

[0172] 3GPP has performed various studies on MDAS.

[0173] As a first example study, 3GPP SA5 TR 28.809 describes several use cases for MDAS. For each use case the set of required input and outputs has been identified, but without defining a reporting structure and mechanism to deliver MDA reports towards the consumer. The effort in 3GPP SA5 focuses on the interface aspects, and introduces re-usability irrespective of the Management Service (MnS).

[0174] As a second example study, an alternative analytics framework was developed by 3GPP SA2. This alternative analytics framework focused on a Network Data Analytics Function (NWDAF) according to 3GPP TS 29.520. This second example

study also considered network function models, and defined a report with respect to each different kind of analytics. Under this framework, the NWDAF provides analytics to consumers via a subscription, which assumes that input data is constantly being collected and that analytics results are already computed without providing any option for choosing a computational model or selecting the input data sources.

[0175] As a further example study, an analytics job has been described that focuses on requesting analytics by introducing further analytics attributes concentrating on computation method, filtering, etc., as well as on introducing further ways on asking how to report analytics, i.e. immediately if a feasible subscription to an existing analytics data is available or after a time period if input data or analytics need to be collected and/or processed before being reported.

[0176] The Analytics Job in S5-203151 can also be adopted as an example of a base mechanism that instantiates MDA reporting, wherein the proposed reporting mechanisms, control and MDA report structure and data format can be used.

[0177] Figure 9 illustrates the analytics job control Network Resource Management (NRM) fragment assuming that the MDA producer may belong to a sub network, managed element, managed function or network slice level. In the present case, the NRM fragment is an information model representing how an analytics job can control reporting. Figure 9 shows a proxy class Managed entity 901 that represents at least one of the following Information Object Classes: SubNetwork, ManagedElement, ManagedFunction, and/or NetworkSliceSubnet. The Information Object Class “analytics job” 902 is defined/named towards the proxy class Managed entity 901.

[0178] A further study, S5-212418, considers the MDA request towards the MDAS producer comprising analytics attributes that include at least one of: the identifier of the analytics, reporting method, file information (e.g. size, format, filter information). In addition, this study lists the potential reporting options based on TS 28.532.

[0179] To address at least one of the above-identified problems, the following introduces a mechanism to request analytics that allows an MDAS consumer to indicate the desired service parameters and reporting type. This request may comprise, for example, an analytics name, time schedule, filtering information, analytics type, computational method, etc.

[0180] The following discloses a mechanism of structuring the MDA report towards consumers in a generic manner that also takes advantage of the analytics information identified in 3GPP TR 28.809. For example, when analytics are specified in a way to

address particular use cases, a different type of analytics report would be created per use case. This may prove to be cumbersome for the analytics deployment and standardisation. In contrast, the use of a generic structure, as disclosed herein, may allow scalability and flexibility for accommodating even further use cases without limiting the MDA reporting structure and mechanisms.

[0181] The following further discloses procedures for choosing a reporting mechanism and providing a reporting framework that satisfies the MDA consumer request in response to particular types of analytics being requested. In case the MDA reporting contains small amounts of data, such as root cause analysis results, the use of reporting by providing notifications may be used. In contrast, when large amounts of data are produced file-based reporting mechanisms can be used, and when analytics data is produced frequently, this may be reported using a streaming mechanism.

[0182] The MDA producer may rely on data that is at that specific time available or that is collected from certain or selected input sources. However, currently MDA does not include any mechanisms to let the MDA consumer know about the state of a pending report nor to allow the consumer to control dynamically reporting process.

[0183] The MDA consumer as described herein may also indicate in the request for analytics certain check conditions or check points or filters, e.g. mobility speed or geographical area or network load, which, when met, causes the MDA producer to check (and potentially modify) the reporting conditions and mechanisms.

[0184] The following further discloses providing a series of notification reports for informing the MDA consumer regarding the state of the MDA reporting upon check points. These notification reports may comprise, for example, information such as a time schedule, accuracy, input data sources or fault and errors that may impact related report parameters and delivery options.

[0185] The following proposes multi-use case mechanisms for requesting and reporting analytics for both standardized and proprietary analytics that may be supported by a given Management Data Analytics Function. There is provided a structure of the MDA request and related Application Programming Interface (API) calls, a structure of the MDA report, a corresponding data type for the MDA report, and the implementation of the analytics reporting mechanisms as extensions of the Performance Management reporting for optimizing parts of the described mechanism.

[0186] The presently described request mechanism may enable the MDA consumer to control the process and provide filters for the production of analytics according to a

specific context for an ARI. The reporting mechanism provides an MDA reporting framework defining the interactions needed to support the efficient delivery of MDA reports for any kind of analytics use case.

[0187] Figure 10 provides an overview of the operations that may be performed as part of the process described herein.

[0188] Figure 10 illustrates operations performed by an MDAF 1001 and an MDA consumer 1002 that interact with each other.

[0189] At 10001, the MDA consumer 1002 signals the MDAF 1001 to request that some analytics be performed by the MDAF. This analytics request may comprise, for example, an indication of an analytics service and context for performing the indicated analytics service. These are discussed further below.

[0190] At 10002, in response to receiving the signalling of 10001, the MDAF 1001 computes and/or generates the requested analytics (assuming that the MDAF 1001 is capable of performing these operations for the requested analytics of 10001).

[0191] At 10003, the MDAF 1001 compiles an analytics report comprising the analytics computed/generated in 10002.

[0192] The MDAF 1001 may then signal the analytics report to the MDA consumer. This is shown being performed in three different ways at 10004a, 10004b, and 10004c.

[0193] At 10004a, the MDAF 1001 is configured to provide the analytics report using file-based reporting.

[0194] At 10004b, the MDAF 1001 is configured to provide the analytics report using streaming. To effect this, a connection with the MDA consumer 1002 is first established before the report is streamed. The streaming may be performed such that the report provision is performed on a loop after the connection has been established.

[0195] At 10004c, the MDAF 1001 is configured to signal the analytics report using a notification-based system, where the MDA consumer is notified of the existence of the report and may subsequently retrieve a copy of the report.

[0196] The following provides more information on how the above may be implemented in a 3GPP system.

[0197] First, the process of requesting analytics will be considered.

[0198] An MDA consumer determines what analytics job it would like to request. When the analytics job already exists, the MDA consumer may request to subscribe to the existing Analytics Job. The MDA consumer may determine whether the analytics job already exists using the discovery procedure, which may also provide capabilities of

the MDA producer(s). The MDA consumer may use this information to select an MDA producer to which to send the analytics request. When the analytics job does not exist, the MDA consumer may request that the MDA producer instantiate an analytics job by specifying a particular description and context as part of the request. To instantiate is to create an instance of an object in an object-oriented programming (OOP) language. An instantiated object is given a name and created in memory or on disk using the structure described within a class declaration that is provided as part of the request.

[0199] The request may be made using an interface language, such as Abstract Syntax Notation One (ASN.1). ASN.1 is a standard interface description language for defining data structures that can be serialized and deserialized in a cross-platform way. Protocol developers define data structures in ASN.1 modules, which are generally a section of a broader standards document written in the ASN.1 language. The advantage is that the ASN.1 description of the data encoding is independent of a particular computer or programming language. ASN.1 also widely uses a concept of Information Object Class (IOC) to provide a language that lets a program or object written in one language communicate with another program written in an unknown language. IDLs describe an interface in a language-independent way, enabling communication between software components that do not share one language.

[0200] The request may include an analytics job description, agnostic information, specific information for the analytics job description, and an Analytics Job context, which may comprise, for example, scheduling time, filter, etc. These are illustrated with respect to Tables 1 and 2.

[0201] Table 1 demonstrates potential attributes of an ARI for a specific analytics job. As mentioned above, ARI refers to a capability of an entity to produce analytics for a given use case. One ARI will typically relate to at least one analytics job. The ARI is associated with at least one analytics computation model. The ARI is associated with a set of parameters (also referred to herein as an ARI Context Set of analytics parameters). This set of parameters may comprise time scheduling, filtering, analytics model, etc. An analytics report instance may support different analytics jobs with a distinct context.

[0202] In the present case, the ARI attributes comprise ARI agnostic description information, ARI specific description information, and ARI context information.

[0203] The ARI agnostic description information focuses on the computational model specifics and comprises a plurality of attributes, such as “Model Type”, “Model

Metrics", etc. These are shown below in Table 1 as an "Attribute name", and are each provided with an accompanying description.

[0204] The ARI specific description information focuses on parameters for computational model in the specific case and comprises a plurality of attributes, such as "Location", "Reporting Methods", etc. These are shown below in Table 1 as an "Attribute name", and are each provided with an accompanying description.

[0205] The ARI context information focuses on contextual information for running the computational model is to be implemented in the specific case, and comprises a plurality of attributes, such as "Scheduling Time", "Object Configuration", etc. These are shown below in Table 1 as an "Attribute name", and are each provided with an accompanying description.

Information Group	Attribute name	Description
ARI agnostic Description information	Model Type	Type of model used to compute the analytics, e.g., convolutional neural network, ML, a mathematical/statistical function, a time-series perdition.
	Model Metrics	The metrics that may be used to describe the performance of the analytics service. Examples are True Positives, false positives, the F1 score, etc.
	Model Data Type	Indication of the desired input data type as real-time, near real-time or non real-time.
	Model Time Stamp	Time stamp when the model was trained or put into service.
	Model Modification Time	Time stamp that indicates the last modification in the analytics model including a rule modification or model replacement.
	Model Computation Flag	Flag that indicates if the analytics model can provide a computational result immediately or not immediately, e.g., because it needs to collect PMs/KPIs to compute analytics.
ARI specific Description information	Location	Geographical location related to analytics or locationName.
	Network Objects Instances	Network objects or network resource instances (e.g. network elements and procedures) for which analytics are to be provided.
	Performance Metric(s)	PMs, trace, Configuration Management/Fault Management (CM/FM), Quality of Experience (QoE), KPIs or network function metrics related to produced analytics.

	Analytics Type	Indication of the capability to provide statistics, predictions, recommendation option(s), or root cause analysis result(s).
	Reporting Methods	Indication of the reporting method, i.e. file based, streaming or notifications.
	Availability Time	Time stamp that indicates the time when a report shall be available, i.e. if there is an undergoing computational task.
	Monitoring Input Granularity	Indicates the time granularity of collecting trace, CM/FM, QoE, PMs/KPIs for providing an analytics result.
	Job Subscription Flag	Indicates whether the consumer is willing to subscribe to an existing Job or requires creating another separate Job that it may modify at any time.
ARI Context information	Object configuration	Configuration of a target object, e.g., NF, gNB, cell, related to analytics.
	Analytics scope	Indication of the analytics scope, i.e., issue type, (e.g. load prediction, optimal mobility target), root cause indication or alarm correlation.
	Scheduling time(s)	Timing information, i.e., start time and duration as well as target time, validity time, related to analytics service.
	Target object(s)	Target UEs, Area of Interest, Connection/session related to analytics service.
	Filters	Conditions for triggering a report, e.g., load threshold, UE movement, UE entering Area of Interest, etc.
	Sampling accuracy	Indication of the desired sampling ratio of analytics target objects, e.g., 60% of the UEs.

Table 1

[0206] Table 2 illustrates attributes that may be comprised within an Analytics Job request. It is understood that only some of these parameters may be comprised within the request, depending on the specific implementation.

[0207] Table 2 lists Attributes separately for Description Information Attributes and Context Information Attributes. However, for each of the attributes listed under these categories, each attribute is provided with an indication of whether the attribute is readable, writable, invariant and/or notifiable. In this indication, “T” represents that the listed attribute does have that quality while “F” represents that the listed attribute does not have that quality.

Attribute name	isReadable	isWritable	isInvariant	isNotifyable
Description Information Attributes				
analyticsName	T	T	F	T
modelType	T	T	F	T
modelMetrics	T	T	F	T
modelDatatype	T	T	F	T
modelTimestamp	T	T	F	T
modelModtime	T	T	F	T
modelCompflag	T	T	F	T
Context Information Attributes				
performanceMetrics	T	**T**	F	T
reporting Methods	T	**T**	F	T
analyticsType	T	**T**	F	T
startTime	T	**T**	F	T
duationTime	T	**T**	F	T
targetTime	T	**T**	F	T
geoLocation	T	**T**	F	T
locationName	T	**T**	F	T
inputGranularity	T	**T**	F	T
targetObjects	T	**T**	F	T
subscriptionFlag	T	**T**	F	T
samplingAccuracy	T	**T**	F	T
thresholdInfoList	T	**T**	F	T
monitorGranularityPeriod	T	**T**	F	T
objectInstances	T	**T**	F	T

Table 2

[0208] To support the request mechanism, the ARI is modelled as an Information Object Class with the attributes as described in Tables 1 and 2.

[0209] As the ARI is modelled as an Information Object Class, the MDA consumer may make the analytics request using a create operation as:

createMOI (ARI_IOC, ARI_IOC_Attributes)

where:

- An MOI is a managed object instance;
- ARI_IOC represents the standardized IOC for all ARIs; and
- ARI_IOC_Attributes represents the specific attributes and values thereof (such as those listed in Table 3 or a similar set to be defined in the 3GPP standard) that apply for the specific analytics instance that the MDA consumer is requesting to instantiate.

[0210] When a subscription request is issued by the MDA consumer, the subscription request may comprise a positive option in the existing subscriptionFlag field that indicates the analytics name or Analytics identity, and the ARI description as per Table 1. The process of subscription may follow the steps described in TS 23.288. In addition to subscribing, an MDA consumer may modify the subscription and unsubscribe from the subscription.

[0211] When an MDA consumer requests that an analytics job be instantiated, the request may comprise indications of a plurality of attributes for the analytics job. These are shown below in Table 3, with existing attributes that are re-used for the purpose of analytics being italicized.

Attribute Name	Documentation and Allowed Values	Properties
analyticsName	Identifier of the analytics service by indicating a name to allow a consumer to request analytics reports. Example of allowedValues: - coverageIssues - alarmIssues - mobilityOptimization - latencyAssurance - etc.	type: String multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
analyticsType	Describes the type of the requested MDA report output data. It contains two fields: - characterization of analytics result with allowedValues: (i) statistics, or (ii) predictionanalytics output results type with allowedValues: (i) numeric, i.e. array or list of data values, (ii) recommendation options and (iii) root cause analysis results. -	type: (ENUM, ENUM) multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
geoLocation	Indicates a geographical location using Tracking Areas (TAs), cells, and/or coordinates allowedValues: N/A	type: String multiplicity: * isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False

Attribute Name	Documentation and Allowed Values	Properties
inputGranularity	Indicates the frequency in time units, of collecting trace, CM/FM, QoE, PMs/KPIs data for providing the analyticsDatavalues or analyticsRecommendation or analyticsRootcause.	type: DateTime multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
locationName	*The physical location of this entity (e.g. an address).* *allowedValues: N/A*	*type: String* *multiplicity: 0..1* *isOrdered: N/A* *isUnique: N/A* *defaultValue: None* *isNullable: False*
modelCompFlag	Flag that indicates if the analytics model can provide a computational result immediately or not.	type: Boolean multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False

Attribute Name	Documentation and Allowed Values	Properties
modelDatatype	Indicates the type of input data that feeds the analytics Model. allowedValues: - real-time, - near real-time, - non real-time	type: ENUM multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
modelId	Identifier of the analytics model for reference purposes, i.e. to allow notifications towards consumer.	type: Integer multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
modelModtime	Time stamp that indicates the last modification in the analytics model.	type: DateTime multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False

Attribute Name	Documentation and Allowed Values	Properties
modelMetrics	Metrics used to describe the performance of the analytics service. Examples of allowedValues: - True Positives, - False positives, - F1 score, - etc.	type: Integer multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
modelTimestamp	Time stamp that indicates when the model was trained or put into service.	type: DateTime multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
modelType	Type of analytics Model used to compute the analyticsValues or analyticsRecommendation or analyticsRootcause. Example of allowedValues: - ML Model, - RL Model, - Rule based Model, - etc.	type: String multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False

Attribute Name	Documentation and Allowed Values	Properties
monitorGranularityPeriod	*Granularity period used to monitor measurements for threshold crossings (TS 28.622). The period is defined in seconds.* *allowedValues: Integer with a minimum value of 1*	*type: Integer* *multiplicity: 1* *isOrdered: False* *isUnique: True* *defaultValue: None* *isNullable: False*
objectInstances	*Managed object instance identified by its Distinguished Name, which is a unique identifier.* *allowedValues: N/A*	*type: String* *multiplicity: 1* *isOrdered: N/A* *isUnique: N/A* *defaultValue: None* *isNullable: None*

Attribute Name	Documentation and Allowed Values	Properties
performanceMetrics	*List of performance metrics.* *Performance metrics include measurements defined in TS 28.552 [20] and KPIs defined in TS 28.554 [28]. Performance metrics can also be those specified by other SDOs or vendor specific metrics. Performance metrics are identified with their names. A name can also identify a vendor specific group of performance metrics.* *For measurements defined in TS 28.552 [20] the name is constructed as follow:* *- "family.measurementName.subcounter" for measurement types with subcounters* *- "family.measurementName" for measurement types without subcounters* *- "family" for measurement families* *For KPIs defined in TS 28.554 [28] the name is defined in the KPI definitions template as the component designated with e).* *allowedValues: N/A*	*type: String* *multiplicity: ** *isOrdered: N/A* *isUnique: True* *defaultValue: None* *isNullable: False*
reportingMethods	*List of reporting methods for performance metrics* *allowedValues:* *- "FILE_BASED_LOC_SET_BY_PRODUCER",* *- "FILE_BASED_LOC_SET_BY_CONSUMER",* *- "STREAM_BASED"* *- "NOTIFICATION_BASED"*	*Type: ENUM* *multiplicity: ** *isOrdered: N/A* *isUnique: True* *defaultValue: None* *isNullable: False*

Attribute Name	Documentation and Allowed Values	Properties
samplingAccuracy	Indicate the desired sampling ratio of an analytics target, i.e. a sampling ratio of UEs or gNBs, e.g. 60% of UEs.	type: Integer multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
startTime	Time stamp that indicates the starting instance related to analyticsDatavalues or analyticsRecommendation or analyticsRootcause. It can be (i) in the past when the analyticsType is statistics or root cause or (ii) in the future when the analyticsType is a prediction or recommendation or root cause prediction.	type: DateTime multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
subscriptionFlag	Indicates whether the consumer is willing to subscribe to an existing Analytics Job provided that it holds the same context information attributes as the ones requested.	type: Boolean multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False

Attribute Name	Documentation and Allowed Values	Properties
targetObjects	Object instance related to the analytics result and reporting identified by: - Distinguished Name if it is a managed object, - S-NSSAI if it is a slice - UE identifier if it is a UE. allowedValues: N/A	type: String multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: None
targetTime	Time stamp that indicates until when (i.e. time instance) the consumer can wait to receive a requested MDA report.	type: DateTime multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
thresholdInfoList	*List of threshold infos.*	*type: ThresholdInfo* *multiplicity: 1..** *isOrdered: False* *isUnique: True* *defaultValue: None* *isNullable: False*

Table 3

[0212] On the MDAS producer side, when the requested analytics job comprises attributes/parameters that are identical to an existing analytics job, the MDAS producer subscribes the consumer to that existing analytics job, provided that the consumer is

willing to subscribe to an existing analytics job. Otherwise, the MDAS producer creates the desired Analytics Job, which may then be modified based on the consumer update requests at any subsequent point in time.

[0213] The MDAS producer then notifies the MDAS consumer with the Job Name/ID if the request was successful, and also indicates whether (or not) the MDAS consumer is now subscribed to an existing Analytics Job. If the request was not successful the consumer is notified that the request was not successful. This may be accompanied with an indication of why the request was not successful, i.e., indicating the reasons why the requested Analytics Job is not supported.

[0214] When the requested Analytics Job is supported but the MDAS producer is not able to provide the analytics immediately (for example, the MDAS producer may take time to compute the requested analytics), the MDAS producer may return a notification to the MDAS consumer that informs the MDAS consumer of an estimated analytics availability time. This estimated time may be provided with an indication of at least one reason why this analytics job will take this length of time, and/or an indication of conditions under which the requested analytics will be provided.

[0215] The MDAF may provide multiple analytics jobs. Each analytics job may be based on a single ARI that produces statistics, predictions, recommendation options or route cause analysis results to the consumer. This means that the configurability of the definition of the analytics job is flexible enough to allow different MDA reports to be derived.

[0216] There may be several different types of analytics computation model that can be selected. The following provides a non-exhaustive list of types of models that may be selected as part of an analytics job request:

- Mathematical function, e.g., for computing the statistics of the input data like a standard deviation or a range
- Machine learning model, i.e. a model that has been trained to perform a prediction for, for example, a number or a series
- Reinforcement learning model
- Artificial Intelligence model
- Rule-based procedure say for threshold crossing analytics.

[0217] Each Analytics Computation Model can support multiple MDA report variations as a result of the ability to specify different contexts. Each analytics Computation model may also instantiate an MDA report request if the specified analytics context is within the ARI capability limits for that model. Consequently, ARI capabilities provide a degree of flexibility in accommodating MDA request and reports.

[0218] Once an MDA report request has been instantiated by an analytics producer (assuming the request is within the capabilities of the ARI), an analytics job is created that handles the MDA reports towards the consumer. The ARI capabilities and the Analytics Job may comprise fields for: an ARI name(s), description, context, and metrics information that contain potential set of options or a range of supported values. An analytics job may thus comprise a single ARI name, specific description and context information, while also comprising an indication of what form the output of the job should take (e.g. analytics data values, recommendations, and/or root cause analysis results). These four attribute fields are for the purpose of requesting and reporting analytics. They are further illustrated by Tables 4 and 5, which respectively illustrate attributes for the ARI and for the Analytics Job.

Attribute name	**Description**
ARI Name/ID	Name(s) that identifies the ARI
ARI Description information	Information that describes the ARI and enables an MDA consumer to request and select analytics
ARI Context information	Configurable ARI parameters that identify the different conditions for which analytics can be provided towards the MDA consumer
ARI Metrics information	Metrics that describe the analytics data values or recommendations or root cause analysis result.

Table 4

Attribute name	Description
Job Name/ID	A name that identifies the Analytics Job
Job Description information	Information that describes computational model and related parameters that is used in the Analytics Job
Job Context information	Context parameters that specify the conditions (e.g. timing, filter, etc.) for which analytics can be provided towards the MDA consumer
Job Metrics and Output Data	Metrics that describe the analytics data values or recommendations or root cause analysis result, including corresponding output data.

Table 5

[0219] The analytics output data in the MDA report may be statistics or predictions. Either of these outputs may be provided as one of 1-, 2-, or n-valued tuples, as illustrated with respect to Table 6. Meanwhile, an Analytics Job may produce output for more than a single analytics data variable. This means that the analytics job output may use a different tuple from the three listed in Table 6 relative to the output data in the MDA report. An Analytics Job may for example concurrently report the mean, range, and deciles on a piece of data, and further comprise an expected value at a particular point of time.

Category	Description	Examples
1-valued	A single value	Mean, standard deviation, expected
2-valued	A pair of values	Range (min, max)
n-valued	A tuple of more than 2 values	Quartiles, deciles, percentiles, CDFs

Table 6

[0220] When the analytics output data in the MDA report holds recommendation options or root cause analysis results, the same tuple categories may be adopted. However, instead of carrying data values, the tuple instead comprises the root cause result and/or recommendation options following the 1-, 2-, or n-valued paradigm.

[0221] The Analytics Job Metric and Out Data may comprise a variable length array or list for each analytics output data. This array or list may comprise entries including, for example, output_metric_type or name, output_metric_length, output_data_value, and confidence degree. These are discussed further below.

[0222] The output_metric_type specifies the name of the object that is computed. For example, the object may comprise (i) the mean, standard deviation, or Cumulative Distribution Function (CDF) when the output contains statistics or predictions or (ii) a name of object(s) (e.g. User Plane Function(s)), a network state (e.g. activate Mobility Load Balancing (MLB), feasibility check, start RAN software update), a mechanism (e.g. choose Handover mechanism), configuration options (e.g. gNB attribute), or a policy (e.g. Handover- gNB selection) when the output contains recommendation options, or (iii) a name "root cause" when this is the output data.

[0223] The output_metric_length may comprise the length of the output value field, i.e., either 1, 2 or n in the present example.

[0224] The output_data_value may comprise at least one of: (i) the computed values when the output comprises statistics or predictions (ii) a set of recommendations options and/or (iii) the root cause results. The output_data_value may be a fixed length array of size 1, 2 or n, depending on the computed object.

[0225] Confidence degree may indicate the probability range that contains the true value.

[0226] The *AnalyticsReport file* produced as a result of running the model may captures the MDA report details as illustrated in Table 7:

File content item	Description
analyticsDataFile	Top-level tag indicating the file contains analytics metrics. Each file comprises a header ("analyticsFileHeader"), a collection of information elements with produced analytics results and associated meta data and a footer ("analyticsFileFooter").
analyticsFileHeader	File header including the file format version, information about the sending node (Distinguished Name, type and vendor) and a time stamp indicating the begin of the first granularity period contained in the file ("analyticsBeginTime").
analyticsFileFooter	File footer with a time stamp indicating the end of the last granularity period contained in the file ("analyticsEndTime").
fileFormatVersion	File format version applied by the sender as indicated by the specific format version identifier provided for each version.
senderName	Distinguished Name (DN)of the entity, that generated and sent the file. The entity is either a managed element represented by a "ManagedElement" or a management node represented by a "ManagementNode"
senderType	Type of the entity, that generated and sent the file, as defined in 3GPP TS 28.620. The type of a management node is "MANAGEMENT_NODE".
vendorName	Vendor of the entity that generated and sent the file.
analyticsBeginTime	Time stamp indicating the begin of the first granularity period for which analytics result are stored in the file.
analyticsEndTime	Time stamp indicating the end of the last granularity period for which analytics result are stored in the file.
analyticsReportingPeriod	Period used for regular analytics reporting.
analyticsavailabilityTime	Time stamp indicating the expected time until the next MDA Report can be ready and available towards the consumer.

analyticsName	Identifier of the analytics service by indicating a name to allow a consumer to request analytics report, e.g., coverage issues, alarm issues, latency assurance, etc.
modelId	Identifier of the analytics model for reference purposes, i.e. to allow notifications towards consumer.
modelTimestamp	Time stamp that indicates when the model was trained or put into service.
modelModtime	Time stamp that indicates the last modification in the analytics model.
analyticsType	Describes the type of MDA report output data. It contains three fields: - characterization of analytics result either (i) statistics, or (ii) prediction - results type, which can be: (i) numeric, (ii) recommendations, i.e. objects or mechanisms and (iii) root cause analysis results.
resultType	Describes the type of the analytics result, which can be: - For numeric values, e.g. average, CDF, Standardards deviation - For recommendations, e.g. objects (UPF), state, mechanisms - For root cause, e.g. root alarm
resultLength	Indicate the length of the analytics result, which can be numeric, recommendations and root cause.

issueType	Indicate the type of issue related to the analytics result. This can contain two fields indicating: - the sub-domain or domain or managed element, etc., where the issue takes place - the associated (i) performance parameter, e.g., load, delay, etc., when reporting is related with statistics or predictions or (ii) an issue related to the recommendation options or root cause analysis, e.g., coverage issue type can be coverage hole, pilot pollution, overshoot coverage, or DL and UL channel coverage mismatch, etc.
validityTime	Time stamp that indicates until when (i.e. time instance) the analytics result can be valid.
geoLocation	Indicates a relevant geographical location, e.g. in Tracking Areas, cells or coordinates.
targetObjects	Object instance related to the analytics result and reporting identified by: - Distinguished Name or set of Distinguished Names of a managed object name containing the reporting control fragment, - Slice id, - UE or group of UE identifier
severityLevel	Impact of the analytics result to the consumer that indicates the urgency of decision
remainingReports	Number or time of remaining reports so the consumer is aware when analytics results shall be renewed or expect to be terminated.
analyticsResult	List of result values for the observed or computed analytics. The NULL value is reserved to indicate that the analytics are not applicable or could not be produced for the object instance.

confidenceDegree	A probability range that contains the true value of the analytics numeric values or the degree of accuracy of the recommendation options or alarm prediction.

Table 7

[0227] The analyticsName indicates the desired analytics service.

[0228] The modelId associates a model identification with the specific attributes of: modelType, modelMetrics and modelDatatype and it is used for reference purposes.

[0229] The illustrated *AnalyticsReport* file comprises three different options for reporting analytics output data towards the MDA consumer. These three different options include: (i) analytics numeric data values that holds statistics or prediction data values or (ii) analytics recommendations that holds recommendation option name(s) for: a) object (e.g. managed object), b) state (e.g. network state or self-organised network state), c) mechanism (e.g. for handover) d) configuration attribute (e.g. for a self-organised network function) e) policy (e.g. handover policy), or (iii) analytics root cause that holds the root cause analysis result (e.g. alarm or network state). These three different options are not mutually exclusive and are thus can be employed simultaneously in a variety of combinations.

[0230] This reporting file may be formed as an extension of the performance management report that includes analytics specific related to model and analytics context description.

[0231] MDAS reporting can be implemented using the 3GPP TS 28.532 file-based, streaming and notification-based reporting mechanisms.

[0232] These were described above in relation to Figure 10.

[0233] For the file-based reporting, the respective MDA Report may be compiled into a file that is transferred to the consumer using the file-based report mechanism. The analyticsName and all other attributes of the MDA report may all be comprised every file delivered to the MDA consumer containing only the analytics description information attributes (in Table 3) or even a subset of that. Alternatively, the analyticsName, the description and context information attributes (in Table 3) may be contained in a notify file ready indication transmitted to the MDA consumer, and then the file transfer comprises only the analytics output attributes.

[0234] Streaming reporting divides the process into two parts. It first establishes a connection using the analyticsName, the description and context information attributes

(in Table 3) and then the analytics output attributes are streamed every time there is any change in the analyticsDatavalues or analyticsRecommendation or analyticsRootcause. The MDA report that contains the analytics output attributes may include a streaming identifier to indicate the position of the report in the stream sequence.

[0235] For the notification-based reporting, the analyticsName and all other attributes of the MDA report are all contained in every notification delivered to the MDA consumer, since the analytics output attributes are of a small size.

[0236] The above therefore provides information on extending the Network Resource Model to include requesting MDA and the MDA report as information object classes and the related notifications. This includes specifying the messages as services to be supported by the management data analytics services.

[0237] Specifically, the above illustrates a mechanism for allowing an MDA consumer to request analytics from the MDA producer with specific controls that specify how the analytics shall be produced and what may be contained considering analytics data and meta data in the analytics report.

[0238] The MDA consumer may request for a specific analytics by stating the name or identifier of the Analytics Service. In particular, the MDA consumer may subscribe to a running instance of the analytics service (i.e. to an ongoing Analytics Job) or may request for the creation of a new analytics job to service the new request.

[0239] The MDA consumer may control the production of the analytics by indicating the desired characteristics of the analytics service, ARI description information, that may include e.g. computational model specifics, input data sources, time, filtering, analytics type, etc.

[0240] The MDA request may also include constraints on the reporting of the analytics, e.g. the length of time within which the MDA report must be provided (how long the consumer can wait for the report).

[0241] There is further illustrated a mechanism for allowing the MDAS producer to produce analytics according to the control and filters provided by the MDA consumer in way that supports multiple different consumers providing different standardised and proprietary analytics.

[0242] The MDA producer may serve the request using a running instance of the analytics service (i.e. using an ongoing Analytics Job), in which case the MDA producer may fine tune the running analytics job to support the requirements of the

new request. For example, if a current job analyses data to produce the moving average while the new request requires the range, the running job, the MDA producer may re-configured an ongoing analytics Job to produce a range for each time window for which the running average is computed.

[0243] The MDA producer may also instantiate a new ARI (and a new analytics job) to service the new request.

[0244] The MDA producer (or an MDAF in general) may structure an MDA report towards an MDA consumer for different kinds of analytics based on the same framework that provides for a report detailing the analytics name/id, specified description, the context and reported values.

[0245] The MDA report may be of the same type as a PM report, but using significant extensions relative to existing PM reports to include meta data related to model and context description.

[0246] This will enable the MDA consumer to match a received report with the request, the MDA report comprising the description information which may include the computational method or computational model name/id, analytics type, etc.

[0247] The MDA report may further comprise information about the context for which analytics has been produced. Such context may include time schedule, filtering, objects, etc.

[0248] The MDA report may comprise the analytics data output. The analytics data output may comprise at least one of:

i. Characterization of the analytics result, statistics (based on historic information) or predictions considering future data
ii. Type of the result that can be numeric, recommendations or root cause
iii. Description of the analytics result that depends of the type of the result, e.g. for numeric it can be average, CDF, etc., for recommendations it can be objects, states, mechanisms, etc., and for root cause it can an alarm, etc.
iv. Length of a result, e.g. 1, 2 or n
v. Confidence degree

[0249] The analytics data output may be one or more of numeric results, recommendations, and root cause analysis results.

[0250] The reporting framework, including the reporting type and reporting mechanisms for delivering MDA reports, may be specified by the MDA consumer as part of the initial request to the MDA producer.

[0251] The MDA producer may deliver the analytics report according to the MDA consumer's specification.

[0252] The MDA reporting may support at least one of file-based, and/or streaming and/or notification-based reporting, introducing analytics name/id in every MDA report file or notification or upon the establishment of the streaming connection.

[0253] File-based reporting may be used for non-time critical data, e.g. data needed upon certain filtering conditions and/or on a regular basis. For file-based reporting, the MDA producer sends a notification to the MDA consumer once the MDA report is ready, after which the MDA consumer may retrieve the MDA report if it is still needed.

[0254] The analytics output data together with the analytics description and context information may be comprised in the file transfer step. Alternatively, the analytics description and context information may be transmitted within the file ready notification so that the file transfer step only contains that analytics output data.

[0255] Streaming comprises the establishment of a connection before allowing MDA reports to be streamed towards the consumer. Streaming of analytics may be used for real-time or critical decision making processes.

[0256] For example, SLS assurance may rely on Streaming analytics, given the strict requirements for insight of new analytics upon: (i) any variation in the input PMs/KPIs, and/or trace and/or QoE data, and/or (ii) any significant variation based on the given filtering conditions in the input PMs/KPIs/trace/QOE or computed analytics.

[0257] The analytics description and context information may be carried within the same stream as analytics output data, e.g. with the analytics description and context information carried as the first data within in the stream. Alternatively, the streaming may be used to carry only the analytics output data e.g. with the analytics description and context information exchanged during the handshaking used to set up the stream.

[0258] Notifications may assist use cases which need to communicate small data towards the consumer. For Notification-based reporting, the MDA producer sends the MDA report as a notification directly to the MDA consumer once the MDA report is ready.

[0259] Example data used to deliver analytics via notification may include:

1. alarm predictions,
2. root case analysis that indicates managed objects responsible for a given observed outcome, e.g. the set of objects (such as tilt or pilot pollution) that may be responsible for any observed coverage issues

3. recommendations e.g. NF load is optimal for gNB A, gNB B and gNB C.

[0260] The analytics output data together with the data description and context attributes may be contained in every notification since the size is relatively small.

[0261] The MDA producer may define and send a series of notification reports that inform the MDA consumer regarding the state of the MDA reporting.

[0262] Figures 11 and 12 illustrate potential operations that may be respectively performed by each of an analytics producer and an analytics consumer interacting with that analytics consumer.

[0263] Figure 11 illustrates potential operations that may be performed by an analytics producer.

[0264] At 1101, the analytics producer receives a request for performing an analytics reporting control from an analytics consumer using information object class signalling. The analytics consumer may be as described below in respect of Figure 12. The request comprises an indication of determined parameters. The determined parameters may be determined by the analytics consumer. The analytics reporting control may be an analytics job, as discussed above.

[0265] At 1102, the analytics producer performs at least part of the analytics reporting control to produce output results.

[0266] At 1103, the analytics producer forms an analytics report comprising the output results.

[0267] At 1104, the analytics producer signals the analytics report to the analytics consumer.

[0268] Figure 12 is a flow chart illustrating potential operations that may be performed by an apparatus of the analytics consumer referenced in Figure 11.

[0269] At 1201, the analytics consumer determines parameters for requesting an analytics reporting control to be performed.

[0270] At 1202, the analytics consumer signals a request for performing the analytics reporting control to an analytics producer using information object class signalling, the request comprising an indication of the determined parameters.

[0271] At 1203, the analytics consumer receives an analytics report from the analytics producer that is based on the signalled request.

[0272] The following applies generally to both of Figures 11 and 12, and is consistent with the provided examples. It is therefore understood that features described above in relation to the examples may also apply to the apparatus of Figures 11 and 12.

[0273] The indication may be a request to subscribe to an existing analytics reporting control. This may be the case, for example, when the analytics consumer has performed a discovery operation for determining the analytics consumer's capabilities and/or existing analytics jobs/analytics reporting controls.

[0274] On receiving the request for the analytics consumer to subscribe to the existing analytics reporting control, the analytics consumer may modify the existing analytics reporting control to perform both the requested analytics reporting control and the analytics reporting control performed by the existing analytics reporting control prior to modification. In this case, performing at least part of the analytics reporting control comprises performing the modified existing analytics reporting control to produce output results.

[0275] The indication may be a request to for the analytics producer to instantiate the analytics reporting control at the analytics producer. This indication may be sent when the analytics producer does not have an existing analytics reporting control that corresponds to the determined parameters. When the analytics producer receives the indication to instantiate the analytics reporting control, the analytics producer first determines that it is able to instantiate the analytics reporting control and, if so, instantiates it.

[0276] In this case, the request may comprises a plurality of parameters for instantiating the analytics reporting control, the plurality of parameters comprising agnostic information related to a computational model for performing the analytics reporting control, specific information relating to the computation model in relation to a specific use case, and context information relating to the specific use case.

[0277] In all of the above cases, the request may comprise an identifier of an analytics service being requested.

[0278] The request may comprise parameters indicating at least one of: a frequency, and/or duration, and/or period and/or mechanism by which the analytics producer should signal the analytics report. The request may comprise an indication that the analytics report is to be signalled by one of: a notification-based mechanism, a streaming-based mechanism, and by a file request mechanism. The indication for how the report is to be signalled may be selected in dependence on a frequency and/or expected amount of output data to be produced by the analytics reporting control, as described in more detail above. The analytics producer may use the indication of

signalling when determining how to signal the analytics report to the analytics consumer.

[0279] The request may comprise a value for a time within which the analytics consumer is to receive the analytics report. In this case, if the analytics producer believes that it will be unable to provide the analytics report within the indicated time, the analytics producer may signal the analytics consumer with a time value by which it expects to have produced the analytics report, and the analytics consumer may respond to this by either accepting the new time value or by abandoning the analytics reporting control.

[0280] The analytics report may comprise at least one of: an indication of an analytics result; an indication that the analytics result is at least one of a numeric result, a recommendation, and/or a root cause result; a description of the analytics result being provided; a length of the result; and/or a degree of confidence in the analytics result. The indication of an analytics result may indicate whether the analytics result is based on statistics using historic data and/or predictions of future data.

[0281] The request may comprise an indication of at least one of an analytics performance input and/or a granularity for collecting measurements for performing the analytics reporting control.

[0282] The request may comprise at least one of a location of and/or an identification of at least one object for performing the analytics reporting control.

[0283] Information mentioned above as being comprised within the request may be used by the analytics producer to perform (i.e. run) the requested analytics reporting control.

[0284] Figure 2 shows an example of a control apparatus for a communication system, for example to be coupled to and/or for controlling a station of an access system, such as a RAN node, e.g. a base station, gNB, a central unit of a cloud architecture or a node of a core network such as an MME or S-GW, a scheduling entity such as a spectrum management entity, or a server or host, for example an apparatus hosting an NRF, NWDAF, AMF, SMF, UDM/UDR etc. The control apparatus may be integrated with or external to a node or module of a core network or RAN. In some embodiments, base stations comprise a separate control apparatus unit or module. In other embodiments, the control apparatus can be another network element such as a radio network controller or a spectrum controller. The control apparatus 200 can be arranged to provide control on communications in the service area of the system. The

apparatus 200 comprises at least one memory 201, at least one data processing unit 202, 203 and an input/output interface 204. Via the interface the control apparatus can be coupled to a receiver and a transmitter of the apparatus. The receiver and/or the transmitter may be implemented as a radio front end or a remote radio head. For example the control apparatus 200 or processor 201 can be configured to execute an appropriate software code to provide the control functions.

[0285] A possible wireless communication device will now be described in more detail with reference to Figure 3 showing a schematic, partially sectioned view of a communication device 300. Such a communication device is often referred to as user equipment (UE) or terminal. An appropriate mobile communication device may be provided by any device capable of sending and receiving radio signals. Non-limiting examples comprise a mobile station (MS) or mobile device such as a mobile phone or what is known as a 'smart phone', a computer provided with a wireless interface card or other wireless interface facility (e.g., USB dongle), personal data assistant (PDA) or a tablet provided with wireless communication capabilities, or any combinations of these or the like. A mobile communication device may provide, for example, communication of data for carrying communications such as voice, electronic mail (email), text message, multimedia and so on. Users may thus be offered and provided numerous services via their communication devices. Non-limiting examples of these services comprise two-way or multi-way calls, data communication or multimedia services or simply an access to a data communications network system, such as the Internet. Users may also be provided broadcast or multicast data. Non-limiting examples of the content comprise downloads, television and radio programs, videos, advertisements, various alerts and other information.

[0286] A wireless communication device may be for example a mobile device, that is, a device not fixed to a particular location, or it may be a stationary device. The wireless device may need human interaction for communication, or may not need human interaction for communication. In the present teachings the terms UE or "user" are used to refer to any type of wireless communication device.

[0287] The wireless device 300 may receive signals over an air or radio interface 307 via appropriate apparatus for receiving and may transmit signals via appropriate apparatus for transmitting radio signals. In Figure 3 transceiver apparatus is designated schematically by block 306. The transceiver apparatus 306 may be provided for example by means of a radio part and associated antenna arrangement.

The antenna arrangement may be arranged internally or externally to the wireless device.

[0288] A wireless device is typically provided with at least one data processing entity 301, at least one memory 302 and other possible components 303 for use in software and hardware aided execution of tasks it is designed to perform, including control of access to and communications with access systems and other communication devices. The data processing, storage and other relevant control apparatus can be provided on an appropriate circuit board and/or in chipsets. This feature is denoted by reference 704. The user may control the operation of the wireless device by means of a suitable user interface such as key pad 305, voice commands, touch sensitive screen or pad, combinations thereof or the like. A display 308, a speaker and a microphone can be also provided. Furthermore, a wireless communication device may comprise appropriate connectors (either wired or wireless) to other devices and/or for connecting external accessories, for example hands-free equipment, thereto.

[0289] Figure 4 shows a schematic representation of non-volatile memory media 400a (e.g. computer disc (CD) or digital versatile disc (DVD)) and 400b (e.g. universal serial bus (USB) memory stick) storing instructions and/or parameters 402 which when executed by a processor allow the processor to perform one or more of the steps of the methods of Figure 11 and/or Figure 12.

[0290] The embodiments may thus vary within the scope of the attached claims. In general, some embodiments may be implemented in hardware or special purpose circuits, software, logic or any combination thereof. For example, some aspects may be implemented in hardware, while other aspects may be implemented in firmware or software which may be executed by a controller, microprocessor or other computing device, although embodiments are not limited thereto. While various embodiments may be illustrated and described as block diagrams, flow charts, or using some other pictorial representation, it is well understood that these blocks, apparatus, systems, techniques or methods described herein may be implemented in, as non-limiting examples, hardware, software, firmware, special purpose circuits or logic, general purpose hardware or controller or other computing devices, or some combination thereof.

[0291] The embodiments may be implemented by computer software stored in a memory and executable by at least one data processor of the involved entities or by hardware, or by a combination of software and hardware. Further in this regard it

should be noted that any procedures, e.g., as in Figure 11 and/or Figure 12, may represent program steps, or interconnected logic circuits, blocks and functions, or a combination of program steps and logic circuits, blocks and functions. The software may be stored on such physical media as memory chips, or memory blocks implemented within the processor, magnetic media such as hard disk or floppy disks, and optical media such as for example DVD and the data variants thereof, CD.

[0292] The memory may be of any type suitable to the local technical environment and may be implemented using any suitable data storage technology, such as semiconductor-based memory devices, magnetic memory devices and systems, optical memory devices and systems, fixed memory and removable memory. The data processors may be of any type suitable to the local technical environment, and may include one or more of general purpose computers, special purpose computers, microprocessors, digital signal processors (DSPs), application specific integrated circuits (AStudy ItemC), gate level circuits and processors based on multi-core processor architecture, as non-limiting examples.

[0293] Alternatively or additionally some embodiments may be implemented using circuitry. The circuitry may be configured to perform one or more of the functions and/or method steps previously described. That circuitry may be provided in the base station and/or in the communications device.

[0294] As used in this application, the term “circuitry” may refer to one or more or all of the following:

(a) hardware-only circuit implementations (such as implementations in only analogue and/or digital circuitry);

(b) combinations of hardware circuits and software, such as:

(i) a combination of analogue and/or digital hardware circuit(s) with software/firmware and

(ii) any portions of hardware processor(s) with software (including digital signal processor(s)), software, and memory(ies) that work together to cause an apparatus, such as the communications device or base station to perform the various functions previously described; and

(c) hardware circuit(s) and or processor(s), such as a microprocessor(s) or a portion of a microprocessor(s), that requires software (e.g., firmware) for operation, but the software may not be present when it is not needed for operation.

[0295] This definition of circuitry applies to all uses of this term in this application, including in any claims. As a further example, as used in this application, the term circuitry also covers an implementation of merely a hardware circuit or processor (or multiple processors) or portion of a hardware circuit or processor and its (or their) accompanying software and/or firmware. The term circuitry also covers, for example integrated device.

[0296] The foregoing description has provided by way of exemplary and non-limiting examples a full and informative description of some embodiments. However, various modifications and adaptations may become apparent to those skilled in the relevant arts in view of the foregoing description, when read in conjunction with the accompanying drawings and the appended claims. However, all such and similar modifications of the teachings will still fall within the scope as defined in the appended claims.

[0297] In the above, different examples are described using, as an example of an access architecture to which the presently described techniques may be applied, a radio access architecture based on long term evolution advanced (LTE Advanced, LTE-A) or new radio (NR, 5G), without restricting the examples to such an architecture, however. The examples may also be applied to other kinds of communications networks having suitable means by adjusting parameters and procedures appropriately. Some examples of other options for suitable systems are the universal mobile telecommunications system (UMTS) radio access network (UTRAN), wireless local area network (WLAN or WiFi), worldwide interoperability for microwave access (WiMAX), Bluetooth®, personal communications services (PCS), ZigBee®, wideband code division multiple access (WCDMA), systems using ultra-wideband (UWB) technology, sensor networks, mobile ad-hoc networks (MANETs) and Internet Protocol multimedia subsystems (IMS) or any combination thereof.

[0298] Figure 5 depicts examples of simplified system architectures only showing some elements and functional entities, all being logical units, whose implementation may differ from what is shown. The connections shown in Figure 5 are logical connections; the actual physical connections may be different. It is apparent to a person skilled in the art that the system typically comprises also other functions and structures than those shown in Figure 5.

[0299] The examples are not, however, restricted to the system given as an example but a person skilled in the art may apply the solution to other communication systems provided with necessary properties.

[0300] The example of Figure 5 shows a part of an exemplifying radio access network. For example, the radio access network may support sidelink communications described below in more detail.

[0301] Figure 5 shows devices 500 and 502. The devices 500 and 502 are configured to be in a wireless connection on one or more communication channels with a node 504. The node 504 is further connected to a core network 506. In one example, the node 504 may be an access node such as (e/g)NodeB serving devices in a cell. In one example, the node 504 may be a non-3GPP access node. The physical link from a device to a (e/g)NodeB is called uplink or reverse link and the physical link from the (e/g)NodeB to the device is called downlink or forward link. It should be appreciated that (e/g)NodeBs or their functionalities may be implemented by using any node, host, server or access point etc. entity suitable for such a usage.

[0302] A communications system typically comprises more than one (e/g)NodeB in which case the (e/g)NodeBs may also be configured to communicate with one another over links, wired or wireless, designed for the purpose. These links may be used for signalling purposes. The (e/g)NodeB is a computing device configured to control the radio resources of communication system it is coupled to. The NodeB may also be referred to as a base station, an access point or any other type of interfacing device including a relay station capable of operating in a wireless environment. The (e/g)NodeB includes or is coupled to transceivers. From the transceivers of the (e/g)NodeB, a connection is provided to an antenna unit that establishes bi-directional radio links to devices. The antenna unit may comprise a plurality of antennas or antenna elements. The (e/g)NodeB is further connected to the core network 506 (CN or next generation core NGC). Depending on the deployed technology, the (e/g)NodeB is connected to a serving and packet data network gateway (S-GW +P-GW) or user plane function (UPF), for routing and forwarding user data packets and for providing connectivity of devices to one or more external packet data networks, and to a mobile management entity (MME) or access mobility management function (AMF), for controlling access and mobility of the devices.

[0303] Examples of a device are a subscriber unit, a user device, a user equipment (UE), a user terminal, a terminal device, a mobile station, a mobile device, etc

[0304] The device typically refers to a mobile or static device (e.g. a portable or non-portable computing device) that includes wireless mobile communication devices operating with or without an universal subscriber identification module (USIM), including, but not limited to, the following types of devices: mobile phone, smartphone, personal digital assistant (PDA), handset, device using a wireless modem (alarm or measurement device, etc.), laptop and/or touch screen computer, tablet, game console, notebook, and multimedia device. It should be appreciated that a device may also be a nearly exclusive uplink only device, of which an example is a camera or video camera loading images or video clips to a network. A device may also be a device having capability to operate in Internet of Things (IoT) network which is a scenario in which objects are provided with the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction, e.g. to be used in smart power grids and connected vehicles. The device may also utilise cloud. In some applications, a device may comprise a user portable device with radio parts (such as a watch, earphones or eyeglasses) and the computation is carried out in the cloud.

[0305] The device illustrates one type of an apparatus to which resources on the air interface are allocated and assigned, and thus any feature described herein with a device may be implemented with a corresponding apparatus, such as a relay node. An example of such a relay node is a layer 3 relay (self-backhauling relay) towards the base station. The device (or, in some examples, a layer 3 relay node) is configured to perform one or more of user equipment functionalities.

[0306] Various techniques described herein may also be applied to a cyber-physical system (CPS) (a system of collaborating computational elements controlling physical entities). CPS may enable the implementation and exploitation of massive amounts of interconnected information and communications technology, ICT, devices (sensors, actuators, processors microcontrollers, etc.) embedded in physical objects at different locations. Mobile cyber physical systems, in which the physical system in question has inherent mobility, are a subcategory of cyber-physical systems. Examples of mobile physical systems include mobile robotics and electronics transported by humans or animals.

[0307] Additionally, although the apparatuses have been depicted as single entities, different units, processors and/or memory units (not all shown in Figure 5) may be implemented.

[0308] 5G enables using multiple input – multiple output (MIMO) antennas, many more base stations or nodes than the LTE (a so-called small cell concept), including macro sites operating in co-operation with smaller stations and employing a variety of radio technologies depending on service needs, use cases and/or spectrum available. 5G mobile communications supports a wide range of use cases and related applications including video streaming, augmented reality, different ways of data sharing and various forms of machine type applications (such as (massive) machine-type communications (mMTC), including vehicular safety, different sensors and real-time control). 5G is expected to have multiple radio interfaces, e.g. below 6GHz or above 24 GHz, cmWave and mmWave, and also being integrable with existing legacy radio access technologies, such as the LTE. Integration with the LTE may be implemented, at least in the early phase, as a system, where macro coverage is provided by the LTE and 5G radio interface access comes from small cells by aggregation to the LTE. In other words, 5G is planned to support both inter-RAT operability (such as LTE-5G) and inter-RI operability (inter-radio interface operability, such as below 6GHz – cmWave, 6 or above 24 GHz – cmWave and mmWave). One of the concepts considered to be used in 5G networks is network slicing in which multiple independent and dedicated virtual sub-networks (network instances) may be created within the same infrastructure to run services that have different requirements on latency, reliability, throughput and mobility.

[0309] The current architecture in LTE networks is fully distributed in the radio and fully centralized in the core network. The low latency applications and services in 5G require to bring the content close to the radio which leads to local break out and multi-access edge computing (MEC). 5G enables analytics and knowledge generation to occur at the source of the data. This approach requires leveraging resources that may not be continuously connected to a network such as laptops, smartphones, tablets and sensors. MEC provides a distributed computing environment for application and service hosting. It also has the ability to store and process content in close proximity to cellular subscribers for faster response time. Edge computing covers a wide range of technologies such as wireless sensor networks, mobile data acquisition, mobile signature analysis, cooperative distributed peer-to-peer ad hoc networking and processing also classifiable as local cloud/fog computing and grid/mesh computing, dew computing, mobile edge computing, cloudlet, distributed data storage and retrieval, autonomic self-healing networks, remote cloud services, augmented and

virtual reality, data caching, Internet of Things (massive connectivity and/or latency critical), critical communications (autonomous vehicles, traffic safety, real-time analytics, time-critical control, healthcare applications).

[0310] The communication system is also able to communicate with other networks 512, such as a public switched telephone network, or a VoIP network, or the Internet, or a private network, or utilize services provided by them. The communication network may also be able to support the usage of cloud services, for example at least part of core network operations may be carried out as a cloud service (this is depicted in Figure 5 by "cloud" 514). The communication system may also comprise a central control entity, or a like, providing facilities for networks of different operators to cooperate for example in spectrum sharing.

[0311] The technology of Edge cloud may be brought into a radio access network (RAN) by utilizing network function virtualization (NFV) and software defined networking (SDN). Using the technology of edge cloud may mean access node operations to be carried out, at least partly, in a server, host or node operationally coupled to a remote radio head or base station comprising radio parts. It is also possible that node operations will be distributed among a plurality of servers, nodes or hosts. Application of cloudRAN architecture enables RAN real time functions being carried out at or close to a remote antenna site (in a distributed unit, DU 508) and non-real time functions being carried out in a centralized manner (in a centralized unit, CU 510).

[0312] It should also be understood that the distribution of labour between core network operations and base station operations may differ from that of the LTE or even be non-existent. Some other technology advancements probably to be used are Big Data and all-IP, which may change the way networks are being constructed and managed. 5G (or new radio, NR) networks are being designed to support multiple hierarchies, where MEC servers can be placed between the core and the base station or nodeB (gNB). It should be appreciated that MEC can be applied in 4G networks as well.

[0313] 5G may also utilize satellite communication to enhance or complement the coverage of 5G service, for example by providing backhauling. Possible use cases are providing service continuity for machine-to-machine (M2M) or Internet of Things (IoT) devices or for passengers on board of vehicles, Mobile Broadband, (MBB) or ensuring service availability for critical communications, and future

railway/maritime/aeronautical communications. Satellite communication may utilise geostationary earth orbit (GEO) satellite systems, but also low earth orbit (LEO) satellite systems, in particular mega-constellations (systems in which hundreds of (nano)satellites are deployed). Each satellite in the mega-constellation may cover several satellite-enabled network entities that create on-ground cells. The on-ground cells may be created through an on-ground relay node or by a gNB located on-ground or in a satellite.

[0314] It is obvious for a person skilled in the art that the depicted system is only an example of a part of a radio access system and in practice, the system may comprise a plurality of (e/g)NodeBs, the device may have an access to a plurality of radio cells and the system may comprise also other apparatuses, such as physical layer relay nodes or other network elements, etc. At least one of the (e/g)NodeBs or may be a Home(e/g)nodeB. Additionally, in a geographical area of a radio communication system a plurality of different kinds of radio cells as well as a plurality of radio cells may be provided. Radio cells may be macro cells (or umbrella cells) which are large cells, usually having a diameter of up to tens of kilometers, or smaller cells such as micro-, femto- or picocells. The (e/g)NodeBs of Figure 5 may provide any kind of these cells. A cellular radio system may be implemented as a multilayer network including several kinds of cells. Typically, in multilayer networks, one access node provides one kind of a cell or cells, and thus a plurality of (e/g)NodeBs are required to provide such a network structure.

[0315] For fulfilling the need for improving the deployment and performance of communication systems, the concept of “plug-and-play” (e/g)NodeBs has been introduced. Typically, a network which is able to use “plug-and-play” (e/g)Node Bs, includes, in addition to Home (e/g)NodeBs (H(e/g)nodeBs), a home node B gateway, or HNB-GW (not shown in Figure 5). A HNB Gateway (HNB-GW), which is typically installed within an operator’s network may aggregate traffic from a large number of HNBs back to a core network.

Claims

1) An apparatus for an analytics producer, comprising means for:

receiving a request for performing an analytics reporting control from an analytics consumer using information object class signalling, the request comprising an indication of determined parameters;

performing at least part of the analytics reporting control to produce output results;

forming an analytics report comprising the output results; and

signalling the analytics report to the analytics consumer.

2) An apparatus for an analytics consumer, comprising means for:

determining parameters for requesting an analytics reporting control to be performed;

signalling a request for performing the analytics reporting control to an analytics producer using information object class signalling, the request comprising an indication of the determined parameters; and

receiving an analytics report from the analytics producer that is based on the signalled request.

3) An apparatus as claimed in any preceding claim, wherein the indication is a request to subscribe to an existing analytics reporting control.

4) An apparatus as claimed in claim 3 when dependent on claim 1, comprising means for modifying the existing analytics reporting control to perform both the requested analytics job and the job performed by the existing analytics reporting control prior to modification, and the means for performing at least part of the analytics reporting control comprises means for performing the modified existing analytics reporting control to produce output results.

5) An apparatus as claimed in any of claims 1 to 2, wherein the indication is a request to instantiate the analytics reporting control at the analytics producer.

6) An apparatus as claimed in claim 5, wherein the request comprises a plurality of parameters for instantiating the analytics reporting control, the plurality of

parameters comprising agnostic information related to a computational model for performing the analytics reporting control, specific information relating to the computation model in relation to a specific use case, and context information relating to the specific use case.

7) An apparatus as claimed in any preceding claim, wherein the request comprises an identifier of an analytics service being requested.

8) An apparatus as claimed in any preceding claim, wherein the request comprises parameters indicating at least one of: a frequency, and/or duration, and/or period and/or mechanism by which the analytics producer should signal the analytics report.

9) An apparatus as claimed in claim 8, wherein the request comprises an indication that the analytics report is to be signalled by one of: a notification-based mechanism, a streaming-based mechanism, and by a file request mechanism.

10) An apparatus as claimed in any preceding claim, wherein the request comprises a value for a time within which the analytics consumer is to receive the analytics report.

11) An apparatus as claimed in any preceding claim, wherein the analytics report comprises at least one of: an indication of an analytics result; an indication that the analytics result is at least one of a numeric result, a recommendation, and/or a root cause result; a description of the analytics result being provided; a length of the result; and/or a degree of confidence in the analytics result.

12) An apparatus as claimed in claim 11, wherein the indication of an analytics result indicates whether the analytics result is based on statistics using historic data and/or predictions of future data.

13) An apparatus as claimed in any preceding claim, wherein the request comprises an indication of at least one of an analytics performance input and/or a granularity for collecting measurements for performing the analytics reporting control.

14)An apparatus as claimed in any preceding claim, wherein the request comprises at least one of a location of and/or an identification of at least one object for performing the analytics reporting control.

15)A method for an apparatus for an analytics producer, the method comprising:

receiving a request for performing an analytics reporting control from an analytics consumer using information object class signalling, the request comprising an indication of determined parameters;

performing at least part of the analytics reporting control to produce output results;

forming an analytics report comprising the output results; and

signalling the analytics report to the analytics consumer.

16)A method for an apparatus for an analytics consumer, the method comprising:

determining parameters for requesting an analytics reporting control to be performed;

signalling a request for performing the analytics reporting control to an analytics producer using information object class signalling, the request comprising an indication of the determined parameters; and

receiving an analytics report from the analytics producer that is based on the signalled request.

17) A computer program product that, when run on an apparatus for an analytics producer causes the apparatus to perform:

receiving a request for performing an analytics reporting control from an analytics consumer using information object class signalling, the request comprising an indication of determined parameters;

performing at least part of the analytics reporting control to produce output results;

forming an analytics report comprising the output results; and

signalling the analytics report to the analytics consumer.

18) A computer program product that, when run on an apparatus for an analytics producer causes the apparatus to perform:

determining parameters for requesting an analytics reporting control to be performed;

signalling a request for performing the analytics reporting control to an analytics producer using information object class signalling, the request comprising an indication of the determined parameters; and

receiving an analytics report from the analytics producer that is based on the signalled request.

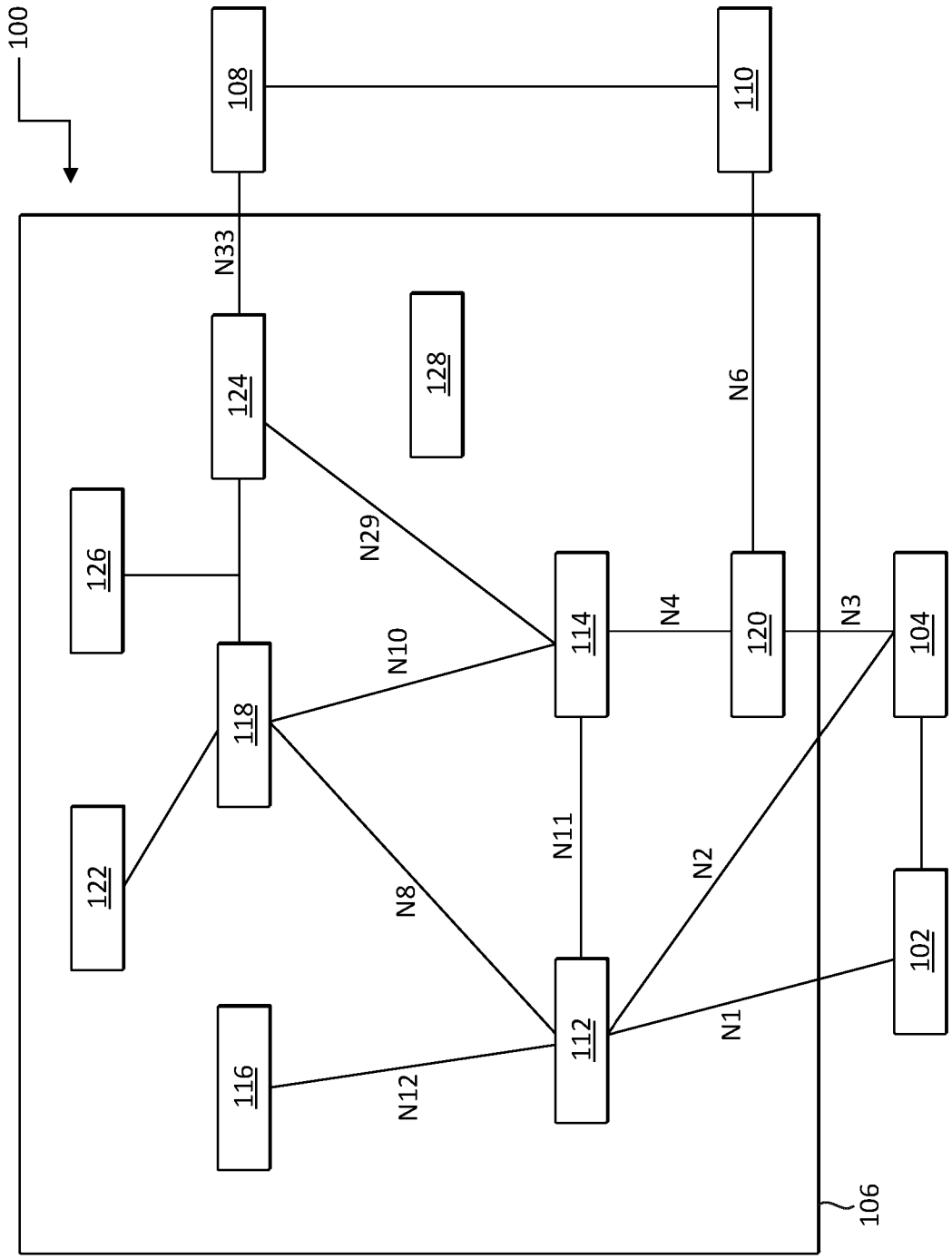
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FIG. 1A

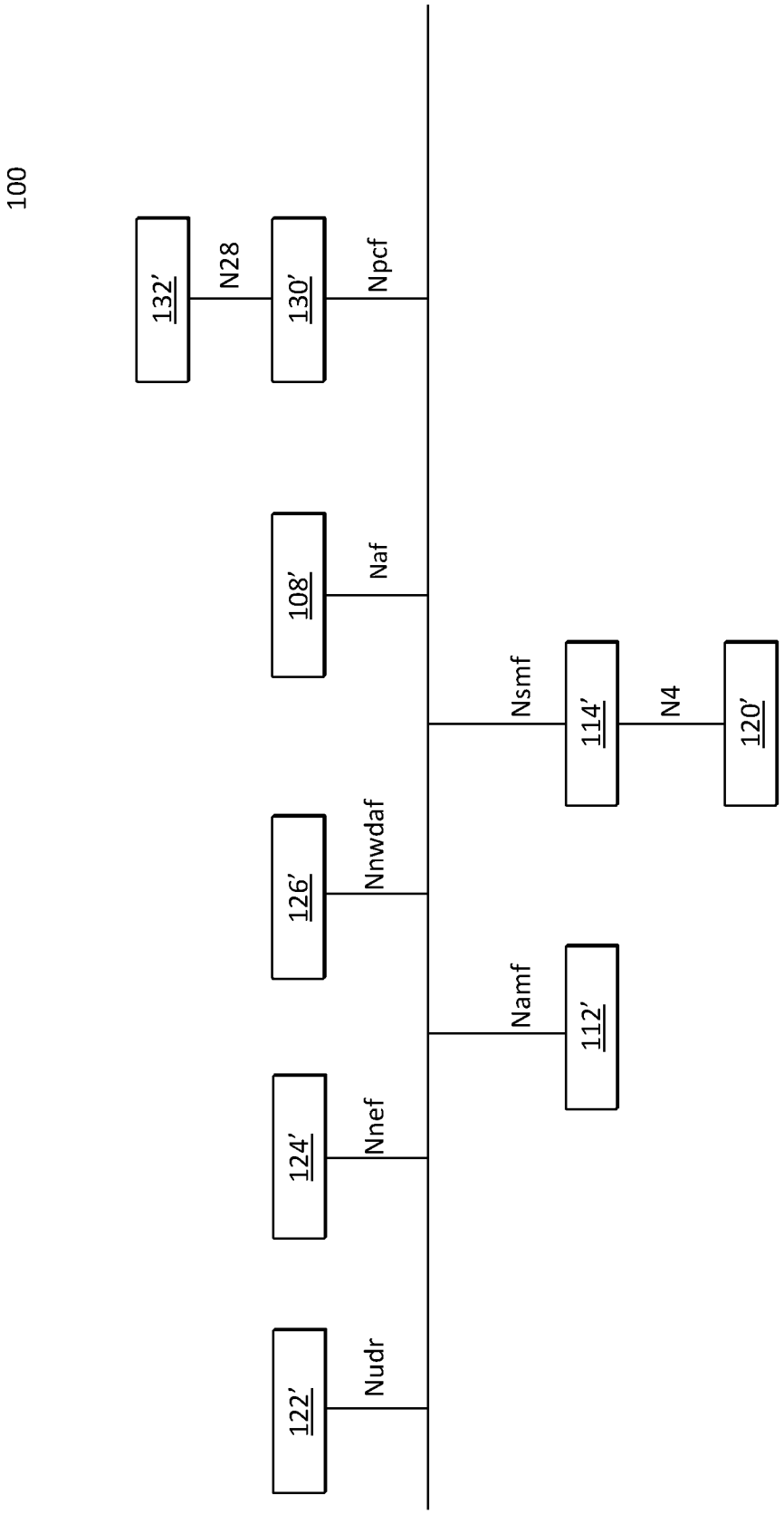
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FIG. 1B

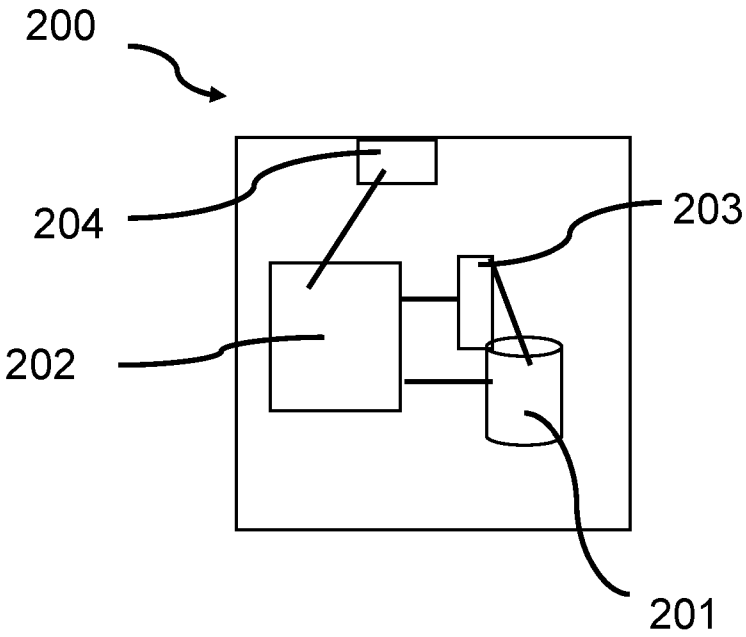


FIG. 2

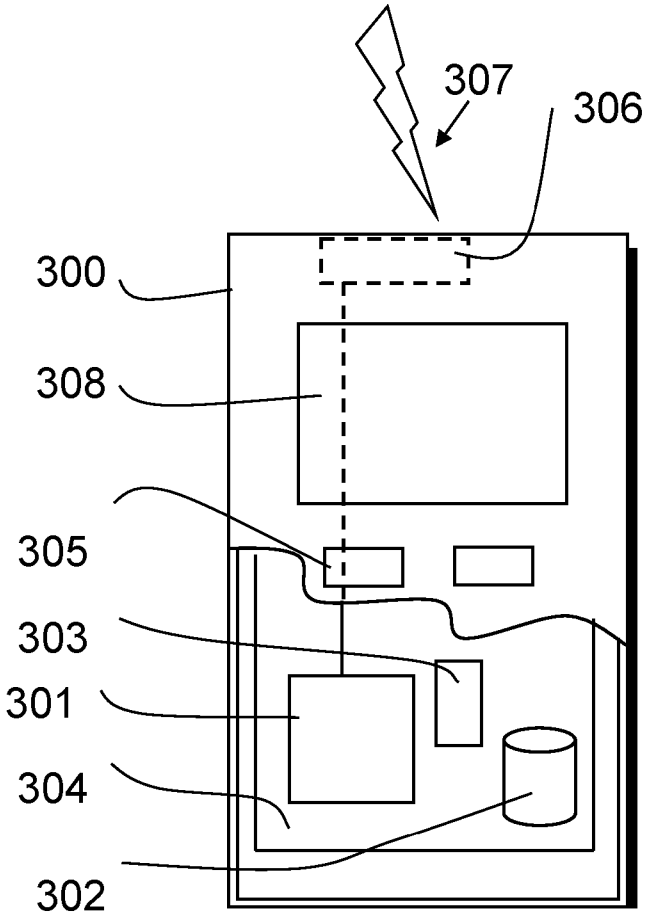


FIG. 3

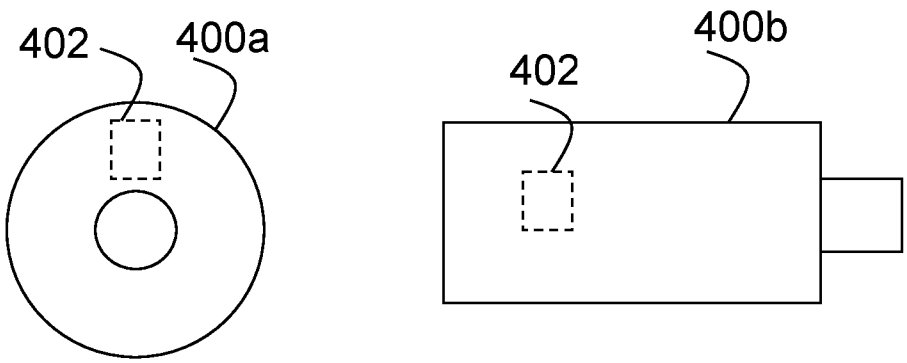


FIG. 4

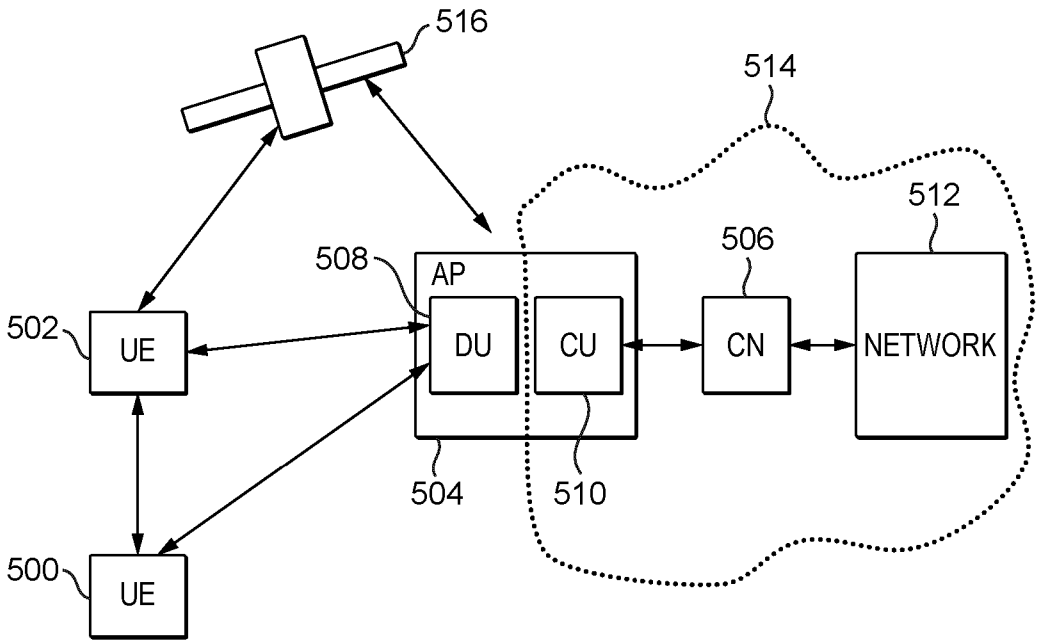


FIG. 5

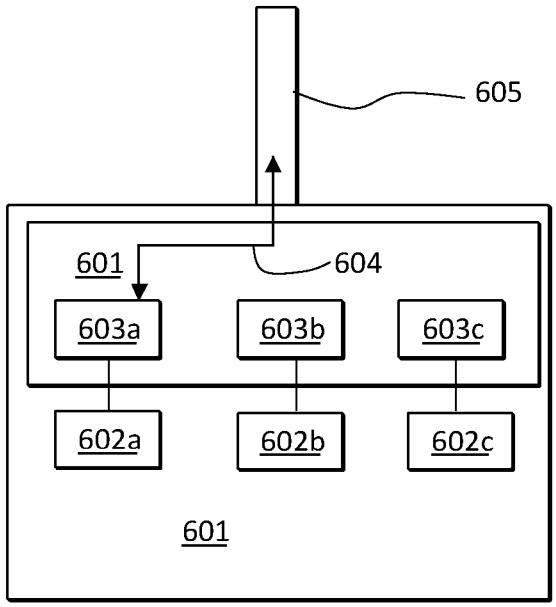


FIG. 6

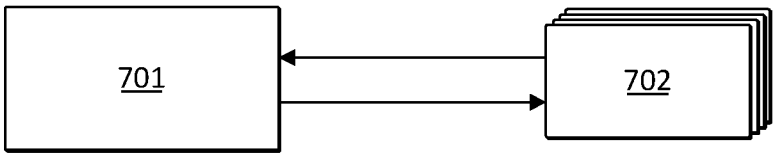


FIG. 7

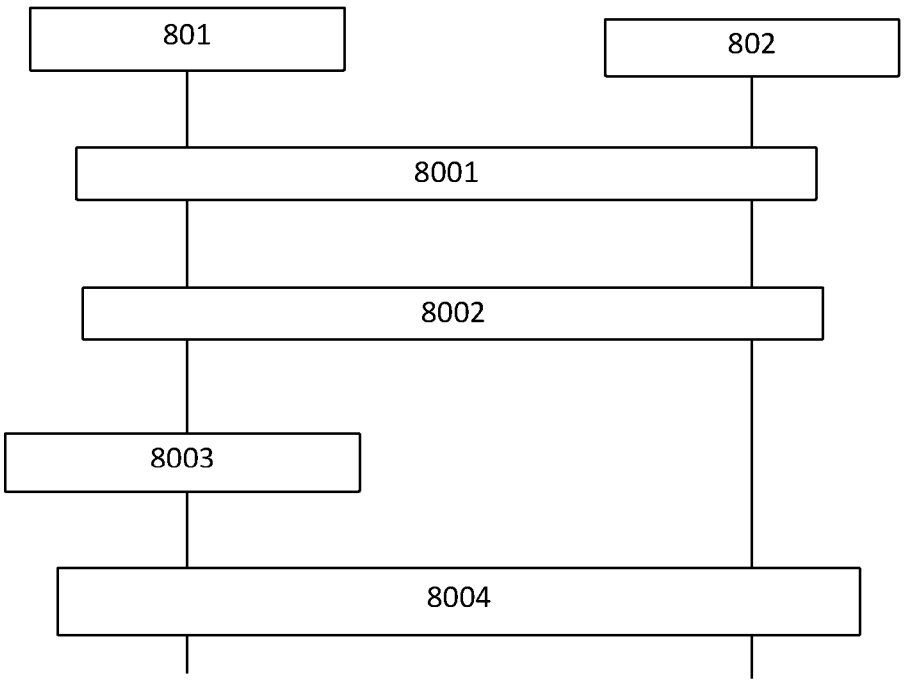


FIG. 8

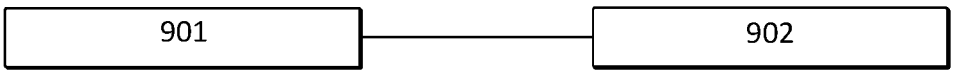
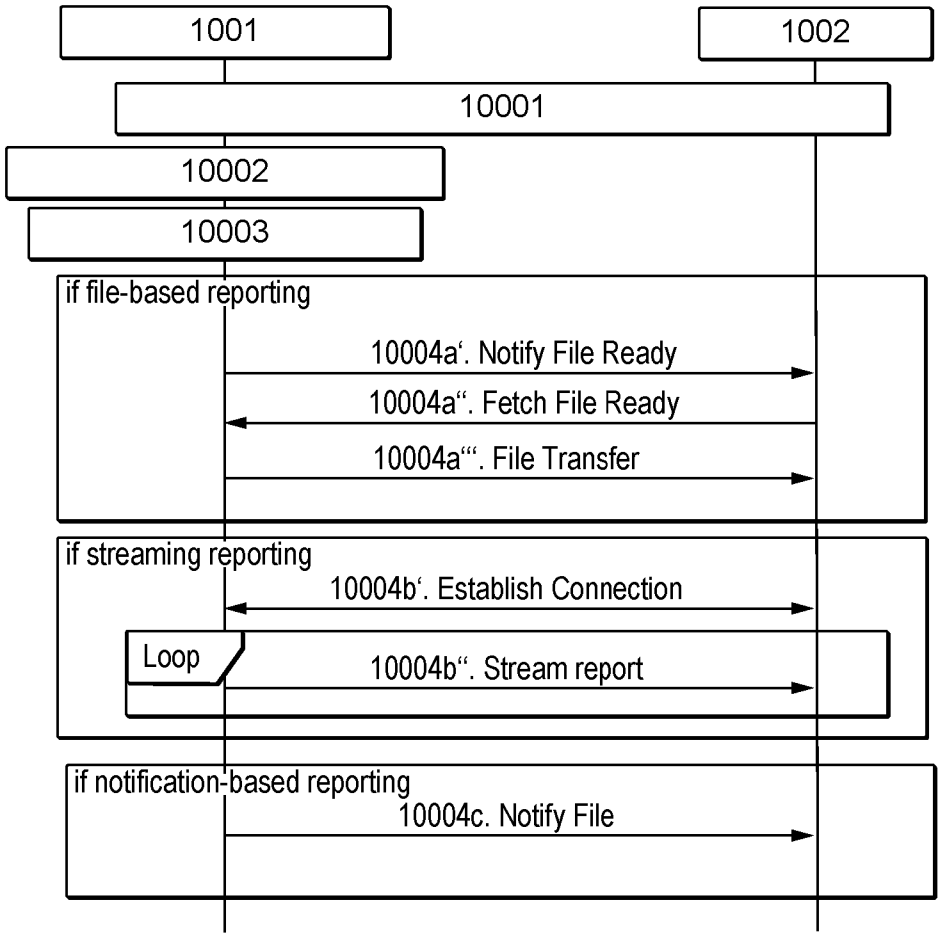


FIG. 9


1001
1002
10001
10002
10003
if file-based reporting
10004a‘. Notify File Ready
10004a“. Fetch File Ready
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if streaming reporting
10004b‘. Establish Connection
Loop
10004b“. Stream report
if notification-based reporting
10004c. Notify File

FIG. 10

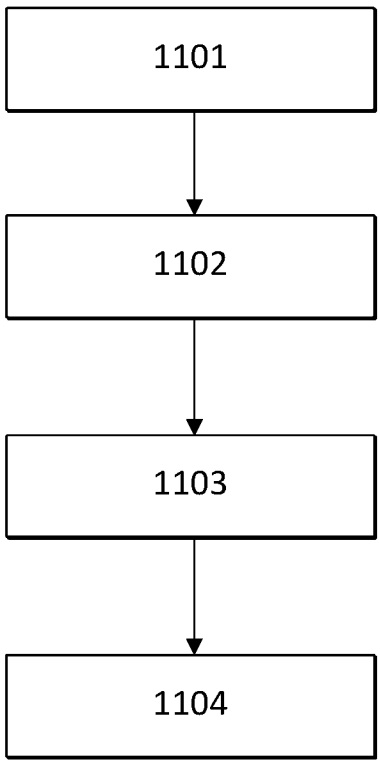

FIG. 11

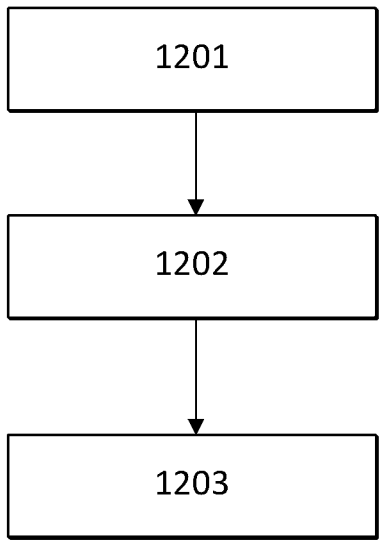

FIG. 12

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2021/071494

A. CLASSIFICATION OF SUBJECT MATTER
INV. H04L41/14
ADD. H04W24/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
H04L H04W

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	"3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; Management and orchestration; Study on enhancement of Management Data Analytics (MDA) (Release 17)", 3GPP STANDARD; TECHNICAL REPORT; 3GPP TR 28.809, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ; FRANCE , no. V1.1.0 4 December 2020 (2020-12-04), pages 1-93, XP051961771, Retrieved from the Internet: URL:https://ftp.3gpp.org/Specs/archive/28_series/28.809/28809-110.zip 28809-110.docx [retrieved on 2020-12-04] -/--	1-3,5, 7-9, 11-18

[x] Further documents are listed in the continuation of Box C. [ ] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance;; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance;; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
12 April 2022	25/04/2022

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Gavin Alarcon, Oscar

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Form PCT/ISA/210 (second sheet) (April 2005)

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	whole section 6.99.2 with reference to Fig. 6.99.2.3-1 sections 6.99.1, 6.99.3, 6.99.4 -----	6
X	"3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; Management and orchestration; Study on enhancement of Management Data Analytics (MDA) (Release 17)", 3GPP STANDARD; TECHNICAL REPORT; 3GPP TR 28.809, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ; FRANCE , vol. SA WG5, no. V17.0.0 6 April 2021 (2021-04-06), pages 1-96, XP052000543, Retrieved from the Internet: URL:https://ftp.3gpp.org/Specs/archive/28_series/28.809/28809-h00.zip 28809-h00.docx [retrieved on 2021-04-06]	1-5, 7-10, 14-18
A	whole section 6.10.2 with reference to Fig. 6.10.2.3-1 sections 6.10.1, 6.10.3 and 6.10.4 -----	6
A	"3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; Architecture enhancements for 5G System (5GS) to support network data analytics services (Release 17)", 3GPP STANDARD; 3GPP TS 23.288, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ; FRANCE , no. V17.1.0 24 June 2021 (2021-06-24), pages 1-192, XP052029593, Retrieved from the Internet: URL:https://ftp.3gpp.org/Specs/archive/23_series/23.288/23288-h10.zip 23288-h10.docx [retrieved on 2021-06-24] Sections 6.1.1, 6.1.2, 6.1.3 Sections 7.1, 7.2, 7.3 ----- -/--	1-18

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	"3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; Management and orchestration; Architecture framework (Release 16)", 3GPP STANDARD; TECHNICAL SPECIFICATION; 3GPP TS 28.533, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ; FRANCE , vol. SA WG5, no. V16.7.0 6 April 2021 (2021-04-06), pages 1-30, XP052000529, Retrieved from the Internet: URL:https://ftp.3gpp.org/Specs/archive/28_series/28.533/28533-g70.zip 28533-g70_clean.doc [retrieved on 2021-04-06] Section 4.6; Annex A.5, A.6 and A.7 -----	1-18
A	"3rd Generation Partnership Project; Technical Specification Group Core Network and Terminals; 5G System; Network Data Analytics Services; Stage 3 (Release 17)", 3GPP STANDARD; TECHNICAL SPECIFICATION; 3GPP TS 29.520, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ; FRANCE , vol. CT WG3, no. V17.3.0 25 June 2021 (2021-06-25), pages 1-125, XP052029727, Retrieved from the Internet: URL:https://ftp.3gpp.org/Specs/archive/29_series/29.520/29520-h30.zip 29520-h30.doc [retrieved on 2021-06-25] Sections 4.3.2.1, 4.3.2.2 -----	1-18

1