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Patent Details

Department	2019-20	2020-21	2021-22	2022-23
CSE	1	2	-	2
CIVIL	-	-	-	1
MECH	1	3	1	5
EEE	-	-	-	1
ECE	-	-	-	1
Total	**2**	**5**	**1**	**10**

FORM 2

THE PATENTS ACT 1970

39 OF 1970

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THE PATENT RULES 2003

COMPLETE SPECIFICATION

(SEE SECTIONS 10 & RULE 13)

1. TITLE OF THE INVENTION

"A METHOD FOR INDUSTRIAL AUTOMATION USING 5G WIRELESS COMMUNICATION NETWORK"

2. APPLICANT(S)

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3. PREAMBLE TO THE DESCRIPTION

COMPLETE SPECIFICATION

The following specification particularly describes the invention and the manner in which it is to be performed

A METHOD FOR INDUSTRIAL AUTOMATION USING 5G WIRELESS COMMUNICATION NETWORK

FIELD OF THE INVENTION

[0001]The present disclosure is related to wireless communications networks and describes network architecture, wireless devices, and wireless network nodes suitable for industrial applications, using a fifth-generation (5G) or other wireless communications network.

BACKGROUND OF THE INVENTION

[0002]The fifth generation of mobile technology (5G) will be able to provide wider range of services than the existing 3G/4G technologies. Three main use cases of 5G are: Enhanced Mobile Broadband (eMBB), Massive Machine Type of Communication (mMTC) and Ultra Reliable Low Latency Communication (URLLC). A key objective of the 5G system is to be able to support the stringent system requirements from vertical markets. Those requirements include simultaneously supporting multiple combinations of reliability, latency, throughput, positioning, and availability, as well as, local deployments with local survivability, local data/routing, local managements, security, data integrity and privacy.

[0003]A wireless end-user device has wireless wide-area network (WWAN) and wireless local-area network (WLAN) modems. One or more processors determine when an application is running in a background state or as a foreground application. The processors control application access for Internet service activities through an application program interface (API). At a time when Internet service activities are communicated through the WWAN modem, the processors

use a differential traffic control policy to selectively block and allow network access for an application based on the determination as to whether the application is running in a background state or as a foreground application. A different policy may apply to WLAN modem usage.

[0004]In a wireless communication system, a user equipment (UE) transmits, to a base station (BS), UE capability information comprising whether the UE supports cooperative communication for receiving physical downlink shared channels (PDSCHs) from a plurality of transmission reception points (TRPs) in a particular time-frequency resource, obtains, via radio resource control (RRC), information about whether the cooperative communication is to be applied from the BS, identifies a format of a medium access control (MAC) control element (CE) received from the BS based on whether the BS is to apply the cooperative communication, and determines transmission configuration indication (TCI) states according to the respective TRPs, based on the identified format of the MAC CE.

[0005]Techniques for enhancing performance in Industrial Internet-of-Things (IIoT) scenarios, including techniques for time-sensitive networking (TSN) and 5G wireless network integration. An example method, performed by a wireless device, comprises receiving system information (SI) from a radio base station (RBS) of a radio access network (RAN), the SI being indicative of support for TSN through the RBS, and establishing at least one TSN stream with an external data network, through the RBS. The example method further includes receiving a first timing signal from the wireless communications network, via the RBS, receiving a second timing signal from the external TSN data network to which the wireless device is connected, comparing the first timing signal to the second timing signal to determine an offset, and transmitting the offset to the wireless communications network.

[0006]Various attempts are being made to apply 5G communication systems to the IoT network. For example, technologies related to sensor networks, M2M communication, and MTC are being implemented by using 5G communication

technology including beamforming, MIMO, and array antennas. Application of cloud radio access network (cloud-RAN) as the above-described big data processing technology may be an example of convergence of 5G communication technology and IoT technology. Due to development in a wireless communication system, methods of transmitting and receiving data for network cooperative communication are being required.

[0007]In the industrial applications space, requirements include support for mixed services in factory and manufacturing environments, including support for different service levels, such as massive Machine-Type Communications (mMTC), enhanced Mobile Broadband (eMBB), and ultra-reliable low-latency communications (URLLC) traffic in the same deployment. Support for industrial deterministic service is needed. Integration between the 5G System (5 GS) and existing industrial networks is also required. Interoperability, including support for non-public networks and interoperability with the public land mobile network (PLMN) is required.

OBJECTS OF THE INVENTION

[0008]It is an object of the present invention, a method, performed by a UE, of performing communication in a wireless communication system may include: transmitting, to a BS, UE capability information including whether the UE supports cooperative communication for receiving PDSCHs from a plurality of transmission reception points (TRPs) in a particular time-frequency resource.

[0009]Another object of the present invention is to identifying a format of a MAC CE received from the BS based on whether the BS is to apply the cooperative communication.

[0010]Yet another object of the present disclosure is to determining of the TCI states may include, when the cooperative communication is applied from the BS, identifying, from the MAC CE, information about a plurality of TCI code

identifiers (IDs) to be activated at a first TRP and TCI states of a second TRP, the TCI states being activated in association with the plurality of TCI code IDs.

[0011]A further object of the present invention is, a result of the identifying of the format of the MAC CE, when one activated TCI state is mapped to code point of one TCI field, receiving a PDSCH via the particular time-frequency resource.

[0012]Another further object of the present invention is, the MAC CE may have a structure in which pairs are arrayed, each of the pairs including a TCI code ID to be activated and an additional TCI state associated with the TCI code ID.

[0013]These and another objects and advantages will become more apparent when reference is made to the following description and accompanying drawings.

SUMMARY OF THE INVENTION

[0014]A solution to one or more drawbacks of the existing technology and additional advantages are provided through the present disclosure. Additional features and advantages are realized through the technicalities of the present disclosure. Other aspects of the disclosure are described in detail herein and are considered to be a part of the claimed disclosure.

[0015]In an aspect of the present invention, a combination of a standalone local network and a public MNO network can also be used as basis for providing a non-public network service across the two network domains. An industrial user might deploy a local network on-site, which together with the public network infrastructure provides the non-public network service via federated network slicing. For example, the local deployment may be deployed to “harden” the public network, in terms of local coverage, availability, capacity and computing resources.

[0016]In an aspect of the present invention, a local network can also provide neutral-host capabilities, by extending a public network on site in addition to

providing a local standalone network. For this purpose, network sharing solutions such as multi-operator core network (MOON) or multi-operator radio access network (MORAN) can be applied. In shared network approaches, a resource management solution is needed that can provide guaranteed resources and performance for the different supported networks (or network slices). A network sharing solution may be well motivated for both local and public network providers.

[0017]In an aspect of the present invention, the local provider can provide a free local site for the MNO, while the MNO may provide its spectrum resources for the network. Since the same base stations can support public and private services, some improved coexistence between the local and the public network should be possible. Further, a shared solution may be motivated by different services. For example, a public MNO may provide conventional enterprise services on the industrial site, e.g., telephony, mobile broadband and IT connectivity, while the private standalone local network is used for local industrial OT connectivity.

[0018]In an aspect of the present invention, network slicing is a conceptual way of viewing and realizing the provider network. Instead of the prevailing notion of a single and monolithic network serving multiple purposes, technology advancements such as Virtualization and SDN allows us to build logical networks on top of a common and shared infrastructure layer.

[0019]In an aspect of the present invention, just as existing networks are built to realize services, so are network slices. They are not services in themselves, but they are built to realize one or several services. As a special case, a service (or instance thereof) maps one-to-one with a network slice, allowing, for example, wholesale type of services. Resources (physical or logical) can be dedicated to a slice, i.e. separate instances, or they could be shared across multiple slices.

[0020]In an aspect of the present invention, as slices can be created to address a new business requirement or customer and may need to adapt to changes, they require a new type of life cycle management functions, which has the role of

creating, changing (e.g., upgrading) or removing them. Network slicing allows for different network architectures which are optimized for the specific use case that the slice is being used for.

[0021]In an aspect of the present invention, several more characteristics, uses, embodiments, and/or modifications of the disclosed invention will be seen from the items are placed and the in-depth description that follows. Without straying from the fundamentals of the disclosed technology, further and/or alternative configurations of the components, systems, quasi computer readable media, and techniques can be used.

BRIEF DESCRIPTION OF THE DRAWINGS

[0022]Figure 1 illustrates a method for industrial automation using 5G wireless communication network;

[0023]The figure of the present subject matter depict for illustration only. A person skilled in the art will easily recognize from the following description that the illustration herein may be employed without departing from the principles of the disclosure described herein.

DETAILED DESCRIPTION OF THE INVENTION

[0024]The present invention is of the best mode presently contemplated for carrying out the invention. This description is not to be taken in a limiting sense, but is made merely for the purpose of describing the general principles of the invention. The scope of the invention should be determined with reference to the claims.

[0025]Referring to Figure 1, the computer program instructions may be provided to a processor of a general-purpose computer, special purpose computer, or other programmable data processing apparatus, such that the instructions, which are

executed via the processor of the computer or other programmable data processing apparatus, generate means for performing functions specified in the flowchart block or blocks.

[0026]The computer program instructions may also be stored in a computer usable or computer-readable memory that may direct the computer or other programmable data processing apparatus to function in a particular manner, such that the instructions stored in the computer usable or computer-readable memory produce an article of manufacture including instruction means that perform the functions specified in the flowchart block or blocks. The computer program instructions may also be loaded onto the computer or other programmable data processing apparatus to cause a series of operational steps to be performed on the computer or other programmable apparatus to produce a computer implemented process such that the instructions that are executed on the computer or other programmable apparatus provide steps for implementing the functions specified in the flowchart block or blocks.

[0027]The terms used in the specification are defined in consideration of functions used in the disclosure and can be changed according to the intent or commonly used methods of users or operators. Accordingly, definitions of the terms are understood based on the entire descriptions of the present specification. In the following description, the term "base station" refers to an entity for allocating resources to a user equipment (UE) and may be used interchangeably with at least one of a gNode B, an eNode B, a node B, a base station (BS), a radio access unit, a base station controller (BSC), or a node over a network.

[0028]Wireless communication systems have been developed from wireless communication systems providing voice centered services in the early stage toward broadband wireless communication systems providing high-speed, high-quality packet data services, like communication standards of high speed packet access (HSPA), long term evolution (LTE or evolved universal terrestrial radio access (E-UTRA)), LTE-advanced (LTE-A), and LTE-pro of the 3GPP, high rate

packet data (HRPD) and ultra mobile broadband (UMB) of 3GPP2, 802.16e of the institute of electrical and electronic engineers (IEEE), or the like.

[0029]According to some embodiments of the disclosure, the eMBB service may be aimed to provide a more enhanced data rate compared to a data rate supported by LTE, LTE-A, or LTE-Pro. For example, the eMBB service in the 5G communication systems need to provide a peak data rate of 20 gigabits per second (Gbps) for a DL and provide a peak data rate of 10 Gbps for a UL in view of a single base station. Simultaneously, the 5G communication is required to provide an increased user-perceived data rate of a UE. To satisfy these requirements, the 5G communication systems requires various enhanced transmission/reception technologies including enhanced multiple-input and multiple-output (MIMO).

[0030]Therefore, for the URLLC service, the 5G communication systems need to provide a smaller transmit time interval (TTI) compared to other services and, at the same time, may be required to broadly allocate resources in a frequency band. However, mMTC, URLLC, and eMBB described above are only examples of different service types, and thus service types to which embodiments of the disclosure are applied are not limited thereto.

[0031]The above-described services considered in the 5G communication systems should be provided in a converged manner based on one framework. That is, for efficient resource management and control, respective services may be integrated, controlled, and transmitted as one system rather than the services operate independently.

[0032]As another example, in order to support different numerologies, the BS may configure a plurality of BWPs for the UE. For example, in order to support a random UE for data transmission and reception using both subcarrier spacing of 15 kHz and subcarrier spacing of 30 kHz, two BWPs may be configured to use subcarrier spacing of 15 kHz and subcarrier spacing of 30 kHz, respectively. Different BWPs may be frequency division multiplexed, and in order to transmit

or receive data by using particular subcarrier spacing, a BWP configured with the particular subcarrier spacing may be activated.

[0033]The BS may additionally transmit an indicator to switch a configuration of a BWP to the UE. In this regard, the switching of the configuration of a BWP may be equally regarded as an operation of activating a particular BWP (e.g., activation is switched from BWP A to BWP B). The BS may transmit, to the UE, a configuration switching indicator in a particular slot. The UE may receive the configuration switching indicator from the UE, and then may determine a BWP to be activated from a particular time point by being applied a configuration switched based on the configuration switching indicator. Also, the UE may perform monitoring on a PDCCH in a CORESET for which the activated BWP is configured.

[0034]In the LTE and NR, the UE performs a procedure of reporting, to a serving BS, capability supported by the UE when the UE is connected to the serving BS. In descriptions below, the report by the UE is called a UE capability report. The serving BS may transfer a UE capability enquiry message requesting the UE to perform a capability report to the UE in a connected state. The UE capability enquiry message may include a UE capability request from the BS according to each radio access technology (RAT) type. The request according to each RAT type may include requested frequency band information.

[0035]Also, the UE capability enquiry message may request a plurality of RAT types in one RRC message container. According to another embodiment of the disclosure, the UE capability enquiry message including the request according to each RAT type may be transferred to a plurality of UEs. The UE capability enquiry is repeated a plurality of times, and the UE may configure a UE capability information message corresponding thereto and may perform reporting a plurality of times.

[0036]The UE may determine the number of antenna ports used to transmit PDSCHs, based on Table indicating DMRS ports. In DCI Format 1_1, an antenna

port indication method based on new radio (NR) NR Rel-15 specification is determined based on an index with a length of 4 to 6 bits indicated by an antenna port field in DCI. The UE may identify the number and index of DMRS ports for PDSCHs, the number of front-load symbols, and information about the number of CDM groups, based on an indicator (index) transmitted from the BS.

[0037]The device communications stack from the bottom to the top of the stack as shown, the device communications stack provides a communication layer for each of the modems of the device at the bottom of the device communications stack. Example measurement point VI resides within or just above the modem driver layer. For example, the modem driver performs modem bus communications, data protocol translations, modem control and configuration to interface the networking stack traffic to the modem.

[0038]The terminology used herein is for the purpose of describing particular embodiments only and is not intended to be limiting of this disclosure. As used herein, the singular forms “a”, “an” and “the” are intended to include the plural forms as well, unless the context clearly indicates otherwise. It will further be understood that the terms “comprises” and/or “comprising,” when used in this specification, specify the presence of stated features, integers, steps, operations, elements, and/or components, but do not preclude the presence or addition of one or more other features, integers, steps, operations, elements, components, and/or groups thereof. Further, references to “a method” or “an embodiment” throughout are not intended to mean the same method or same embodiment, unless the context clearly indicates otherwise.

[0039]The invention has been described with reference to a number of illustrative embodiments, but those versed in the art will recognise that numerous modifications and equivalents may be made without straying from the spirit and scope of the invention. Also, a variety of changes may be made without straying from the invention's core principles in order to fit a given circumstance or piece of information to its teachings. Hence, it is intended that the invention encompass all

embodiments falling within the purview of the appended claims rather than just the specific embodiment revealed as the optimal method proposed for carrying out this invention.

We claim:

1. A method for industrial automation using 5G wireless communication network comprising:
   - identifying a format of a medium access control control element received from the based on the base station obtained information indicating whether the cooperative communication is applied by the base station;
   - transmitting, to a base station, capability information indicating whether the UE supports the cooperative communication for receiving physical downlink shared channels from a plurality of transmission reception points in a time-frequency resource;
   - receiving, from a user equipment, capability information indicating whether the UE supports the cooperative communication for receiving physical downlink shared channels from a plurality of transmission reception points in a time-frequency resource.

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(57) Abstract :
The Microbial Fuel Cell (MFC) is a device that uses microorganisms to produce energy by discharging electrons to an electrode while consuming organic molecules as a source of nutrients. In this work, multiple chamber MFCs and double chamber MFCs were built to generate power from microorganisms found in samples of organic waste. Samples were taken from organic wastes dumped nearby in a wetland, and indigenous b the samples were used to oxidise the waste to produce energy. The output of electricity steadily rose as organisms grew, but it eventually re owing to the loss of organic matter. The external addition of glucose was used to maintain a constant condition for power production. Using wastewater devoid of organic matter as a substrate, the electrogenic activity of each isolate was investigated. Sustainable energy production a carbon dioxide-free renewable technique of generating power from biodegradable materials.

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