**3GPP TSG-SA5 Meeting #150 S5-235zzz**

**Goteborg, Sweden, August 21-25, 2023 was S5-235zzz**

**Source: Samsung, ...**

**Title: Rel-18 pCR 28.ABC clause 4 Overview**

**Document for: Approval**

**Agenda Item: 6.6.4.1 (NSOEU\_WoP#1) General**

# 1 Decision/action requested

***The group is asked to discuss and approve the proposals.***

# 2 References

This pCR is motivated by reference to preceding work relevant to the feature.

[1] 3GPP TR 22.867, "Study on 5G smart energy and infrastructure".

[2] 3GPP TS 22.104, "Service requirements for cyber-physical control applications in vertical domains".

[3] 3GPP TS 22.261, "Service requirements for the 5G system".

[4] 3GPP TR 28.829, "Study on network and service operations for energy utilities".

# 3 Rationale

The overview will provide an introduction to the TS that clarifies which functionality is supported and why. The overview provides a bit of background, mentioning the overall objectives that were concluded in the SA1 FS\_5GSEI study [1] and then added as normative requirements. [2] [3]

The three supported use cases described in TR 28.829 [4] are explained.

Some of the material from TRs 22.867 [1] and TR 28.829 [4] is summarized.

# 4 Detailed proposal

It is proposed to agree to the following change to TS 28.318, 0.0.0.

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| **Begin Change** |

# 2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non‑specific.

- For a specific reference, subsequent revisions do not apply.

- For a non-specific reference, the latest version applies. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document*.

[1] 3GPP TR 21.905: "Vocabulary for 3GPP Specifications".

[G] IEC "Bringing intelligence to the grid", International Electrotechnical Commission, Geneva, Switzerland, 2018. https://www.iec.ch/basecamp/bringing-intelligence-grid <accessed: 12.7.23>

[H] IEEE SMARTGRID, "Standards", IEEE, 2023. https://smartgrid.ieee.org/about-ieee-smart-grid/standards <accessed: 12.7.23>

[I] [A] Sendin, A., Stafford, J., Grilli, A., "Utilities and Telecommunications in a Nutshell", EUTC, Ediciones Experiencia, 2022.

[J] 3GPP TS 22.104, " Service requirements for cyber-physical control applications in vertical domains; Stage 1".

[K] 3GPP TS 22.261, " Service requirements for the 5G system; Stage 1".

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# 4 Overview

## 4.1 General

The present document specifies exposed management services that enable improved operation of energy utility networks used for energy distribution. Energy service can be logically considered as four components: generation, transmission, distribution and consumption points. In a typical energy system, there are few centralized generation facilities (e.g. nuclear, thermal and hydro plants), where nature's energy is converted into electricity. Then, there are a limited number of high power transmission lines covering great distance with the minimum of energy loss. Then, a great many sites are part of medium and low voltage distribution networks. The distribution system transforms and delivers energy to customers. Finally, there is an extremely large number of consumption points (i.e. every household, business, public infrastructure site such as traffic lights at an intersection.) This simple model of the energy service delivery system is depicted in Figure 4.1-1.



Figure 4.1-1: Energy service delivery system

Diverse standardized "smart grid" services are used to manage the energy system effectively - with high availability, safety and efficiency. IEC, IEEE and other organizations standardize these services. [G] [H] To support these services, diverse communication systems are employed, including fiber optic, mobile telecommunications, power line communications and others. The services are generally defined at the application layer, meaning that they can operate over any access. The choice of which access to employ is made by energy service operators, and is determined by many factors outside of the scope of the present document. In many deployments, the choice is to employ mobile telecommunications to support smart grid services. [I]

Since there are few energy generators and the requirements of transmission facilities are not changing that much over time, the focus for smart energy services and the communication systems that they rely on are mainly on distribution services. The distribution grid is the part of the energy system that is on the outer part of the system, the one closer to end-customers and, thus, the most extensive one. It is here that the energy system is changing fastest, as distributed energy generation, distributed energy storage and other trends disrupt the simpler top-down hierarchy of generation, transmission, distribution, consumption. Though there are smart grid services associated with consumption and distributed generation, these use cases and requirements have not been further developed as part of the present document.

Supporting the communication requirements of the distribution system is the focus of the present document. These networks, operated by Distribution System Operators (DSOs), aim at extremely high availability. The services employed in the distribution system include SCADA and DA, which can detect and correct abnormalities, reconfigure and restart services rapidly. If remote operations and monitoring is not available, even for a short time, it can result in service outages of much longer duration, often requiring manual intervention by a service technician sent to the affected site.

An important form of 'fate sharing' exists between mobile telecommunications networks and the energy system. If energy service interruptions persist, the mobile telecommunications network will also become unavailable once the sites' independent energy storage and generation capacity are exhausted. If the mobile telecommunications service is interrupted, smart grid services will also be interrupted in a significant number of sites, leading to increasing risk of energy service outages over time. These scenarios are considered further in the present document.

Telecom management service exposure requirements, procedures and solution set details are specified to improve communication service availability to DSOs.

## 4.2 Background

The topics described in clause 4.1 have been considered in stage 1 standardization in 3GPP. Relevant requirements are specified in TS 22.104 [J] and TS 22.261 [K]. These requirements are shown in Table 4.2-1.

Table 4.2-1: Relevant Service Requirements

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| Reference | Requirement | Relation to the present document |
| TS 22.261, 6.23.2 | The 5G system shall provide a means by which an MNO informs a third party of network events (failure of network infrastructure affecting UEs in a particular area, etc.). | Motivates clauses 4.3 and 5.1.  |
| TS 22.261, 6.23.2 | Based on MNO policy, the 5G system shall provide a mechanism to automatically report service degradations, communications loss, and sustained connection loss in a specific geographic area (e.g., a cell sector, a cell or a group of cells) to a third party. [NOTE1] | Motivates clauses 4.3 and 5.1. |
| TS 22.104, 9.2 | Subject to regulatory requirements and operator policy, the 5G system shall support a mechanism by which an MNO can identify the ability of the MNO's infrastructure to continue operation despite a lack of electrical supply service, specifying which physical regions would be affected in terms of physical topology and the remaining time in which operation is possible. [NOTE2] | Motivates clauses 4.4 and 5.2. |
| TS 22.104, 9.2 | Subject to regulatory requirements, the 5G system shall support a mechanism by which a third party can, in the event of an energy distribution system service interruption, communicate the energy distribution system recovery status in terms of location and time table to the MNO. [NOTE3] | Motivates clauses 4.4 and 5.2. |
| [NOTE1] These reports use a standard format. The specific values, thresholds, and conditions upon which alarms occur can include the measured values for end-to-end latency, service bit rate, communication service availability, end-to-end latency jitter, etc. for a UE, the UE’s location, and the time(s) during which the degradation occurred.[NOTE2] This information can facilitate energy distribution system recovery operations.[NOTE3] This information can facilitate MNO operations to facilitate energy system recovery. |

The stage 1 service requirements in Table 4.2-1 were considered to motivate and scope an investigation of stage 1 telecom management requirements. The function that has been introduced by the present specification is described in the clauses 4.3 and 4.4. The normative stage 1 telecommunications requirements are specified in clauses 5.2 and 5.3.

## 4.3 Exposed network performance monitoring and prediction

The DSO requires extremely high availability communication services to provide smart energy services such SCADA and DA. These services, if available, in the energy system enable increased availability of energy service.

The availability requirement of communication for the energy system's most critical services is higher than that which can be achieved by the mobile telecommunication system. To achieve the required availability of communication service, the DSO can operate with the possibility of employing a back up communication system.

Operation with of both the primary and back up systems continuously is not feasible, for operational reasons such as energy consumption, operational expenditures, etc. Rather, at opportune times, the back up system is activated and used in lieu of the primary system. The difficulty faced by a DSO is to determine when to activate the back up system. If the primary system cease to be available, the back up must be brought into service. This operation costs minutes. where each minute is 1.9 \* (10)-6 of a year. It is impossible to achieve 99.9999% availability with even 2 minutes of down time in a year.

If a problem were to occur during the time between communication offered by the primary and back up service were to occur, in which remote monitoring and control is done, it could be catastrophic. Even if a catastrophic event were not to occur, recovering from even an incident of moderate severity may require manual intervention at remote sites. Until recovery completes, energy service may be interrupted for a significant period of time (e.g. 1 hour). A service outage of the energy system must be avoided as it can cause damage to property and endanger human life. This is not only a business and social consideration, there are often regulations that DSOs are subject to.

To avoid the risk of being surprised by the primary communication system's failure, the DSO monitors diverse aspects of the communication service, including latency, packet loss, cell and network availability etc. The monitoring can be analyzed by the DSO to identify 'problematic conditions,' using past experience as a guide and model. Once a potential problem is identified, the DSO can proactively activate the back up communication system. In practice, this approach allows the DSO to avoid or significantly reduce communication service interruptions.

DSO monitoring can be done 'over the top' even without 3GPP standards, but this has three shortcomings. First, if the network is not available, the measurements taken by remote systems cannot be obtained by the centralized DSO network management system. Second, probes to determine the network's latency and packet loss can only be sent infrequently without contributing significantly to traffic on the network. Third, if there is a problem, it is not clear whether it is a problem with the DSO's network or the mobile telecommunication system that it relies on.

To address these problems and to increase the availability of the energy system, the 5G management system supports standardized functionality to expose network monitoring and performance prediction information to the DSO.

## 4.4 Exposed management services for energy system recovery

This functionality concentrates on the distribution system, as depicted in Figure 4.1-1, which can have a series of sub-stations between high voltage transmission and the final distribution to energy consumers.

Interruptions occur in the distribution system, as at some level, the medium voltage network may require local reconfigurations or suffer unplanned loss of distribution service (e.g. due to distribution cable damage, etc.) The resulting energy service interruptions last a variable amount of time (from minutes to hours.)

The normal situation is that a utility may need to disconnect a certain Medium Voltage feeder. As the grid does not automatically re-connect this feeder to an active one, there will be a power outage in all points of supply connected to it while the power is being restored. The procedures and times to reconnect the affected feeder would be the same if for any reason this has been caused by a planned operation, an unexpected incident, or if it is a major grid problem.

In the recovery procedures, the DSO network operations centre needs to restore power in a certain order often for regulatory compliance: the order includes prioritizing the more important energy consumers (e.g., Hospitals, government sites).

This prioritization may also include major MNOs' sites, such as base stations and core network sites to restore communication services, which is in the interest of both MNO and DSO stakeholders. This prioritized recovery of MNO sites is enabled by this use case.

A standardized mechanism connecting DSOs and MNOs benefits both operators.

There are two supported scenarios.

For the first scenario, which is the most typical, there is a redundant topology of feeders to the energy distribution substations. When a particular feeder is taken out of service or suffers an unplanned loss of service, the task is to bring up another line in the topology to sufficiently distribute energy to the entire distribution substation topology. This requires lines to be activated and deactivated in various ways. This could temporarily interrupt energy service to sites that are critical to the mobile telecommunication network. If the interruption time exceeds the uninterruptable (reserve or generated) energy capacity of the site, then the telecommunication service could be interrupted. This in turn would greatly complicate the energy service restoration process, since manual operations could be required. Service technicians would need to work at various energy service distribution substations at the same time. To address this problem, so that the MNO will avoid exhausting the uninterruptable energy capacity of all relevant mobile telecommunication sites, information is shared by the MNO and DSO so that the DSO can identify which mobile telecommunication site depends on which energy system distribution substation, what the uninterruptable energy capacity of the site is, and other information.

For the second scenario, which can arise in remote areas, there is not a redundant topology of feeders to the distribution substations, rather the distribution line is effectively 'serial,' connecting one substation after another. Even though this scenario is rarer than the redundant topology deployment, it is still vitally important as energy service must also be provided to remote areas. When this feeder is taken out of service, it must be restored before energy service can resume. This task has two parts. First, which can be a long process, a service technician repairs or replaces the damaged distribution line, etc. Second, service is restored in and between the distribution substions fed by the restored line. This second task can be quite rapid (accomplished in seconds or minutes) if it can be accomplished through remote smart grid energy services, or it can be slow (if service technicians must manually intervene in energy distribution substations in remote areas.) The problem is that mobile telecommunication sites could run out of uninterruptible (reserve or generated) energy capacity during the 'first' phase and have no service by the time the 'second' phase is possible. To address this problem, information is exchanged between the MNO (or site operator(s)) and DSO so that the MNO (or site operator(s)) could, if feasible and desirable, reserve energy capacity and operate the telecommunication service for DSO during the opportune time in the needed locations.

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