3GPP TSG SA WG2 #165 S2-2411077

14 - 18 October, 2024, Hyderabad, India (revision of S2-2409641)

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| *CR-Form-v12.2* |
| **CHANGE REQUEST** |
|  |
|  | **23.501** | **CR** | **5629** | **rev** | **3** | **Current version:** | **19.1.0** |  |
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| *For* [***HE******LP***](http://www.3gpp.org/3G_Specs/CRs.htm#_blank)*on using this form: comprehensive instructions can be found at* [*http://www.3gpp.org/Change-Requests*](http://www.3gpp.org/Change-Requests)*.* |
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| ***Proposed change affects:*** | UICC apps |  | ME |  | Radio Access Network |  | Core Network | **X** |

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|  |
| ***Title:***  | Description of the energy related information based NF selection and discovery |
|  |  |
| ***Source to WG:*** | [Samsung, Rakuten Mobile, Vivo, NEC, ZTE, ETRI, Nokia, Huawei, HiSilicon, Motorola Mobile Com Technology, InterDigital] |
| ***Source to TSG:*** | SA2 |
|  |  |
| ***Work item code:*** | EnergySys |  | ***Date:*** | 2024-10-04 |
|  |  |  |  |  |
| ***Category:*** | ***B*** |  | ***Release:*** | *Rel-19* |
|  | *Use one of the following categories:****F*** *(correction)****A*** *(mirror corresponding to a change in an earlier release)****B*** *(addition of feature),* ***C*** *(functional modification of feature)****D*** *(editorial modification)*Detailed explanations of the above categories canbe found in 3GPP [TR 21.900](http://www.3gpp.org/ftp/Specs/html-info/21900.htm). | *Use one of the following releases:Rel-8 (Release 8)Rel-9 (Release 9)Rel-10 (Release 10)Rel-11 (Release 11)…Rel-16 (Release 16)Rel-17 (Release 17)Rel-18 (Release 18)Rel-19 (Release 19)* |
|  |  |
| ***Reason for change:*** | Based on KI#3 conclusion in TR 23.700-66, the energy related information awared NF discovery and (re-)selection should be supported in Rel-19. |
|  |  |
| ***Summary of change:*** | * Energy related information to be included to the NF profile is introduced.
* Energy related information awared NF discovery and selection principles and related procedure descriptions are introduced.
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|  |  |
| ***Consequences if not approved:*** | The NF selection/re-selection related functionalities considering energy saving and energy efficiency cannot be supported. |
|  |  |
| ***Clauses affected:*** | 5.X.Y (new), 5.X.Z (new), 6.2.6.2, 6.3.1 |
|  |  |
|  | **Y** | **N** |  |  |
| ***Other specs*** |  | **X** |  Other core specifications  | TS/TR ... CR ... |
| ***affected:*** |  | **X** |  Test specifications | TS/TR ... CR ...  |
| ***(show related CRs)*** |  | **X** |  O&M Specifications | TS/TR ... CR ...  |
|  |  |
| ***Other comments:*** |  |
|  |  |
| ***This CR's revision history:*** |  |

\* \* \* \* First 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".

[2] 3GPP TS 22.261: "Service requirements for next generation new services and markets; Stage 1".

[3] 3GPP TS 23.502: "Procedures for the 5G System; Stage 2".

[4] 3GPP TS 23.203: "Policies and Charging control architecture; Stage 2".

[5] 3GPP TS 23.040: "Technical realization of the Short Message Service (SMS); Stage 2".

[6] 3GPP TS 24.011: "Point-to-Point (PP) Short Message Service (SMS) support on mobile radio interface: Stage 3".

[7] IETF RFC 7157: "IPv6 Multihoming without Network Address Translation".

[8] IETF RFC 4191: "Default Router Preferences and More-Specific Routes".

[9] IETF RFC 2131: "Dynamic Host Configuration Protocol".

[10] IETF RFC 4862: "IPv6 Stateless Address Autoconfiguration".

[11] ITU‑T Recommendation I.130: "Method for the characterization of telecommunication services supported by an ISDN and network capabilities of an ISDN".

[12] ITU‑T Recommendation Q.65: "The unified functional methodology for the characterization of services and network capabilities".

[13] 3GPP TS 24.301: "Non-Access-Stratum (NAS) protocol for Evolved Packet System (EPS): Stage 3".

[14] Void.

[15] 3GPP TS 23.228: "IP Multimedia Subsystem (IMS); Stage 2".

[16] 3GPP TS 22.173: "IMS Multimedia Telephony Service and supplementary services; Stage 1".

[17] 3GPP TS 23.122: "Non-Access-Stratum (NAS) functions related to Mobile Station in idle mode".

[18] 3GPP TS 23.167: "3rd Generation Partnership Project; Technical Specification Group Services and Systems Aspects; IP Multimedia Subsystem (IMS) emergency sessions".

[19] 3GPP TS 23.003: "Numbering, Addressing and Identification".

[20] IETF RFC 7542: "The Network Access Identifier".

[21] 3GPP TS 23.002: "Network Architecture".

[22] 3GPP TS 23.335: "User Data Convergence (UDC); Technical realization and information flows; Stage 2".

[23] 3GPP TS 23.221: "Architectural requirements".

[24] 3GPP TS 22.153: "Multimedia priority service".

[25] 3GPP TS 22.011: "Service Accessibility".

[26] 3GPP TS 23.401: "General Packet Radio Service (GPRS) enhancements for Evolved Universal Terrestrial Radio Access Network (E-UTRAN) access".

[27] 3GPP TS 38.300: "NR; NR and NG-RAN Overall Description".

[28] 3GPP TS 38.331: "NR; Radio Resource Control (RRC); Protocol Specification".

[29] 3GPP TS 33.501: "Security architecture and procedures for 5G system".

[30] 3GPP TS 36.300: "Evolved Universal Terrestrial Radio Access (E-UTRA) and Evolved Universal Terrestrial Radio Access Network (E-UTRAN); Overall description; Stage 2".

[31] 3GPP TS 37.340: "Evolved Universal Terrestrial Radio Access (E-UTRA) and NR; Multi-connectivity; Stage 2".

[32] 3GPP TS 23.214: "Architecture enhancements for control and user plane separation of EPC nodes; Stage 2".

[33] 3GPP TS 22.101: "3rd Generation Partnership Project; Technical Specification Group Services and Systems Aspects; Service aspects; Service principles".

[34] 3GPP TS 38.413: "NG-RAN; NG Application Protocol (NGAP)".

[35] 3GPP TS 33.126: "Lawful Interception Requirements".

[36] 3GPP TS 23.682: "Architecture enhancements to facilitate communications with packet data networks and applications".

[37] 3GPP TS 22.280: "Mission Critical Services Common Requirements (MCCoRe); Stage 1".

[38] 3GPP TS 23.379: "Functional architecture and information flows to support Mission Critical Push To Talk (MCPTT); Stage 2".

[39] 3GPP TS 23.281: "Functional architecture and information flows to support Mission Critical Video (MCVideo); Stage 2".

[40] 3GPP TS 23.282: "Functional architecture and information flows to support Mission Critical Data (MCData); Stage 2".

[41] 3GPP TS 32.240: "Charging management; Charging architecture and principles".

[42] 3GPP TS 38.401: "NG-RAN Architecture description".

[43] 3GPP TS 23.402: "Architecture enhancements for non-3GPP accesses".

[44] IETF RFC 4960: "Stream Control Transmission Protocol".

[45] 3GPP TS 23.503: "Policy and Charging Control Framework for the 5G System".

[46] 3GPP TS 23.041: "Public Warning System".

[47] 3GPP TS 24.501: "Non-Access-Stratum (NAS) protocol for 5G System (5GS); Stage 3".

[48] 3GPP TS 24.502: "Access to the 5G System (5GS) via non-3GPP access networks; Stage 3".

[49] 3GPP TS 29.500: "5G System; Technical Realization of Service Based Architecture; Stage 3".

[50] 3GPP TS 38.304: "NR; User Equipment (UE) procedures in idle mode".

[51] 3GPP TS 36.331: "Evolved Universal Terrestrial Radio Access (E-UTRA); Radio Resource Control (RRC); Protocol specification".

[52] 3GPP TS 36.304: "Evolved Universal Terrestrial Radio Access (E-UTRA); User Equipment (UE) procedures in idle mode".

[53] Void.

[54] IETF RFC 4861: "Neighbor Discovery for IP version 6 (IPv6)".

[55] 3GPP TS 23.271: "Functional stage 2 description of Location Services (LCS)".

[56] 3GPP TS 23.060: "General Packet Radio Service (GPRS); Service description; Stage 2".

[57] IETF RFC 4555: "IKEv2 Mobility and Multihoming Protocol (MOBIKE)".

[58] 3GPP TS 29.510: "5G System: Network function repository services; Stage 3".

[59] 3GPP TS 29.502: "5G System: Session Management Services: Stage 3".

[60] IETF RFC 7296: "Internet Key Exchange Protocol Version 2 (IKEv2) ".

[61] 3GPP TS 23.380: "IMS Restoration Procedures".

[62] 3GPP TS 24.229: "IP multimedia call control protocol based on Session Initiation Protocol (SIP) and Session Description Protocol (SDP); Stage 3".

[63] 3GPP TS 23.292: "IP Multimedia Subsystem (IMS) centralized services; Stage 2".

[64] 3GPP TS 23.222: "Functional architecture and information flows to support Common API Framework for 3GPP Northbound APIs".

[65] 3GPP TS 29.244: "Interface between the Control Plane and the User Plane Nodes; Stage 3".

[66] 3GPP TS 32.421: "Telecommunication management; Subscriber and equipment trace; Trace concepts and requirements".

[67] 3GPP TS 32.290: "5G system; Services, operations and procedures of charging using Service Based Interface (SBI)".

[68] 3GPP TS 32.255: "5G Data connectivity domain charging; Stage 2".

[69] 3GPP TS 38.306: "NR; User Equipment -UE) radio access capabilities".

[70] 3GPP TS 36.306: "Evolved Universal Terrestrial Radio Access -E-UTRA); User Equipment -UE) radio access capabilities".

[71] 3GPP TS 29.518: "5G System; Access and Mobility Management Services; Stage 3".

[72] Void.

[73] IETF RFC 2865: "Remote Authentication Dial In User Service (RADIUS)".

[74] IETF RFC 3162: "RADIUS and IPv6".

[75] 3GPP TS 29.281: "General Packet Radio System (GPRS) Tunnelling Protocol User Plane (GTPv1-U)".

[76] 3GPP TS 26.238: "Uplink streaming".

[77] 3GPP TR 26.939: "Guidelines on the Framework for Live Uplink Streaming (FLUS)".

[78] International Telecommunication Union (ITU), Standardization Bureau (TSB): "Operational Bulletin No. 1156"; http://handle.itu.int/11.1002/pub/810cad63-en (retrieved October 5, 2018).

[79] 3GPP TS 28.533: "Management and orchestration; Architecture framework".

[80] 3GPP TS 24.250: "Protocol for Reliable Data Service; Stage 3".

[81] IETF RFC 8684: "TCP Extensions for Multipath Operation with Multiple Addresses".

[82] IETF RFC 8803: "0-RTT TCP Convert Protocol".

[83] IEEE Std 802.1CB-2017: "IEEE Standard for Local and metropolitan area networks-Frame Replication and Elimination for Reliability".

[84] 3GPP TS 23.316: "Wireless and wireline convergence access support for the 5G System (5GS)".

[85] WiFi Alliance Technical Committee, Hotspot 2.0 Technical Task Group: "Hotspot 2.0 (Release 2) Technical Specification".

[86] 3GPP TS 23.288: "Architecture enhancements for 5G System (5GS) to support network data analytics services".

[87] 3GPP TS 23.273: "5G System (5GS) Location Services (LCS); Stage 2".

[88] 3GPP TS 23.216: "Single Radio Voice Call Continuity (SRVCC); Stage 2".

[89] CableLabs DOCSIS MULPI: "Data-Over-Cable Service Interface Specifications DOCSIS 3.1, MAC and Upper Layer Protocols Interface Specification".

[90] BBF TR-124 issue 5: "Functional Requirements for Broadband Residential Gateway Devices".

[91] BBF TR-101 issue 2: "Migration to Ethernet-Based Broadband Aggregation".

[92] BBF TR-178 issue 1: "Multi-service Broadband Network Architecture and Nodal Requirements".

[93] BBF TR-456 issue 2: "AGF Functional Requirements".

[94] BBF WT-457: "FMIF Functional Requirements".

Editor's note: The reference to BBF WT-457 will be revised when finalized by BBF.

[95] Void.

[96] Void.

[97] IEEE Std 802.1AB-2016: "IEEE Standard for Local and metropolitan area networks -- Station and Media Access Control Connectivity Discovery".

[98] IEEE Std 802.1Q-2022: "IEEE Standard for Local and metropolitan area networks--Bridges and Bridged Networks".

[99] 3GPP TS 38.423: "NG-RAN; Xn Application Protocol (XnAP)".

[100] 3GPP TS 36.413: "Evolved Universal Terrestrial Radio Access Network (E-UTRAN); S1 Application Protocol (S1AP)".

[101] 3GPP TS 29.274: "Evolved General Packet Radio Service (GPRS) Tunnelling Protocol for Control plane (GTPv2-C); Stage 3".

[102] 3GPP TS 23.632: "User Data Interworking, Coexistence and Migration; stage 2".

[103] 3GPP TS 29.563: "5G System (5GS); HSS services for interworking with UDM; Stage 3".

[104] IEEE Std 802.1AS-2020: "IEEE Standard for Local and metropolitan area networks--Timing and Synchronization for Time-Sensitive Applications".

[105] 3GPP TS 22.104: "Service requirements for cyber-physical control applications in vertical domains".

[106] IEEE Std 802.11-2012: "IEEE Standard for Information technology - Telecommunications and information exchange between systems - Local and metropolitan area networks - Specific requirements - Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications".

[107] IEEE Std 1588-2008: "IEEE Standard for a Precision Clock Synchronization Protocol for Networked Measurement and Control Systems".

[108] 3GPP TS 28.552: "Management and orchestration; 5G performance measurements".

[109] 3GPP TS 24.193: "Access Traffic Steering, Switching and Splitting; Stage 3".

[110] 3GPP TS 24.526: "User Equipment (UE) policies for 5G System (5GS); Stage 3".

[111] 3GPP TS 22.186: "Enhancement of 3GPP support for V2X scenarios; Stage 1".

[112] 3GPP TR 38.824: "Study on physical layer enhancements for NR ultra-reliable and low latency case (URLLC)".

[113] IEEE: "Guidelines for Use of Extended Unique Identifier (EUI), Organizationally Unique Identifier (OUI), and Company ID (CID)", https://standards.ieee.org/content/dam/ieee-standards/standards/web/documents/tutorials/eui.pdf.

[114] 3GPP TS 32.256: "Charging Management; 5G connection and mobility domain charging; Stage 2".

[115] 3GPP TS 33.210: "Network Domain Security (NDS); IP network layer security".

[116] 3GPP TS 38.415: "PDU Session User Plane Protocol".

[117] 3GPP TS 24.535: "Device-side Time-Sensitive Networking (TSN) Translator (DS-TT) to network-side TSN Translator (NW-TT) protocol aspects; Stage 3".

[118] 3GPP TS 32.274: "Charging Management; Short Message Service (SMS) charging".

[119] 3GPP TS 23.008: "Organization of subscriber data".

[120] 3GPP TS 38.314: "NR; Layer 2 measurements".

[121] 3GPP TS 23.287: "Architecture enhancements for 5G System (5GS) to support Vehicle-to-Everything (V2X) services".

[122] 3GPP TS 29.503: "5G System; Unified Data Management Services; Stage 3".

[123] 3GPP TS 32.254: "Charging management; Exposure function Northbound Application Program Interfaces (APIs) charging".

[124] 3GPP TS 33.535: "Authentication and Key Management for Applications based on 3GPP credentials in the 5G System (5GS)".

[125] 3GPP TS 38.410: "NG-RAN; NG general aspects and principles".

[126] IEEE Std 1588: "IEEE Standard for a Precision Clock Synchronization Protocol for Networked Measurement and Control Systems", Edition 2019.

[127] ST 2059-2:2015: "SMPTE Standard - SMPTE Profile for Use of IEEE-1588 Precision Time Protocol in Professional Broadcast Applications".

[128] 3GPP TS 23.304: "Proximity based Services (ProSe) in the 5G System (5GS)".

[129] 3GPP TS 23.247: "Architectural enhancements for 5G multicast-broadcast services".

[130] 3GPP TS 23.548: "5G System Enhancements for Edge Computing; Stage 2".

[131] IEEE Std 802.3: "Ethernet".

[132] 3GPP TS 29.561: "5G System; Interworking between 5G Network and external Data Networks; Stage 3".

[133] 3GPP TS 29.513: "Policy and Charging Control signalling flows and QoS parameter mapping; Stage 3".

[134] 3GPP TS 23.558: "Architecture for enabling Edge Applications (EA)".

[135] 3GPP TS 26.501: "5G Media Streaming (5GMS); General description and architecture".

[136] 3GPP TS 23.256: "Support of Uncrewed Aerial Systems (UAS) connectivity, identification and tracking; Stage 2".

[137] GSMA NG.116: "Generic Network Slice Template".

[138] IETF RFC 3948: "UDP Encapsulation of IPsec ESP Packets".

[139] 3GPP TS 24.539: "5G System (5GS); Network to TSN translator (TT) protocol aspects; Stage 3".

[140] 3GPP TS 33.220: "Generic Authentication Architecture (GAA); Generic bootstrapping architecture".

[141] 3GPP TS 33.223: "Generic Authentication Architecture (GAA); Generic Bootstrapping Architecture (GBA) Push function".

[142] 3GPP TS 23.540: "Technical realization of Service Based Short Message Service; Stage 2".

[143] 3GPP TS 38.321: "NR; Medium Access Control (MAC) protocol specification".

[144] 3GPP TS 29.525: "5G System; UE Policy Control Service; Stage 3".

[145] 3GPP TS 29.505: "5G System; Usage of the Unified Data Repository Services for Subscription Data; Stage 3".

[146] IEEE Std 802.1Qdj-2024: "IEEE Draft Standard for Local and metropolitan area networks - Bridges and Bridged Networks - Amendment XX: Configuration Enhancements for Time-Sensitive Networking".

[147] Void.

[148] 3GPP TS 28.557: "Management and orchestration; Management of Non-Public Networks (NPN)".

[149] 3GPP TS 28.541: "Management and orchestration; 5G Network Resource Model (NRM)".

[150] IETF RFC 8655: "Deterministic Networking Architecture".

[151] IETF RFC 8343: "A YANG Data Model for Interface Management".

[152] IETF RFC 8344: "A YANG Data Model for IP Management".

[153] IETF RFC 7224: " IANA Interface Type YANG Module".

[154] IETF draft-ietf-detnet-yang: "Deterministic Networking (DetNet) YANG Model".

Editor's note: The reference to draft-ietf-detnet-yang will be revised to RFC when finalized by IETF.

[155] IETF RFC 6241: "Network Configuration Protocol (NETCONF)".

[156] IETF RFC 8040: "RESTCONF Protocol".

[157] IETF RFC 8939: "Deterministic Networking (DetNet) Data Plane: IP".

[158] IETF RFC 5279: "A Uniform Resource Name (URN) Namespace for the 3rd Generation Partnership Project (3GPP)".

[159] IETF RFC 9330:"Low Latency, Low Loss, Scalable Throughput (L4S) Internet Service: Architecture".

[160] IETF RFC 9331: "Explicit Congestion Notification (ECN) Protocol for Very Low Queuing Delay (L4S)".

[161] IETF RFC 9332: "Dual-Queue Coupled Active Queue Management (AQM) for Low Latency, Low Loss, and Scalable Throughput (L4S)".

[162] IETF RFC 6603: "Prefix Exclude Option for DHCPv6-based Prefix Delegation".

[163] IETF RFC 8415: "Dynamic Host Configuration Protocol for IPv6 (DHCPv6)".

[164] ITU‑T Recommendation G.810: "Definitions and terminology for synchronization networks".

[165] 3GPP TS 38.470: "NG-RAN; F1 general aspects and principles".

[166] IETF RFC 9000: "QUIC: A UDP-Based Multiplexed and Secure Transport".

[167] IETF RFC 9001: "Using TLS to Secure QUIC".

[168] IETF RFC 9002: "QUIC Loss Detection and Congestion Control".

[169] IETF RFC 9221: "An Unreliable Datagram Extension to QUIC".

[170] IETF RFC 9298: "Proxying UDP in HTTP".

[171] IETF RFC 9114: "Hypertext Transfer Protocol Version 3 (HTTP/3)".

[172] IETF RFC 9297: "HTTP Datagrams and the Capsule Protocol".

[173] IETF RFC 9220: "Bootstrapping WebSockets with HTTP/3".

[174] draft-ietf-quic-multipath: "Multipath Extension for QUIC".

Editor's note: The above document cannot be formally referenced until it is published as an RFC.

[175] 3GPP TS 28.530: "Management and orchestration; Concepts, use cases and requirements".

[176] 3GPP TS 28.531: "Management and orchestration; Provisioning".

[177] 3GPP TS 23.434: "Service Enabler Architecture Layer for Verticals (SEAL); Functional architecture and information flows".

[178] IEEE Std 802.1CBdb-2021: "Amendment 2: Extend Stream Identification Functions".

[179] 3GPP TS 26.522: "5G Real-time Media Transport Protocol Configurations".

[180] 3GPP TS 23.586: "Architectural Enhancements to support Ranging based services and Sidelink Positioning".

[181] 3GPP TS 23.542: "Application layer support for Personal IoT Network".

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[183] 3GPP TS 29.571: "5G System; Common Data Types for Service Based Interfaces; Stage 3".

[184] 3GPP TS 23.289: "Mission Critical services over 5G System; Stage 2".

[185] IETF RFC 3550: "RTP: A Transport Protocol for Real-Time Applications".

[186] IETF RFC 3711: "The Secure Real-time Transport Protocol (SRTP)".

[187] IETF RFC 6184: "RTP Payload Format for H.264 Video".

[188] IETF RFC 7798: "RTP Payload Format for High Efficiency Video Coding (HEVC) ".

[189] IETF RFC 8285: "A General Mechanism for RTP Header Extensions".

[190] 3GPP TS 28.405: "Quality of Experience (QoE) measurement collection; Control and configuration".

[191] 3GPP TS 37.355: " LTE Positioning Protocol (LPP)".

[192] 3GPP TS 32.422: "Telecommunication management; Subscriber and equipment trace; Trace control and configuration management".

[193] IETF RFC 3168: "The Addition of Explicit Congestion Notification (ECN) to IP".

[194] 3GPP TS 33.503: "Security Aspects of Proximity based Services (ProSe) in the 5G System (5GS)".

[195] 3GPP TS 38.414: "NG-RAN; NG data transport".

[196] 3GPP TS 38.799: "Study on Additional Topological Enhancements for NR".

[y] ISO/IEC 30134-3:2016: "Information technology -- Data centres -- Key performance indicators -- Part 3: Renewable energy factor (REF)".

\* \* \* \* Second change (all text is new)\* \* \* \*

### 5.X.Y Energy related information in NF profile

NRF maintains energy related information as part of NF profile for registered NF instance. The energy related information includes the following information as defined in Table 5.X.2-1.

[Discussion] Table 5.X.2-1: Energy related information

[Dicussion] Following aspects need to be considered:

1. Whether the value of this information can be determined in consistent way?
2. Whether the value of this information can be static, or not-frequently changed?

|  |  |  |
| --- | --- | --- |
| Information | Description | Category |
| Energy Efficiency? or Energy Inefficiency? | The level of energy efficiency of the NF (e.g. Low, Media High, or 1, 2, 3, 4, 5)The level of energy efficiency that is mapped from the NF load information (NF load information is one of the NF profile information), and the mapping information is decided by operator.Indicate if the NF face problems of excessive energy consumption as characterized by MDA in clause 8.4.4 of TS 28.104.(See energyEfficiencyProblemType allowed Values: HighEnergyConsumption, LowEenergyEfficiency, Other, Unknown, in Table 8.4.4.1.3-1 of TS 28.104) |  |
| Energy Consumption? orEnergy Consumption Level? | The amount of energy consumed by the NFThe level of energy consumption (e.g. low, middle, high)The range of amount of energy consumptionRatio of the NF service KPI (e.g. forwarded data volume of UPF) over the energy consumed in the NF. |  |
| Renewable Energy Factor | Ratio of the renewable energy to the total energy (see ISO/IEC 30134-3:2016 [y])  |  |
| Carbon emission factor | Indicating amount of carbon emissions relative to an amount of resource consumption.E.g. kilograms of equivalent carbon dioxide emitted per kWh (kg of CO2eq/kWh). (see ETSI GS OEU 020 [z]) |  |
| Energy Saving States | The state of energy saving feature. E.g., energy saving activated, energy saving deactivated, or notEnergySaving state, energySaving state as specified in TS 28.310 [x].  |  |
| Scheduled information | Schedule of the energy states (e.g. the time of entering a certain energy saving states)Schedule of the power source characteristics (e.g. the scheduled renewable energy factor and/or the carbon emission factor)Indicating whether the NF is subject to energy related execution (e.g. an UPF that is scheduled to be taken out of service to save energy in energy saving state). |  |
|  |

Editor’s Note: The additional energy related information in Table 5.X.2-1 is FFS.

Editor’s Note: Coordination with SA WG5 is needed for the parameter which are expected to be configured and/or provisioned by OAM.

NOTE 1: The information within NF profile specified in Table 5.X.2-1 is expected not to change frequently, e.g. constantly reflecting changes in energy consumption.

\* \* \* \* Second change (all text is new)\* \* \* \*

### 5.X.Z NF Service Discovery and Selection considering energy related information

The energy related information described in Table 5.X.2-1 is considered during the related procedures such as NF Service Registration, NF Service Update, NF Service Discovery, NF Status Subscribe/Notify procedures in between the NF and the NRF (in clause 4.17 of TS 23.502 [3]).

\* \* \* \* Third change \* \* \* \*

6.2.6.2 NF profile

NF profile of NF instance maintained in an NRF includes the following information:

- NF instance ID.

- NF type.

- PLMN ID in the case of PLMN, PLMN ID + NID in the case of SNPN.

- Network Slice related Identifier(s) e.g. S-NSSAI, NSI ID.

- FQDN or IP address of NF.

- NF capacity information.

- NF priority information.

NOTE 1: This parameter is used for AMF selection, if applicable, as specified in clause 6.3.5. See clause 6.1.6.2.2 of TS 29.510 [58] for its detailed use.

- NF Set ID.

- NF Service Set ID of the NF service instance.

- NF Specific Service authorization information.

- if applicable, Names of supported services.

- Endpoint Address(es) of instance(s) of each supported service.

- Identification of stored data/information.

NOTE 2: This is only applicable for a UDR profile. See applicable input parameters for Nnrf\_NFManagement\_NFRegister service operation in clause 5.2.7.2.2 of TS 23.502 [3]. This information applicability to other NF profiles is implementation specific.

- Other service parameter, e.g. DNN or DNN list, notification endpoint for each type of notification that the NF service is interested in receiving.

- Location information for the NF instance.

NOTE 3: This information is operator specific. Examples of such information can be geographical location, data centre.

- TAI(s).

- NF load information.

- Energy related information, see clause 5.X.Y.- Routing Indicator, Home Network Public Key identifier, for UDM and AUSF.

- For UDM, AUSF and NSSAAF in the case of access to an SNPN using credentials owned by a Credentials Holder with AAA Server, identification of Credentials Holder (i.e. the realm of the Network Specific Identifier based SUPI).

- For UDM and AUSF, and if UDM/AUSF is used for access to an SNPN using credentials owned by a Credentials Holder, identification of Credentials Holder (i.e. the realm if Network Specific Identifier based SUPI is used or the MCC and MNC if IMSI based SUPI is used); see clause 5.30.2.1.

- For AUSF and NSSAAF in the case of SNPN Onboarding using a DCS with AAA server, identification of DCS (i.e. the realm of the Network Specific Identifier based SUPI).

- For UDM and AUSF, and if UDM/AUSF is used as DCS in the case of SNPN Onboarding, identification of DCS (i.e. the realm if Network Specific Identifier based SUPI, or the MCC and MNC if IMSI based SUPI).

- One or more GUAMI(s), in the case of AMF.

- For the UPF, see clause 5.2.7.2.2 of TS 23.502 [3].

- UDM Group ID, range(s) of SUPIs, range(s) of GPSIs, range(s) of internal group identifiers, range(s) of external group identifiers for UDM.

- UDR Group ID, range(s) of SUPIs, range(s) of GPSIs, range(s) of external group identifiers for UDR.

- AUSF Group ID, range(s) of SUPIs for AUSF.

- PCF Group ID, range(s) of SUPIs for PCF.

- HSS Group ID, set(s) of IMPIs, set(s) of IMPU, set(s) of IMSIs, set(s) of PSIs, set(s) of MSISDN for HSS.

- For NWDAF, the following information are supported:

- Analytics ID(s) (possibly per service).

- NWDAF Serving Area information (i.e. list of TAIs for which the NWDAF can provide services and/or data).

- Supported Analytics Delay per Analytics ID (if available).

- NF types of the NF data sources, NF Set IDs of the NF data sources, if available.

- Analytics aggregation capability (if available).

- Analytics metadata provisioning capability (if available).

- ML model Filter information parameters include S-NSSAI(s) and Area(s) of Interest for the trained ML model(s) per Analytics ID(s).

- ML Model Interoperability indicator (if available) per Analytics ID(s).

- FL capability information per analytics ID including FL capability type (i.e. FL server and/or FL client, if available).

- Time interval supporting FL (if available).

- Accuracy checking capability for ML model accuracy monitoring or Analytics Accuracy Monitoring (if available).

- Roaming exchange capability (if available).

NOTE 4: The NWDAF's Serving Area information is common to all its supported Analytics IDs.

NOTE 5: The Analytics IDs supported by the NWDAF may be associated with a Supported Analytics Delay i.e. the Analytics report can be generated with a time (including data collection delay and inference delay) in less than or equal to the Supported Analytics Delay.

NOTE 6: The determination of Supported Analytics Delay, and how the NWDAF avoid updating its Supported Analytics Delay in NRF frequently is NWDAF implementation specific.

- Event ID(s) supported by AFs, in the case of NEF.

- Event Exposure service supported event ID(s) by UPF.

- Application Identifier(s) supported by AFs, in the case of NEF.

- Range(s) of External Identifiers, or range(s) of External Group Identifiers, or the domain names served by the NEF, in the case of NEF.

NOTE 7: This is applicable when NEF exposes AF information for analytics purpose as detailed in TS 23.288 [86].

NOTE 8: It is expected service authorization information is usually provided by OA&M system, and it can also be included in the NF profile in the case that e.g. an NF instance has an exceptional service authorization information.

NOTE 9: The NRF may store a mapping between UDM Group ID and SUPI(s), UDR Group ID and SUPI(s), AUSF Group ID and SUPI(s) and PCF Group ID and SUPI(s), to enable discovery of UDM, UDR, AUSF and PCF using SUPI, SUPI ranges as specified in clause 6.3 or interact with UDR to resolve the UDM Group ID/UDR Group ID/AUSF Group ID/PCF Group ID based on UE identity, e.g. SUPI (see clause 6.3.1 for details).

- IP domain list as described in clause 6.1.6.2.21 of TS 29.510 [58], Range(s) of (UE) IPv4 addresses or Range(s) of (UE) IPv6 prefixes, Range(s) of SUPIs or Range(s) of GPSIs or a BSF Group ID, in the case of BSF.

- SCP Domain the NF belongs to.

- DCCF Serving Area information, NF types of the data sources, NF Set IDs of the data sources, if available, in the case of DCCF.

- Supported DNAI list, in the case of SMF.

- For SNPN, capability to support SNPN Onboarding in the case of AMF and capability to support User Plane Remote Provisioning in the case of SMF.

- IP address range, DNAI for UPF.

- Supported DNS security protocols, in the case of EASDF.

- Additional V2X related NF profile parameters are defined in TS 23.287 [121].

- Additional ProSe related NF profile parameters are defined in TS 23.304 [128].

- Additional MBS related NF profile parameters are defined in TS 23.247 [129].

- Additional UAS related NF profile parameters are defined in TS 23.256 [136].

- Additional Ranging based services and Sidelink Positioning related NF profile parameters are defined in TS 23.586 [180].

- For additional information in PCF profile, see clause 5.2.7.2.2 of TS 23.502 [3].

\* \* \* \* Forth change \* \* \* \*

6.3.1 General

The NF discovery and NF service discovery enable Core Network entities (NFs or Service Communication Proxy (SCP)) to discover a set of NF instance(s) and NF service instance(s) for a specific NF service or an NF type. NF service discovery is enabled via the NF discovery procedure, as specified in clauses 4.17.4, 4.17.5, 4.17.9 and 4.17.10 of TS 23.502 [3].

Unless the expected NF and NF service information is locally configured on the requester NF, e.g. when the expected NF service or NF is in the same PLMN as the requester NF, the NF and NF service discovery is implemented via the Network Repository Function (NRF). NRF is the logical function that is used to support the functionality of NF and NF service discovery and status notification as specified in clause 6.2.6.

NOTE 1: NRF can be colocated together with SCP e.g. for communication option D, depicted in Annex E.

In order for the requested NF type or NF service to be discovered via the NRF, the NF instance need to be registered in the NRF. This is done by sending a Nnrf\_NFManagement\_NFRegister containing the NF profile. The NF profile contains information related to the NF instance, such as NF instance ID, supported NF service instances (see clause 6.2.6 for more details regarding the NF profile). The registration may take place e.g. when the producer NF instance and its NF service instance(s) become operative for the first time. The NF service registration procedure is specified in clause 4.17.1 of TS 23.502 [3].

In order for the requester NF or SCP to obtain information about the NF and/or NF service(s) registered or configured in a PLMN/slice, based on local configuration the requester NF or SCP may initiate a discovery procedure with the NRF by providing the type of the NF and optionally a list of the specific service(s) it is attempting to discover. The requester NF or SCP may also provide other service parameters e.g. slicing related information. For the detailed service parameter(s) used for specific NF and NF service discovery refer to clause 5.2.7.3.2 of TS 23.502 [3]. The requester NF may also provide NF Set related information to enable reselection of NF instances within the NF set. The requester NF may also provide the required supported features of the NF.

For some Network Functions which have access to the subscription data (e.g. HSS, UDM) the NRF may need to resolve the NF Group ID corresponding to a subscriber identifier. If the NRF has no stored configuration mapping identity sets/ranges to NF Group ID locally, the NRF may retrieve the NF Group ID corresponding to a specific subscriber identifier from the UDR using the Nudr\_GroupIDmap\_Query service operation.

In the case of Indirect Communication, a NF Service Consumer employs an SCP which routes the request to the intended target of the request.

If the requester NF is configured to delegate discovery, the requester NF may omit the discovery procedure with the NRF and instead delegate the discovery to the SCP; the SCP will then act on behalf of the requester NF. In this case, the requester NF adds any necessary discovery and selection parameters to the request in order for the SCP to be able to do discovery and associated selection. The SCP may interact with the NRF to perform discovery and obtain discovery result and it may interact with the NRF or UDR to obtain NF Group ID corresponding to subscriber identifier.

NOTE 2: For delegated discovery of the HSS or the UDM, the SCP can rely on the NRF to discover the group of HSS/UDM instance(s) serving the provided user identity, or in some deployments the SCP can first query the UDR for the HSS/UDM Group ID for the provided user identity. It is expected that the stage 3 defines a single encoding for the user identity provided by the service consumer that can be used for both variants of delegated discovery to avoid that the service consumer needs to be aware of the SCP behaviour.

The NRF provides a list of NF instances and NF service instances relevant for the discovery criteria. The NRF may provide the IP address or the FQDN of NF instance(s) and/or the Endpoint Address(es) of relevant NF service instance(s) to the NF Consumer or SCP. The NRF may also provide NF Set ID and/or NF Service Set ID to the NF Consumer or SCP. The response contains a validity period during which the discovery result is considered valid and can be cached. The result of the NF and NF service discovery procedure is applicable to any subscriber that fulfils the same discovery criteria. The entity that does the discovery may cache the NF profile(s) received from the NF/NF service discovery procedure. During the validity period, the cached NF profile(s) may be used for NF selection for any subscriber matching the discovery criteria.

NOTE 3: Refer to TS 29.510 [58] for details on using the validity period.

In the case of Direct Communication, the requester NF uses the discovery result to select NF instance and a NF service instance that is able to provide a requested NF Service (e.g. a service instance of the PCF that can provide Policy Authorization).

In the case of Indirect Communication without Delegated Discovery, the requester NF uses the discovery result to select a NF instance while the associated NF service instance selection may be done by the requester NF and/or an SCP on behalf of the requester NF.

In both the cases above, the requester NF may use the information from a valid cached discovery result for subsequent selections (i.e. the requester NF does not need to trigger a new NF discovery procedure to perform the selection).

In the case of Indirect Communication with Delegated Discovery, the SCP will discover and select a suitable NF instance and NF service instance based on discovery and selection parameters provided by the requester NF and optional interaction with the NRF. The NRF to be used may be provided by the NF consumer as part of the discovery parameters, e.g. as a result of a NSSF query. The SCP may use the information from a valid cached discovery result for subsequent selections (i.e. the SCP does not need to trigger a new NF discovery procedure to perform the selection).

NOTE 4: In a given PLMN, Direct Communication, Indirect Communication, or both may apply.

The requester NF or SCP may subscribe to receive notifications from the NRF of a newly updated NF profile of an NF (e.g. NF service instances taken in or out of service), or newly registered de-registered NF instances. The NF/NF service status subscribe/notify procedure is defined in clauses 4.17.7 and 4.17.8 of TS 23.502 [3].

For NF and NF service discovery across PLMNs, the NRF in the local PLMN interacts with the NRF in the remote PLMN to retrieve the NF profile(s) of the NF instance(s) in the remote PLMN that matches the discovery criteria. If the NRF in the local PLMN indicated support, for the local PLMN, of indirect communication with delegated discovery with NF (re)selection at target PLMN (Model D in Annex E with SCP in target PLMN doing NF (re)selection) and/or of indirect communication without delegated discovery with NF (re)selection at target PLMN (Model C in Annex E with SCP in target PLMN doing NF (re)selection), based on operator's policy and the capabilities of the local PLMN, the NRF in the remote PLMN may also return an indication that indirect communication with delegated discovery with NF (re)selection at target PLMN is requested or that indirect communication without delegated discovery with NF (re)selection at target PLMN is requested and, for delegated discovery in target PLMN, omit NF profiles. The NRF in the local PLMN reaches the NRF in the remote PLMN by forming a remote PLMN specific query using the PLMN ID provided by the requester NF. The remote PLMN NRF may further interact with a target PLMN NRF as specified in clause 6.2.6.1. Based on operator's policy and configuration, the NRF in the local PLMN may also determine without interaction with the NRF in the remote PLMN that indirect communication with delegated discovery with NF (re)selection at target PLMN is requested for communication for that remote PLMN. The NF/NF service discovery procedure across PLMNs is specified in clauses 4.17.5, 4.17.10 and 4.17.10a of TS 23.502 [3].

NOTE 5: See TS 29.510 [58] for details on using the target PLMN ID specific query to reach the NRF in the remote PLMN.

NOTE 6: The NRF in the local PLMN can interact with NRFs in target PLMNs already before receiving related discovery requests to inquire the support of indirect communication by those target PLMNs, cache the received information, and use it for subsequent discovery requests.

For topology hiding, see clause 6.2.17.

For NF and NF service discovery and selection based on the Energy related information, see clause 5.X.Y.

\* \* \* \* End of changes \* \* \* \*