**3GPP TSG-SA WG2 Meeting #13x S2-20xxxx**

**Source: Apple**

**Title: Solution for KI#8 and KI#9: UE sensor data analytics for network improvements and optimisation**

**Document for: Approval**

**Agenda Item: x.x**

**Work Item / Release: FS\_eNA\_ph2 / Rel-17**

*Abstract of the contribution: This contribution proposes a solution for Key Issue #8: UE data as input for analytics generation and for Key Issue #9: Dispersion analytic output provided by NWDAF*

# 1. Introduction

This solution is proposed to address key issues #8 and #9.

The large number of sensors built into today’s devices can provide a valuable source of data to give insights into a UEs surroundings and behaviour. Common examples of UE sensors include (but are not limited to) the barometer, GPS, thermometer, air humidity sensor and gyroscope. These sensors are used to enrich the user experience of smartphones by enabling a wide variety of applications and providing users with feedback and information on their environment.

This proposal will explore how UE sensor data can be gathered and reported to the 5GS for the purposes of assisting networks with improving and optimising RAN operations, and more specifically beam forming procedures.

This proposal will focus on the barometric pressure sensor data being measured by the UE.

# 2. Discussion

Key Issue #8 looks at what UE data can be used for analytics and how it can be gathered as an input to the NWDAF.

As mentioned in the introduction, there are a large number of UE sensors that can potentially be utilised to assist with network operations. The scope and type of sensor data is constantly increasing with the continual introduction of new sensors in phones, tablets, wearables and other networked consumer devices. Some of the current sensor data available is listed in table 6.1.1.2-1. The method of sourcing this data from UEs is to utilise UE Route Selection Policy (URSP) rules and domain descriptors to allow data transfer to the UPF.

Key Issue #9 is concerned with the analytic output of NWDAF and how this reporting could potentially be used.

Mass collection and analysis of UE sensor data can be used by operators for network improvements and optimisations based on statistical reporting and predictions. The NWDAF provides this service to other NFs and OAM. Reporting statistics and providing predictions on UE height distributions in a given geographical area will enable carriers to customise beam management procedures for different gNBs. For example, SSB beam sweep patterns may be optimised to target areas of a cell where there are higher concentrations of users. Similarly, UE height distribution data will be able to support features such as 3D beam forming or automating antenna tilt adjustment to better serve users.

# 3. Proposal

The following changes are proposed for TR 23.700-91.

**\* \* \* \* First Change (All new text) \* \* \* \***

## 6.1 Solution: UE sensor data analytics for network improvements and optimisation

### 6.1.1 Description

#### 6.1.1.1 General

This solution is proposed to address Key Issue #8: UE data as an input for analytics generation.

This solution is also proposed to address Key Issue #9: Dispersion analytic output provided by NWDAF.

This solution specifies how UE sensor data can be sourced and transferred to 5GC for dispersion analytics provided by NWDAF. The analytics can be used for 5G network procedure optimisations and improvements.

#### 6.1.1.2 Input data

The UE sensor data, cellular data and additional network information is sourced from both the UE and NFs in the 5GC. These data inputs are detailed in the following tables 6.1.1.2-1 and 6.1.1.2-2.

**Table 6.1.1.2-1: UE sensor data and mobility information collected from the UE**

|  |  |  |
| --- | --- | --- |
| Information | Source | Description |
| UE sensor data – barometric pressure | UPF | Barometric pressure (hPa or inHg) from the UE |
| GPS co-ordinates | UPF | UE location data from UE  |
| Thermometer | UPF | UE ambient temperature data from UE  |
| Air humidity | UPF | UE ambient humidity data from UE  |
| Gyroscope | UPF | TBD |
| Additional UE data | UPF | TBD |
| PCI | UPF | UE provided cellular data on serving PCI |
| SSB Beam Index | UPF | UE provided cellular data on SSB beam index |
| Timestamp | UPF | A time stamp from UE for collection time of above data inputs |

|  |  |  |
| --- | --- | --- |
| UE ID | AMF | SUPI |
| UE locations (1..max) | AMF | UE positions |
|  >UE location |  | TA or cells that the UE enters |
|  >Timestamp  |  | A time stamp when the AMF detects the UE enters this location |
| Type Allocation code (TAC) | AMF | To indicate the terminal model and vendor information of the UE. The UEs with the same TAC may have similar mobility behavior. The UE whose mobility behavior is unlike other UEs with the same TAC may be an abnormal one. |

*Ref. TS 23.288, Table 6.7.2.2-1*

#### 6.1.1.3 Output Analytics

The NWDAF services as defined in the clause 7.2 and 7.3, TS 23.288 [5], are used to expose the analytics.

- UE sensor data statistics information is defined in Table 6.1.1.3-1.

- UE sensor data predictions information is defined in Table 6.1.1.3-2.

Table 6.12.1.3-1: UE sensor data statistics

|  |  |
| --- | --- |
| Information | Description |
| Height | Average height of the UE in a selected location  |
| Antenna azimuth | ­Average Azimuth/Elevation of the UE in a selected location  |
| PCI information | PCI distribution with respect to UE height for network planning  |
| UE density | Concentration of UE with respect to height for network planning  |
| SSB beam ID distribution | Beam distribution with respect to height for beam management |

Table 6.1.1.3-2: UE sensor data predictions

|  |  |
| --- | --- |
| Information | Description |
| Base Station Antenna Tilt  | Based upon the barometric sensor data, predict the tilt/angular adjustment of Antenna |
| SSB Beam Sweep patterns | Based on UE distributions within a cell, predict the optimal beam sweeping pattern  |
| New Base station deployment | Based upon the concentration of UE at a particular height, predict the deployment of new base station to cover that height |
| Height of UEs in a given cell | Predict likely heights of UEs in a given cell to assist in implementing 3D beam-forming |

#### 6.1.1.4 Procedures



Figure 6.1.1.4-1: Procedure for UE Sensor capability enquiry and data upload to NWDAF

1. UE sends Registration Request to AMF.

NOTE 1: Alternatively, UE could include the sensor information it wants to share with the 5GC, e.g. barometric sensor data could be shared wilfully by UE to optimise Network performance.

2. AMF requests PCF to create a policy for this UE. SUPI is used to identify the UE

3. PCF creates a policy for UE specific to sensor data collection. This policy could be a URSP rule with "Domain Descriptors" differentiating the need to create a new PDU Session when UE decides to send the Sensor data information. Additionally, the URSP rule could have Time Window and/or Location specifying the time & location when UE could send this information. Optionally, a DNN could be dedicated to this UE.

4. AMF sends URSP rules to UE as part of Registration Accept.

5. AMF notifies the NWDAF that a new UE has been added which could share sensor data in future.

NOTE 2: Optionally, the network could enquire the UE of its sensor capability via UECapabilityEnquiry procedure. As a response to the enquiry, UE could send the list of sensors available in the UE.

6. Follows the PDU Session Establishment Procedure defined in TS 23.502 clause 4.3.2.2. The SMF would set user plane integrity protection to required or preferred for this PDU session.

7. After PDU session is successfully established, UE starts sending the "Sensor data" as user plane packets to UPF.

8. UPF routes the data for this PDU session to the NWDAF.

9. NWDAF derives new analytics based on the sensor information received from multiple UEs.

NOTE 3: The proposal is for UE sensor data to be gathered from a very large numbers of UEs.

10. NWDAF notifies the RAN (via AMF) of any improvements to its antenna performance for beamforming. An example, tilt the beamforming pattern by a certain angle for better coverage or performance.

NOTE 4: The expectation is that thousands of UEs within a small geographical area will be providing sensor data (e.g. barometric sensor data) to produce meaningful statistical information and accurate predications on UE distributions and behaviour.

### 6.X.2 Impacts

### 6.X.3 Solution evaluation

**\* \* \* \* End of Changes \* \* \* \***