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ENSURING BILLING ACCURACY FOR OFFLINE CHARGING IN 5G NETWORKS

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ABSTRACT

Ensuring Accounting accuracy is paramount in any mobile network. With the advent of Control and User Plane Separation (CUPS) in Third Generation Partnership Project (3GPP) specifications, beginning in 4G network implementations and extending to 5G network implementations, the erstwhile monolithic gateway has been split into two independent nodes, a control plane network function referred to as the Session Management (SMF) and a user plane network function referred to as the User Plane Function (UPF). This separation renders the UPF unaware of some of the events that have occurred at the SMF, which can result in billing inaccuracies. Proposed herein are techniques that may provide subscriber usage accounting accuracy and may also facilitate optimizing signaling between the SMF and the UPF.

DETAILED DESCRIPTION

Per 3GPP Technical Specification (TS) 32.255, there are two types of charging triggers defined – immediate and deferred. When an "immediate" trigger type is detected at an SMF, the SMF is to generate a charging data record towards a Charging Function (CHF). The generation of such records is also governed by a maximum number of change conditions that can be configured at the SMF. The UPF is expected to reset threshold monitoring and restart usage counts whenever a charging data record is sent to CHF.

In the event that a charging data record is generated by the SMF upon the maximum change condition being reached due to a service data flow (SDF) level threshold trigger, Session/Bearer level usage counts are not reset as the UPF is unaware of this condition. This can lead to charging discrepancies for the subsequent charging data records that can result in inaccurate charging of the subscriber, thus exposing the operator to overcharging litigation or revenue loss.

More specifically, the current set of provisions provided in 3GPP TS 29.244 for the Sx/N4 interface interconnecting an SMF and UPF do not provide a mechanism to reconcile Session/Bearer level Usage Reporting Rule (URR) usage monitoring at the UPF when a charging data record is generated by the SMF due to the maximum number of change conditions being met. This results in inaccurate billing of the subscriber.

Figure 1, below, is a call flow illustrating the message exchanges between an SMF and a UPF for two different triggers.

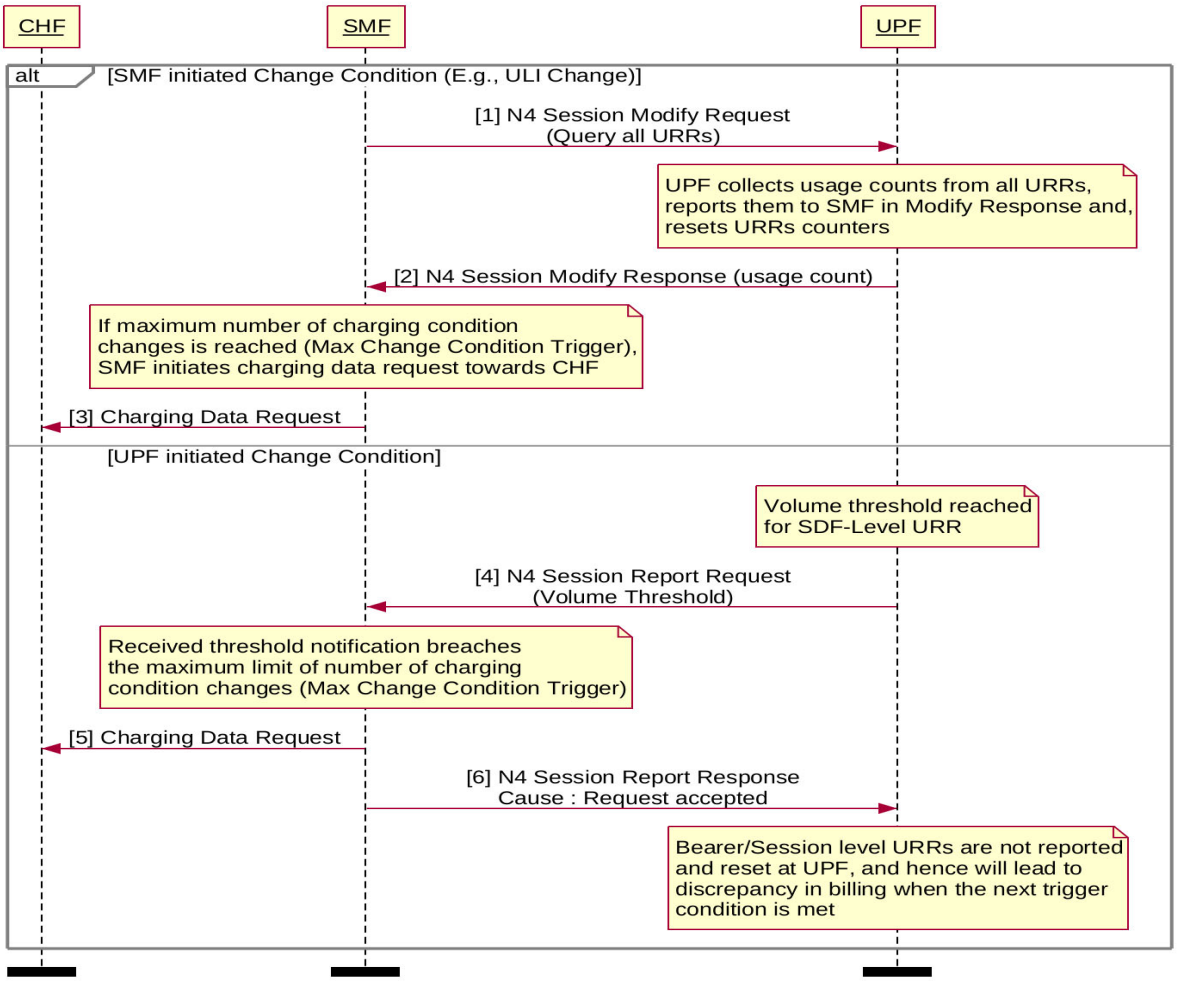

Figure 1: Example SMF/UPF Exchange for Different Triggers

As shown in Figure 1, a first SMF/UPF messaging exchange involves a User Location Information (ULI) change scenario. For the ULI change scenario, upon receiving a ULI change trigger, the SMF sends a Packet Forwarding Control Protocol (PFCP) Modify Request message to the UPF, which queries the UPF for all URRs configured at the UPF

for a given subscriber. Upon receiving the message, the UPF collects the usage across all active URRs for the subscriber, resets the usage for all the URRs, and reports current usage counts for the subscriber to the SMF in a PFCP Modify Response message. Depending on the type of trigger or max number of change conditions, the SMF will generate a Charging Data Record (CDR) to send to the CHF. In this scenario, the billing discrepancy is avoided as the Session/Bearer level URR usage counts are reconciled/recomputed by UPF.

However, consider a second SMF/UPF messaging exchange illustrated in Figure 1 involving a UPF initiated change condition. For the UPF initiated change condition scenario, when a volume/duration threshold for any of the URRs is reached, the UPF sends a PFCP Session Report Request message to the SMF with the usage count of the URR for which the threshold is reached. If the threshold is for a SDF level URR, usage counts for the Session/Bearer level URRs are left unchanged and are not reported. If the maximum number of change condition is met at the SMF, the SMF will generate a charging data record towards the CHF. The SMF responds back to the UPF to indicate that it has accepted the Report request. In this scenario, as the UPF is unaware of the change condition being met at SMF and the usage accumulated in Session/Bearer level URRs is not reset. Thus, the reported usage at Session/Bearer level for subsequent triggers will be inaccurate, which can result in incorrect billing of the subscriber.

The solution proposed in this submission addresses this problem by extending the Sx/N4 interface to include a custom Information Element (IE) that can be used by the SMF to inform the UPF to recalculate the IP-CAN (Connectivity Access Network) Bearer/Session usage counts and reapply the thresholds. The SMF may include this custom IE whenever the charging record closure trigger is met and an offline charging record is generated. Figure 2, below, is a call flow illustrating example details associated with the solution proposed herein.

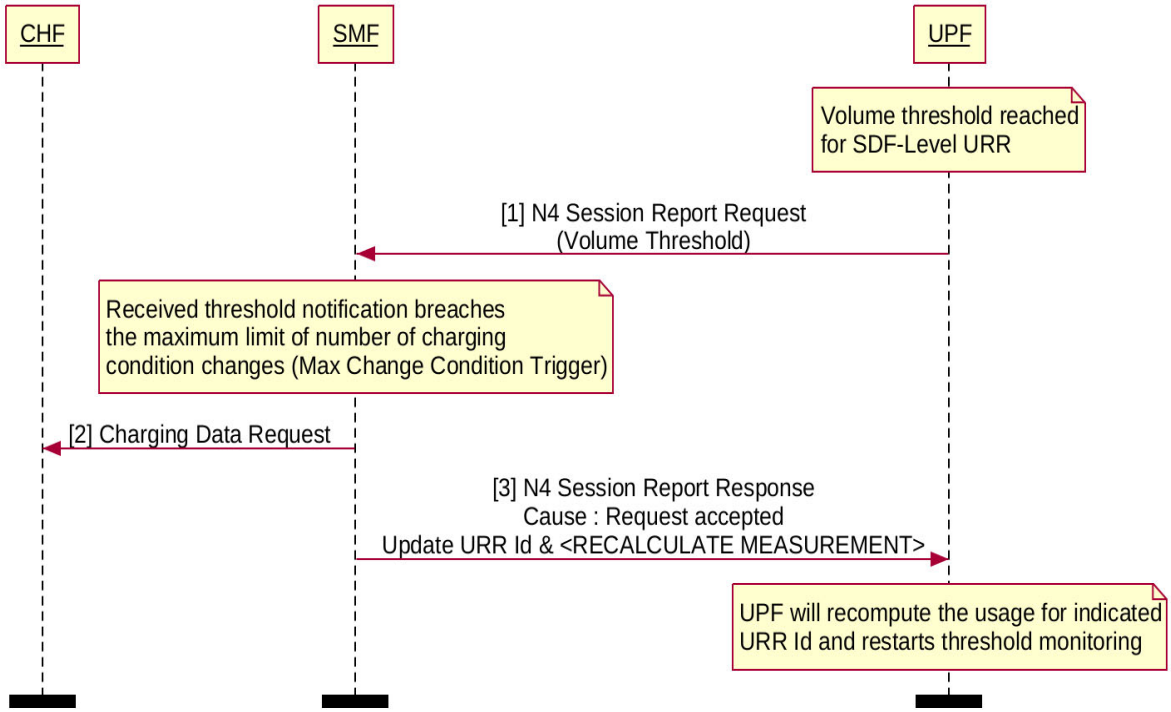

Figure 2: Solution Call Flow

As shown above, in step [3] of Figure 2, the SMF can include a URR Id along with a custom IE "RECALCULATE MEASUREMENT" that can be used to indicate to the UPF that the usage counts for the indicated URR Id should be recalculated.

Figure 3, below, is an example schematic diagram illustrating changes proposed on the Sx/N4 interface between the SMF the UPF. The "RECALCULATE MEASUREMENT" IE can include flags for URR measurement information, which can be encoded as shown in Figure 3.

	Bits							
Octets	8	7	6	5	4	3	2	1
1 to 2	Type = 62 (decimal)							
3 to 4	Length = n							
5	Spare	Spare	Spare	Spare	Spare	Spare	RCVOL	RCDUR
6 to (n+4)	These octet(s) is/are present only if explicitly specified							

Figure 3: Example RECALCULATE MEASUREMENT IE Format

The URR IE in the PFCP Session Report Response message and the PFCP Session Modification Request message can be updated to include the RECALCULATE MESSAGE IE. With reference to the example IE format shown in Figure 3, the following flags are coded within Octet 5:

- Bit 1 – RCDUR (Re-calculate Duration Measurement): when set to 1, this indicates a request for resetting the Duration Measurement to '0' by the UP function;
- Bit 2 – RCVOL (Re-calculate Volume Measurement): when set to 1, this indicates a request for resetting the Volume Measurement to '0' by the UP function. The UP function will then proceed to repopulate the Volume Measurement by aggregating the Volume Measurement of all the URRs containing the Linked URR ID as the URR ID sent in the Update URR IE; and
- Bit 3 to 8: Spare, for future use and set to 0.

Accordingly, proposal presents techniques that may provide subscriber usage accounting accuracy and may also facilitate optimizing signaling between the SMF and the UPF.