**3GPP TSG-WG SA2 Meeting #157 *S2-2307934***

**Berlin, Germany, May 22 – 26, 2023 (revision of S2-2307007)**

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| *CR-Form-v12.2* |
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|  | **23.548** | **CR** | **0120** | **rev** | **5** | **Current version:** | **18.1.1** |  |
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| ***Proposed change affects:*** | UICC apps |  | ME |  | Radio Access Network |  | Core Network | **X** |

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| ***Title:***  | KI#1 EAS Discovery: Resolve ENs |
|  |  |
| ***Source to WG:*** | Huawei, HiSilicon, China Unicom |
| ***Source to TSG:*** | SA2 |
|  |  |
| ***Work item code:*** | EDGE\_Ph2 |  | ***Date:*** | 2023-05-12 |
|  |  |  |  |  |
| ***Category:*** | **B** |  | ***Release:*** | Rel-18 |
|  | *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:*** | 1. V-EASDF uses the HPLMN address information to build ECS option for FQDN of the DNS query which is not authorized for HR-SBOEASDF use ECS option for EAS discovery. In HR-SBO case, for those FQDNs not for HR-SBO, the ECS option should correspond to H-UPF not any IP address in VPLMN. Otherwise V-EASDF will find a EAS close to VPLMN (not H-UPF) and cause unnecessary delay (note, IP address of UE cannot be used in this case since it could be a private IP assigned by HPLMN).**Proposal 1: The H-SMF sends HPLMN address information to V-EASDF via V-SMF in order to build ECS option for target FQDN of the DNS query which is not authorized for HR-SBO.**2. H-UPF rather than UL CL modifies the destination IP address of DNS messagesAccording to R17, it is the local PSA modifies the destination IP address of DNS messages rather than the UL CL. While for HR-SBO roaming, the current TS describes that the UL CL/BP UPF modifies the destination IP address. This contribution clarifies that it is the H-UPF modifies the destination IP address.In addition, for BP case, no need to perform destination IP address modification for DNS messages as the DNS server can resolve AS IP based on source UE IP.**Proposal 2: For HR-SBO roaming, this contribution proposes the H-UPF modifies the destination IP address of DNS messages in case of UL CL.**3. Resolve ENs1) EN4 about the use of VPLMN Specific Offloading InformationEditor’s note: It is FFS how the VPLMN Specific Offloading Information is used by V-SMF in VPLMN.It has been approved that the VPLMN Specific Offloading Policy includes FQDN(s) and/or IP range(s). The H-SMF generates the VPLMN Specific Offloading Information based on the VPLMN Specific Offloading Policy and sends it to the V-SMF. It can be used by the V-SMF to configure 1) the DNS handling rules on the V-EASDF; 2) the traffic detection/routing rules on the UL CL. For 1), it has been added in step 3 of clause 6.7.2.2. This contribution proposes to add descriptions corresponding to 2).**Proposal 3: Clarify that V-SMF configures the traffic detection/routing rules on the UL CL based on the VPLMN Specific Offloading Information.**2) EN5 about QoS control on local PSAEditor’s note: How to retrieve QoS parameter from HPLMN to control local PSA is FFS.The HPLMN may not be aware of the traffic which is offloaded to local DN in VPLMN as the VPLMN (i.e. V-SMF and V-EASDF) controls the traffic to be offloaded to the local DN, the QoS parameters (Authorized Session AMBR) which are applied to such traffic cannot be generated by HPLMN. While the HPLMN can send QoS parameters which are applied to all authorized traffic to be offloaded to local DN in VPLMN.This contribution clarifies that the VPLMN Specific Offloading Information also includes QoS parameter for the traffic to be offloaded to the local part of DN. The V-SMF configures the QoS control on the UL CL/BP and local PSA for the traffic to be offloaded to the local part of DN based on the VPLMN Specific Offloading Information.**Proposal 4.1: Clarify that the VPLMN Specific Offloading Policy and the VPLMN Specific Offloading Information also includes QoS parameter (Authorized Session AMBR) for the traffic to be offloaded to the local part of DN.****Proposal 4.2: Clarify that V-SMF configures the QoS control on the UL CL/BP and local PSA for the traffic to be offloaded to the local part of DN.**4. Editorial changes. |
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| ***Summary of change:*** | See the above proposals. |
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| ***Consequences if not approved:*** | For proposal 1) Wrong EAS will be discovered for FQDN which is not authorized for HR-SBO.For proposal 2) ULCL needs to be enhanced to support IP replacement which has already been supported by PSA UPF.For proposal 3) ENs cannot be resolved. |
|  |  |
| ***Clauses affected:*** | 6.7.1, 6.7.2.1, 6.7.2.2, 6.7.2.3, 6.7.2.4, 6.7.2.5 |
|  |  |
|  | **Y** | **N** |  |  |
| ***Other specs*** | **X** |  |  Other core specifications  | TS/TR 23.502 CR 4060 |
| ***affected:*** |  | **X** |  Test specifications | TS/TR ... CR ...  |
| ***(show related CRs)*** |  | **X** |  O&M Specifications | TS/TR ... CR ...  |
|  |  |
| ***Other comments:*** |  |
|  |  |
| ***This CR's revision history:*** | SA2#157 rev03:1. Clarify the usage of HPLMN DNS server.

When the V-SMF receives the HPLMN DNS server address from the H-SMF, the V-SMF use it for DNS requests which are not for HR-SBO, including to configure the V-EASDF as default DNS server, see clause 6.7.2.3, or to configure V-UPF/Local PSA to perform IP replacement, see clause 6.7.2.5.1. Resolve the EN about DNS traffic routing between V-EASDF and HPLMN DNS server

The routing between V-EASDF and HPLMN DNS server belongs to N6 routing scope which depends on network deployment. This contribution proposes to add a NOTE to clarify that the N6 routing between V-EASDF and HPLMN DNS server is up to network deployment and not standardized in this specification.1. Clarify the configuration on UL CL(/BP) by V-SMF

It was approved that the VPLMN Specific Offloading Information received by the V-SMF from the H-SMF may contain authorized Session AMBR for offloading. This contribution adds descriptions that the V-SMF uses it to configure the QoS parameters on the UL CL/BP and local PSA.It was also approved that the VPLMN Specific Offloading Information includes IP range(s) and/or FQDN(s) allowed to be routed to the local part of DN in VPLMN. This contribution adds descriptions on the V-SMF uses it to configure the traffic detection rules and traffic routing rules on the UL CL.1. Clarify that the H-UPF performs IP replacement for EAS discovery using local DNS
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\* \* \* \* First change \* \* \* \*

## 6.7 Support of the local traffic routing in VPLMN for Home Routed PDU Session for roaming (HR-SBO)

### 6.7.1 General

When roaming, the UE establishes a Home Routed Session that is capable of supporting session breakout in V-PLMN based on the subscription. In this scenario, the Home PLMN and Visited PLMN have an agreement on the support of the local traffic routing (i.e. session breakout performed by V-SMF also called HR-SBO) in VPLMN for the home routed session.

After establishing the HR-SBO PDU Session, the UE can access EAS deployed in EHE in VPLMN while the UE can also access the data network in the Home PLMN.

The reference architecture supporting this scenario is depicted in Figure 4.2-5 in clause 4.2.

### 6.7.2 Procedure

#### 6.7.2.1 General

This clause describes the authorization procedure of the local traffic offloading using HR PDU Session and EAS discovery procedure supporting HR-SBO.

#### 6.7.2.2 PDU Session for supporting HR-SBO in VPLMN



Figure 6.7.2.2-1: Procedure for PDU Session supporting HR-SBO in VPLMN

1. During the Registration procedure, the AMF receives the HR-SBO allowed indication per DNN/S-NSNAI from the UDM in the step 14b of the procedure in the clause 4.2.2.2.2 of TS 23.502 [3].

2. During the PDU Session Establishment procedure for Home-routed roaming as in clause 4.3.2.2.2 of TS 23.502 [3], if the AMF had received in SMF Selection Subcription data from UDM the HR-SBO allowed indication for the DNN/S-NSSAI in the step 1, the AMF selects a V-SMF supporting HR-SBO and sends an HR-SBO allowed indication to the V-SMF in the step 2 and the step3a of the procedure in figure 4.3.2.2.2-1 in clause 4.3.2.2.2 of TS 23.502 [3].

Editor's note: It is FFS how to route the DNS traffic between the UE and the V-EASDF where multiple DNN networks with the same IP address range are deployed in different HPLMNs or in the same HPLMN.

 If the V-SMF supporting the HR-SBO receives the HR-SBO allowed indication from AMF, the V-SMF may:

- select UL CL/BP UPF and L-PSA UPF based on UE location information and this indication in the step 4 of the Figure 4.3.2.2.2-1 of TS 23.502 [3].

NOTE 1: The UL CL/BP UPF and L-PSA UPF can be co-located in the single V-UPF.

- select a V-EASDF,

- obtain the V-EASDF IP address based on local configuration, or invoke Neasdf\_DNSContext\_Create Request including the DNN, S-NSSAI, HPLMN ID and the UE IP address set to unspecified address as specified in clause 7.1.2.2 to obtain the V-EASDF IP address, and

- send the request for the establishment of the PDU Session supporting HR-SBO in VPLMN and optionally send the V-EASDF IP address to the H-SMF in the Nsmf\_PDUSession\_Create Request in the step 6 of the procedure in figure 4.3.2.2.2-1 in clause 4.3.2.2.2 of TS 23.502 [3].

 The H-SMF authorizes the request for HR-SBO based on SM subscription data (i.e. HR-SBO authorization indication) in the step 7 of the procedure in the clause 4.3.2.2.2-1 of TS 23.502 [3].

 Once the HR-SBO is authorized, the H-SMF requests and retrieves the optional VPLMN Specific Offloading Policy from H-PCF. The H-SMF generates VPLMN Specific Offloading Information (i.e. IP range(s) and/or FQDN(s) allowed to be routed to the local part of DN in VPLMN, and/or authorized Session AMBR for Offloading) based on the VPLMN Specific Offloading Policy.

 If HR-SBO is authorized for the PDU session, the H-SMF provides in the Nsmf\_PDUSession\_Create Response in the step 13 of the procedure in figure 4.3.2.2.2-1 in clause 4.3.2.2.2 of TS 23.502 [3] with the following information:

- optional VPLMN Specific Offloading Information

- the V-EASDF IP address (corresponding to clause 6.7.2.3) or DNS server IP address of HPLMN (corresponding to clause 6.7.2.5) as DNS server address to be sent to the UE via PCO and

- optional the DNS server address provided by HPLMN to be used for DNS requests related with traffic not to be subject to HR-SBO, including to configure V-EASDF corresponding to clause 6.7.2.3; or configure the UPF in VPLMN to perform IP replacement as described in clause 6.7.2.5.

NOTE 2: In this release, only public IP address can be used as the DNS server address provided by HPLMN.

- optional the HPLMN address information (e.g. H-UPF IP address on N6) to be used by V-EASDF to build EDNS Client Subnet option for target FQDN of the DNS query which is not authorized for HR-SBO as described in clause 6.7.2.3.

- the HR-SBO authorization result (i.e. whether HR-SBO request is authorized or not).

 The H-SMF may indicate to the UE either that for the PDU Session the use of the EDC functionality is allowed or that for the PDU Session the use of the EDC functionality is required.

 If the request for HR-SBO is not authorized and DNS context has been created, the V-SMF delete the DNS context from the selected V-EASDF, and the subsequent steps related to the EASDF in this procedure are skipped.

 The detailed information of VPLMN Specific Offloading Policy is described in clause 6.4 of TS 23.503 [4].

NOTE 3: The VPLMN Specific Offloading Policy can be prior configured in HPLMN based on the service level agreement between the VPLMN and HPLMN.

3. The V-SMF configures the V-EASDF with the DNS handling rules using the received VPLMN Specific Offloading Information.

 The V-SMF optionally configures the V-EASDF with the DNS server address provided by HPLMN as default DNS server (corresponding to clause 6.7.2.3), after the step 13 of the procedure in figure 4.3.2.2.2-1 in clause 4.3.2.2.2 of TS 23.502 [3] if they are received from H-SMF in the step 2. If V-SMF didn’t receive the DNS server address provided by HPLMN from H-SMF in step 2, a preconfigured default DNS server may be configured to V-EASDF.

 If HPLMN address information is received, the V-SMF may also configures the V-EASDF to build EDNS Client Subnet option based on this HPLMN address information for target FQDN of DNS query which is not authorized for HR-SBO.

 If the V-SMF has interacted with the V-EASDF in step 2, then the V-SMF invokes Neasdf\_DNSContext\_Update Request including UE IP address to complete the configuration of the context in the V-EASDF.

 The V-SMF configures the UL-CL UPF and PSA UPF selected in the step 2 to forward DNS messages to V-EASDF.

4A. EAS Discovery procedure with V-EASDF is performed as described in clause 6.7.2.3.

4B. EAS Discovery procedure with Local DNS Server/Resolver is performed as described in clause 6.7.2.4.

4C. EAS discovery procedure with V-EASDF using IP replacement mechanism as described in clause 6.7.2.5.

Editor's note: It is FFS if and how DNS with security (i.e. DNSSEC, DoT and DoH) can be supported when using IP replacement (step 4C and step 1b of clause 6.7.2.3).

#### 6.7.2.3 EAS Discovery Procedure with V-EASDF for HR-SBO



Figure 6.7.2.3-1: Procedure for EAS Discovery with V-EASDF for HR-SBO roaming scenario

1. The DNS query sent by the UE reaches the V-EASDF via the UL-CL UPF and PSA UPF in VPLMN selected in step 2 of Figure 6.7.2.2-1.

NOTE 1: The network should ensure that EASDF can disambiguate the DNS traffic of different UEs that would be allocated with same private UE IP address. This can be done by implementation and/or deployment specific means, e.g. tunnelling on N6.

If the target FQDN of the DNS query is not part of the FQDN authorized by the H-SMF in step 2 of Figure 6.7.2.2-1, the followinga) or b) may be performed:

a) The V-EASDF proceeds to step 12 of Figure 6.2.3.2.2-1 where it sends the DNS query which may include the HPLMN address information as the EDNS Client Subnet option. The DNS query is sent to the DNS server address according to the DNS message handling rules provided by the V-SMF or to the default DNS server configured in the V-EASDF. Upon receiving the DNS response, the procedure proceeds immediately to step 5.

NOTE 2: If HPLMN DNS or the default DNS server don’t support ECS option, it cannot ensure a AS close to H-UPF will be resolved.

b) The UL CL/BP UPF sends the DNS request to the DNS server address provided by HPLMN via V-UPF (if exists) and H-UPF (through N9), by modifying the packet's destination IP address (corresponding to V-EASDF) to that of the DNS server of HPLMN on ULCL or H-UPF. For the corresponding DNS response received by H-UPF, the H-UPF or ULCL modifies the packets’s destination IP address to that of the V-EASDF.

NOTE 3: Secure DNS, e.g. DNS over TLS, DNS over HTTPs, cannot be supported if b) is used.

 The rest of the procedure assumes the target FQDN of the DNS query is part of the FQDN authorized by the H-SMF in step 2 of Figure 6.7.2.2-1.

2. The step 8 to 15 of the procedure in the Figure 6.2.3.2.2-1 by replacing SMF and EASDF with V-SMF and V-EASDF respectively.

3. The V-SMF selects UL CL/BP and local PSA in VPLMN based on the V-EASDF notification, EAS Deployment Information in the VPLMN and UE location. The V-SMF may perform insertion or change of UL CL/BP and local PSA in VPLMN.

 The V-SMF configures the QoS parameters on the UL-CL/BP and local PSA for the traffic to be offloaded to the local part of DN based on the VPLMN Specific Offloading Information received from H-SMF.

 In case of UL-CL, the V-SMF configures the traffic detection rules and traffic routing rules on the UL CL UPF based on the EAS Deployment Information and the EAS addresses included in VPLMN Specific Offloading Information.

 If there is no other V-UPF between the selected UL CL/BP in this step and H-UPF, the V-SMF sets up user plane between this UL CL/BP and H-UPF via the interaction with H-SMF. Otherwise, the V-SMF sets up user plane between this ULCL/BP and the existing V-UPF.

 The V-SMF sets up user plane between the selected UL CL/BP in this step and RAN (if no other V-UPF exists between RAN and this UL CL/BP) or the V-UPF (if exists between this UL CL/BP and RAN).

NOTE 4: If the selected UL-CL/BP and local PSA in this step is the UL-CL/BP and PSA selected by V-SMF in the step 2 of Figure 6.7.2.2-1, the insertion of UL-CL/BP and local PSA in VPLMN will not be performed in this step.

NOTE 5: In the home routed roaming scenario, the V-UPF selected during PDU session establishment procedure can be deployed at a central area within VPLMN. In this case, the V-UPF is located in the user plane path between UL-CL/BP UPF in VPLMN and PSA-UPF in HPLMN. In some deployments, the UL-CL/BP UPF can be collocated with the V-UPF.

4. The steps 17 to 18 of the procedure in clause 6.2.3.2.2 by replacing SMF and EASDF with V-SMF and V-EASDF respectively.

5. V-EASDF sends the DNS Response to the UE.

#### 6.7.2.4 EAS Discovery Procedure with Local DNS for HR-SBO



Figure 6.7.2.4-1: Procedure for EAS Discovery with local DNS for HR-SBO roaming scenario

If the target FQDN of the DNS query is not part of the FQDN authorized by the H-SMF in step 2 of Figure 6.7.2.2-1, the UL CL/BP UPF is instructed to send the DNS request to the DNS server address provided by HPLMN via V-UPF (if exists) and H-UPF (through N9), by modifying the packet's destination IP address (corresponding to local DNS Server) to that of the DNS server of HPLMN on ULCL or H-UPF . For the corresponding DNS response received by H-UPF, the H-UPF or ULCL modifies the packets’s destination IP address to that of the local DNS Server.

The steps 0 to 5 are the same as the steps 0 to 6 of Figure 6.2.3.2.3-1 with following differences:

- SMF is replaced with V-SMF.

- UE, (R)AN, AMF, UL CL/BP UPF, L-PSA UPF, V-SMF, Local DNS Resolver/Server are located in VPLMN.

- UPF, H-SMF, C-DNS are located in HPLMN.

0. The HR-SBO PDU Session is established. See the procedure in clause 6.7.2.2.

1, UL CL/BP insertion. See the step 1 of the procedure in Figure 6.2.3.2.3.

2, After UL CL/BP insertion is performed, the V-SMF sends new local DNS server address to the UE by performing PDU Session Modification procedure as in clause 4.3.3.3 of TS 23.502 [3] with following additions:

- V-SMF sends Local DNS Server/Resolver to the H-SMF in the step 1a of the procedure as in clause 4.3.3.3 of TS 23.502 [3].

- H-SMF sends the Local DNS Server/Resolver to be sent to the UE via PCO to the V-SMF in the step 3 of the procedure in clause 4.3.3.3 of TS 23.502 [3].

3-5. See the steps 4-6 of the procedure in Figure 6.2.3.2.3.

#### 6.7.2.5 EAS discovery procedure with V-EASDF using IP replacement mechanism for supporting HR-SBO

Based on the operator's configuration and local regulations, the IP replacement mechanism may be used for EAS discovery supporting HR-SBO:

- For supporting HR-SBO, the H-SMF sends DNS server address provided by HPLMN included in PCO to UE via V-SMF during PDU Session Establishment/Modification procedure. The DNS query related to the edge computing (corresponding to FQDNs) can be routed to V-EASDF/Local DNS server in the VPLMN using IP replacement mechanism.

NOTE 1: This EAS discovery procedure requests modification of IP address of DNS messages. Whether this is allowed or not is subject to local regulations. As this procedure for EAS discovery requires an UPF to detect target FQDN in DNS message, it cannot apply when DNS security applies e.g. it does not apply to usage of DoH or DoT.



Figure 6.7.2.5-1: EAS discovery procedure with V-EASDF using IP replacement mechanism for supporting HR-SBO

NOTE 2: This clause assumes the V-SMF has received the HR-SBO allowed indication from the AMF and supports IP replacement mechanism for HR-SBO, it also assumes the HPLMN authorizes HR-SBO in the VPLMN.

0. The Registration procedure is described in step 1 of clause 6.7.2.2.

1. The HR-SBO PDU Session Establishment is described in the step 2 of clause 6.7.2.2 with the following differences:

- After step 3 in clause 4.3.2.2.2 of TS 23.502 [3], the V-SMF selects a UPF in VPLMN supporting UL CL/BP and PSA functionalities based on UE location information.

NOTE 3: Based on the deployment of VPLMN, the selected UPF in VPLMN can support both UL CL and PSA functionalities in case that the UL CL UPF and PSA UPF are co-located. This UPF in VPLMN can be the V-UPF selected in the step 4 of clause 4.3.2.2.2 of TS 23.502 [3].

- The V-SMF sends the request for establishment of the PDU session supporting HR-SBO in VPLMN without the V-EASDF IP address in the step 6 of clause 4.3.2.2.2 of TS 23.502 [3].

- If the Nsmf\_PDUSession\_Create Request received by the H-SMF does not include the V-EASDF IP address, the H-SMF constructs PCO with DNS server address field set to DNS server address provided by HPLMN and sends the PCO to UE via V-SMF in the step 13 of clause 4.3.2.2.2 of TS 23.502 [3].

NOTE 4: The V-SMF can select the V-EASDF and create the DNS context in the V-EASDF before sending Nsmf\_PDUSession\_Create Request or after having received Nsmf\_PDUSession\_Create response.

2. The V-SMF configures the V-EASDF and the UPF in VPLMN as described in step 3 of clause 6.7.2.2 with the following differences:

- Based on the FQDN(s) received from the VPLMN Specific Offloading Information, the V-SMF indicates the UPF in VPLMN to route DNS queries for the FQDN (range) query to V-EASDF. In case of UL-CL, the V-SMF configures the UPF in VPLMN with IP replacement information (i.e. DNS server IP address and port number of HPLMN, V-EASDF IP address and port number). In uplink direction, UPF in VPLMN replaces the destination address of the DNS query targeting an FQDN eligible for HR-SBO related offload from DNS server IP address of HPLMN to V-EASDF IP address; In downlink direction, UPF in VPLMN replaces the source address of the DNS response targeting an FQDN eligible for HR-SBO related offload from V-EASDF IP address to DNS server IP address of HPLMN.

NOTE 5: For the DNS query requiring DNS resolution in the HPLMN, the DNS resolution path is same as the normal path in the HR PDU Session.

3. UE sends DNS query to DNS server of HPLMN.

4a. If the DNS query does not match the FQDN range eligible for HR-SBO related offload, UPF in VPLMN delivers the DNS query via H-PSA through N9 and H-PSA delivers the DNS query to the DNS server of HPLMN.

4b. If the DNS query matches the FQDN range eligible for HR-SBO related offload, the UPF in VPLMN delivers the DNS query to V-EASDF using IP replacement mechanism. The following EAS discovery procedure is based on step 4b.

5. The EAS discovery procedure described in steps 8-18 of clause 6.2.3.2.2 applies with the following differences:

- This EAS discovery procedure is implemented in the VPLMN.

- In step 16, the V-SMF may perform insertion or change of UL CL/BP and local PSA in VPLMN as described in the step 3 of clause 6.7.2.3.

6. The V-EASDF sends the DNS response including FQDN to the UPF in VPLMN. The UPF in VPLMN replaces the source address from V-EASDF to DNS server of HPLMN in the DNS response based on the V-SMF instructions and sends this DNS response to the UE directly or via UL CL/BP of VPLMN if existing in this PDU session.

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