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| 3rd Generation Partnership Project;  Technical Specification Group Core Network and Terminals;  Study on MINT support in EPS for 5G-only national roaming UE;  (Release 19 ) | |
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# Foreword

This Technical Report has been produced by the 3rd Generation Partnership Project (3GPP).

The contents of the present document are subject to continuing work within the TSG and may change following formal TSG approval. Should the TSG modify the contents of the present document, it will be re-released by the TSG with an identifying change of release date and an increase in version number as follows:

Version x.y.z

where:

x the first digit:

1 presented to TSG for information;

2 presented to TSG for approval;

3 or greater indicates TSG approved document under change control.

y the second digit is incremented for all changes of substance, i.e. technical enhancements, corrections, updates, etc.

z the third digit is incremented when editorial only changes have been incorporated in the document.

In the present document, modal verbs have the following meanings:

**shall** indicates a mandatory requirement to do something

**shall not** indicates an interdiction (prohibition) to do something

The constructions "shall" and "shall not" are confined to the context of normative provisions, and do not appear in Technical Reports.

The constructions "must" and "must not" are not used as substitutes for "shall" and "shall not". Their use is avoided insofar as possible, and they are not used in a normative context except in a direct citation from an external, referenced, non-3GPP document, or so as to maintain continuity of style when extending or modifying the provisions of such a referenced document.

**should** indicates a recommendation to do something

**should not** indicates a recommendation not to do something

**may** indicates permission to do something

**need not** indicates permission not to do something

The construction "may not" is ambiguous and is not used in normative elements. The unambiguous constructions "might not" or "shall not" are used instead, depending upon the meaning intended.

**can** indicates that something is possible

**cannot** indicates that something is impossible

The constructions "can" and "cannot" are not substitutes for "may" and "need not".

**will** indicates that something is certain or expected to happen as a result of action taken by an agency the behaviour of which is outside the scope of the present document

**will not** indicates that something is certain or expected not to happen as a result of action taken by an agency the behaviour of which is outside the scope of the present document

**might** indicates a likelihood that something will happen as a result of action taken by some agency the behaviour of which is outside the scope of the present document

**might not** indicates a likelihood that something will not happen as a result of action taken by some agency the behaviour of which is outside the scope of the present document

In addition:

**is** (or any other verb in the indicative mood) indicates a statement of fact

**is not** (or any other negative verb in the indicative mood) indicates a statement of fact

The constructions "is" and "is not" do not indicate requirements.

# 1 Scope

The present document is to study the stage 2 aspect for service requirements defined by SA WG1 under SA1 work item MINT\_Ph2 (Minimization of Service Interruption Phase 2), as specified in 3GPP TS 22.011 [2] and 3GPP TS 22.261 [3] clause 6.31.

# 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 22.011: "Service accessibility".

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

[4] 3GPP TS 23.501: "System Architecture for the 5G System; Stage 2".

# 3 Definitions of terms and abbreviations

## 3.1 Terms

For the purposes of the present document, the terms given in TR 21.905 [1] and the following apply. A term defined in the present document takes precedence over the definition of the same term, if any, in TR 21.905 [1].

## 3.2 Abbreviations

For the purposes of the present document, the abbreviations given in TR 21.905 [1] and the following apply. An abbreviation defined in the present document takes precedence over the definition of the same abbreviation, if any, in TR 21.905 [1].

# 4 Architectural Assumptions and Requirements

## 4.1 Architectural Assumptions

The following architectural assumptions apply:

- Disaster roaming service is supported for a UE in EPS only if the PLMN of the EPS provides services for 5G-only national roaming UEs (in 5GS) and there is a disaster roaming agreement between that PLMN and the HPLMN of the UE.

- The NG-RAN nodes of the operator with disaster condition are assumed to be non-operational.

- In principle, the disaster inbound roamers can receive the same services in a PLMN providing disaster roaming services as non-disaster inbound roamers can receive in the PLMN providing disaster roaming services, subject to agreement between HPLMN of the UE and the PLMN providing disaster roaming services, regulations of the country, and constraints of the PLMN providing disaster roaming services.

- Architecture defined in 3GPP TS 23.501 [4] is used as basis of architecture for supporting minimization of service interruption in EPS that provides services for 5G-only national roaming UEs.

- Notification of disaster condition to the EPS providing disaster roaming services is out of scope of 3GPP.

## 4.2 Architectural Requirements

The following architectural requirements apply:

- The system shall satisfy the stage-1 requirements in 3GPP TS 22.261 [3] clause 6.31.

- The solution developed to support MINT in EPS for a 5G-only national roaming UE should use existing mechanisms specified for Rel-17 MINT as far as possible.

- It is optional for the UE and for the network to support Minimization of service interruption for EPS. The support of MINT for EPS is subject to regulatory requirements and operator's policy.

# 5 Key Issues

## 5.1 Key Issue #1: Notification of disaster condition to the UE

### 5.1.1 Description

According to 3GPP TS 22.261 [Y] clause 6.31.2.1:

*Subject to regulatory requirements, operator's policy or UE capabilities, the 3GPP system shall be able to support a UE, with 5G-only national roaming access to a VPLMN, to* *obtain 4G connectivity service from that VPLMN in the area where a Disaster Condition applies.*

When a disaster condition applies to a particular PLMN, the UE accessing that PLMN via the 5G-only national roaming before the disaster condition or the UE selecting that PLMN via the 5G-only national roaming when the disaster condition applies, shall be able to obtain the information that the disaster condition applies to the PLMN.

The following questions are expected to be studied within this key issue:

- How to deliver the information on the disaster condition of a PLMN to the UE;

- Which network functions or entities are involved for the delivery of the information.

## 5.2 Key Issue #2: Indication of accessibility from EPS to the UE

### 5.2.1 Description

According to 3GPP TS 22.261 [Y] clause 6.31.2.1:

*Subject to regulatory requirements, operator's policy or UE capabilities, the 3GPP system shall be able to support a UE, with 5G-only national roaming access to a VPLMN, to obtain 4G connectivity service from that VPLMN in the area where a Disaster Condition applies.*

When a disaster condition applies to a particular 5G PLMN, the 4G PLMN may be able to provide disaster roaming service to the UE. In this case, the EPS shall indicate that it can accommodate the disaster inbound roamers from the PLMN with disater condition.

The following questions are expected to be studied within this key issue:

- How 4G PLMN indicates that it can accommodate disaster inbound roamer from the PLMN with disaster condition; and

- What information can be provided to potential disaster inbound roamers.

## 5.3 Key Issue #3: Attach to the 4G VPLMN providing disaster roaming services in case of disaster condition

### 5.3.1 Description

When the UE of a 5G VPLMN with disaster condition is notified of disaster condition, according to the conclusion of the Key Issue #1, and the UE selects the 4G VPLMN providing disaster roaming services, then the UE shall perform the attach procedure in order to be registered to the 4G VPLMN.

According to 3GPP TS 22.261 [Y] clause 6.31.2.2:

*The 3GPP system shall be able to support provision of service to Disaster Inbound Roamer only within the specific region where Disaster Condition applies.*

As the service requirement quoted, the 4G VPLMN providing disaster roaming services shall be able to limit the area of service to disaster inbound roamers to the region where disaster condition applies.

The following questions are expected to be studied within this key issue:

- How an attach procedure initiated by inbound disaster roamer is performed towards 4G VPLMN providing disaster roaming services;

- Which network functions or entities are involved for the attach procedure of disaster inbound roamers;

- How a 4G VPLMN providing disaster roaming services can limit the area of service to inbound disaster roamers to the region where disaster condition applies.

## 5.4 Key Issue #4: PLMN selection when disaster condition applies for the 5G VPLMN of 5G-only national roaming UE

### 5.4.1 Description

If the 5G-only national roaming UE determines that a disaster condition applies as described in Key Issue #1 "Notification of Disaster Condition to the UE", there is no available PLMN except for a 4G VPLMN in the list of "Forbidden PLMNs", and the 4G VPLMN indicates accessibility for the UE as described in Key Issue #2 "Indication of accessibility from EPS to the UE", then the PLMN selection procedure needs to be updated so that the UE selects the 4G VPLMN indicating accessibility for the UE.

In addition, if the 5G-only national roaming UE determines that disaster condition applies as described in Key Issue #1 "Notification of Disaster Condition to the UE", a 4G VPLMN is not in the list of “Forbidden PLMNs ”, the 4G VPLMN is available, and the 4G VPLMN indicates accessibility for the UE as described in Key Issue #2 "Indication of accessibility from EPS to the UE", the UE is allowed for 5G-only national roaming, whereas 4G RAT and potentially other RATs, are restricted due to the RAT restriction feature being enabled and indicated to the UE by the VPLMN, or the UE disabled E-UTRA capability in the VPLMN, or TAIs of all available 4G cells of the 4G VPLMN are forbidden, then we need to study how to enable the UE to select the 4G VPLMN to get access in the 4G RAT of the 4G VPLMN.

The following questions are expected to be studied within this key issue:

- If the 4G VPLMN is in the list of “Forbidden PLMNs”, then how to update PLMN selection procedure so that the UE selects the 4G VPLMN indicating accessibility for the UE in disaster condition applies.

- If the 4G VPLMN is not in the list of “Forbidden PLMNs”, 4G RAT is restricted in the 4G VPLMN due to the RAT restriction feature, or the UE disabled E-UTRA capability in the 4G VPLMN, or TAIs of all available cells of the 4G VPLMN are forbidden, then how the UE and the network behave to enable the UE to select the 4G VPLMN to get access in the 4G RAT of the VPLMN.

## 5.5 Key Issue #5: RAT restriction under disaster conditions

### 5.5.1 Description

A UE is allowed for 5G-only national roaming, whereas a specific RAT e.g., 4G, is restricted due to the RAT restriction feature being enabled and indicated to the UE by the operator or due to network conditions. Since the UE is restricted to move to the 4G RAT, e.g., due to RAT restriction, and the UE is not allowed to remain connected to the 5G RAT due to the received disaster condition this creates an issue that needs to be solved.

The following questions are expected to be studied within this key issue:

- How the UE and the network behave for coordinating RAT restriction and disaster condition handling;

- How to handle RAT restriction under disaster condition;

- What kind of information should be delivered to the UE.

## 5.6 Key Issue #6: Notification that disaster condition is no longer applicable to the UEs

### 5.6.1 Description

According to 3GPP TS 22.261 [Y] clause 6.31.2.2:

The 3GPP system shall be able to provide efficient means for a network to inform Disaster Inbound roamers that a Disaster Condition is no longer applicable.

According to 3GPP TS 22.261 [Y] clause 6.31.2.3:

Disaster inbound roamers shall perform network reselection when a Disaster Condition has ended.

When a UE was camping on a 4G VPLMN offering disaster roaming service and was being served by the PLMN, the 4G network can notify disaster inbound roamers that the disaster condition is no longer applicable. When a UE is notified that disaster condition is no longer applicable, the UE shall try to perform network reselection in order to return to its 5G VPLMN.

The following questions are expected to be studied within this key issue:

- When and how to deliver the information that disaster condition is no longer applicable to disaster inbound roamers;

- How to minimize interruption of the service receiving from disaster roaming 4G VPLMN (e.g. emergency service or high priority service) when the UE is notified that disaster condition is no longer applicable;

- How to remove the stored information on disaster condition from the UE’s storage; and

- How disaster inbound roamer UEs perform network selection when notified that disaster condition is no longer applicable.

## 5.7 Key Issue #7: Prevention of signalling overload in the VPLMN providing disaster roaming services in EPS

### 5.7.1 Description

This key issue addresses the following service requirements of 3GPP TS 22.261 [Y] clause 6.31.2:

- *Subject to regulatory requirements, operator's policy or UE capabilities, the 3GPP system shall be able to support a UE, with 5G-only national roaming access to a VPLMN, to obtain 4G connectivity service from that VPLMN in the area where a Disaster Condition applies.*

*- The 3GPP system shall minimize congestion caused by Disaster Roaming.*

When a disaster condition applies, UEs of the VPLMN providing 5G-only national roaming access with disaster condition that are located in the area where the disaster condition applies will attempt to register on the VPLMN providing disaster roaming services in EPS to obtain service. This could cause a large number of UEs to migrate from the VPLMN providing 5G-only national roaming access with disaster condition, to the VPLMN providing disaster roaming services in EPS, and attempt registration at around the same time, leading to signalling overload in the VPLMN providing disaster roaming services in EPS due to the massive influx of roamers. Consequently, mechanisms are needed to prevent signalling overload in the VPLMN providing disaster roaming services in EPS.

The following questions are expected to be studied within this key issue:

- How to distribute the subscribers of the VPLMN providing 5G-only national roaming access with disaster condition between the PLMNs providing disaster roaming service in the area where the disaster condition applies. The PLMNs providing disaster roaming service include the VPLMN providing disaster roaming services in EPS, and potentially other VPLMN(s) providing disaster roaming services in 5GS already supported by Rel-17 MINT;

- How to stagger the arrival of UEs in the VPLMN providing disaster roaming services in EPS;

- How to enable the VPLMN providing disaster roaming services in EPS to efficiently prevent disaster inbound roamers from attempting attach on the PLMN when the PLMN can no longer accept disaster inbound roamers due to congestion; and

- How to enable the VPLMN providing disaster roaming services to efficiently prevent congestion on the ESM level that can be caused by ESM signalling generated by disaster inbound roamers. The existing overload control mechanisms (e.g., NAS level congestion control) should be considered.

As a baseline the mechanism already established for Rel-17 MINT mechanism including the specified timer for MINT, e.g., the disaster roaming wait range, should be reused as much as possible.

## 5.8 Key Issue #8: Prevention of signalling overload by returning UEs in the VPLMN providing 5G-only national roaming access

### 5.8.1 Description

This key issue addresses the following service requirement of 3GPP TS 22.261 [Y] clause 6.31.2:

*- Subject to regulatory requirements, operator's policy or UE capabilities, the 3GPP system shall be able to support a UE, with 5G-only national roaming access to a VPLMN, to obtain 4G connectivity service from that VPLMN in the area where a Disaster Condition applies.*

* *The 3GPP system shall minimize congestion caused by Disaster Roaming.*

When a disaster condition is no longer applicable, all UEs which are currently served by the VPLMN providing disaster roaming services in EPS and are currently in EMM-IDLE mode will perform PLMN reselection and return to the VPLMN providing 5G-only national roaming access that was previously with disaster condition. This could cause a large number of UEs to attempt registration at around the same time, leading to signalling overload in the VPLMN providing 5G-only national roaming access due to the massive return of UEs. Consequently, means are needed to prevent signalling overload in the VPLMN providing 5G-only national roaming access.

For UEs that are currently in EMM-CONNECTED mode, EPS to 5G interworking procedures need to be performed in a way that does not lead to signalling overload in the VPLMN providing 5G-only national roaming access.

The following question is expected to be studied within this key issue:

- How to stagger the return of UEs to the VPLMN providing 5G-only national roaming access.

As a baseline the mechanism already established for Rel-17 MINT mechanism including the specified timer for MINT, e.g., the disaster return wait range, should be reused as much as possible.

# 6 Solutions

## 6.0 Mapping Solutions to Key Issues

Table 6.0-1: Mapping of Solutions to Key Issues

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Key Issues | | | | | | | |
| Solutions | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| 1 | X |  |  |  |  |  |  |  |
| 2 |  | X |  |  |  |  |  |  |
| 3 |  |  | X |  |  |  |  |  |
| 4 |  |  |  | X |  |  |  |  |
| 5 |  |  |  |  | X |  |  |  |
| 6 |  |  |  |  |  | X |  |  |
| 7 |  |  |  |  |  |  | X |  |
| 8 |  |  |  |  |  |  |  | X |

## 6.1 Solution #1: Notification of disaster condition to the UE via E-UTRAN broadcast

### 6.1.1 Introduction

This paper proposes a solution for Key Issue#1:

Key Issue #1: Notification of Disaster Condition to the UE

In this solution, PLMN D is the PLMN of the 5GS with disaster condition PLMN A provides a disaster roaming service for the 5G-only national roaming UE. In addition,

PLMN A is in the area covered by disaster condition by regulatory requirements or operator’s policy. This solution addresses how to deliver the information on the disaster condition of a PLMN to the UE.

### 6.1.2 Detailed description

This solution assumes that the information on the disaster condition of PLMN D can be made available to PLMN A. PLMN A broadcasts the information on the disaster condition of PLMN D when the disaster condition starts in PLMN D.

The information on the disaster condition of a PLMN may contain a 'list of one or more PLMN(s) with disaster condition for which disaster roaming service is offered by the available PLMN' in the impacted area.

PLMN A can broadcast in E-UTRAN the information on the disaster condition of a PLMN to UEs.

Editor's note: Details of broadcast signalling depend on the RAN WGs.

The UE can determine the disaster condition by receiving the information on the disaster condition of PLMN D from PLMN A. After determining the disaster condition, the UE can manage the mobility and roaming procedure of the UE in the disaster condition through the MME.

Editor's note: If the UE does not receive information on disaster condition of a PLMN, the handling is FFS.

### 6.1.3 Impacts on existing nodes and functionality

UE:

- support for receiving the information on the disaster condition of PLMN D in E-UTRAN.

E-UTRAN of PLMN A:

- support for providing the information on the disaster condition of PLMN D via broadcast.

## 6.2 Solution #2: Using pre-provisioned and system information broadcast information

### 6.2.1 Introduction

This solution addresses Key Issue #2: Indication of accessibility from EPS to the UE in clause 5.6. The solution is based on agreed principles for Key Issue #3 in Rel-17 MINT and uses a combination of pre-provisioned information before disaster condition and system information broadcast at the time of disaster condition to indicate accessibility from EPS to the UE.

### 6.2.2 Detailed description

The UE can be provisioned by the network (in the USIM, stored in the ME or through NAS signalling) with the following information:

a) an indication provided by the HPLMN of whether a UE *having 5G-only national roaming access to a VPLMN can obtain disaster roaming service from a 4G VPLMN*;

b) a "list of PLMN(s) providing 4G service to be used in disaster condition" provided by the HPLMN, consisting of zero or more entries, each containing a PLMN ID. The PLMNs are listed in order of decreasing priority, with the first PLMN being the highest priority PLMN;

The network may provide the "list of PLMN(s) providing 4G service to be used in disaster condition", to the UE during a successful attach, tracking area update procedure or during the registration procedure in 5GS.

The 4G PLMN offering disaster roaming service shall indicate accessibility for disaster inbound roamers through SIB messages. The indication may contain the list of PLMN(s) with disaster condition for which disaster roaming service in EPS is offered.

NOTE: The design of the SIB messages is defined by RAN WG2.

### 6.2.3 Impacts on existing nodes and functionality

The UE is impacted and is pre-provisioned information in UE by the network (in the USIM, stored in the ME or through NAS signalling).

The MME is impacted and provides the UE with list of "list of PLMN(s) providing 4G service to be used in disaster condition", to the UE during a successful attach or tracking area update procedure. The AMF is impacted and provides similar information during the registration procedure in 5GS.

The E-UTRAN is impacted and provides indication of accessibility for disaster inbound roamers.

## 6.3 Solution #3: Distinguish Attach Request for normal service from disaster roaming service

### 6.3.1 Introduction

This solution addresses Key Issue #3: Attach to the 4G VPLMN without disaster condition in case of disaster condition in clause 5.6. The solution is based on agreed principles for Key Issue #4 in Rel-17 MINT.

### 6.3.2 Detailed description

The MME of PLMN providing disaster roaming should be able to distinguish the attach request for normal service from disaster roaming service. When the UE performs an attach procedure due to disaster roaming in a PLMN which supports disaster roaming, UE indicates a new EPS attach type in the ATTACH REQUEST message to differentiate between normal attach and attach due to disaster roaming. If the UE does not have a valid mapped 4G-GUTI assigned by the 5G PLMN with disaster condition and the 5G PLMN with disaster condition is not the HPLMN of the UE, in addition to the new EPS attach type type, the UE also indicates the 5G PLMN with disaster condition in the attach request.

Upon receiving ATTACH REQUEST message with a new EPS attach type type for disaster roaming, the MME of 4G PLMN providing disaster roaming service checks that the UE's 5G PLMN with disaster condition provided by the UE, is a PLMN with disaster condition for which the 4G PLMN provides disaster roaming and that the UE is registering in a TA which is part of the disaster area of the UE's 5G PLMN with disaster condition. If both the above checks are successful the 4G PLMN handles the attach request further, otherwise the 4G PLMN rejects the request. The MME of the PLMN offering disaster roaming service determines a registration area for the UE such that the EPS tracking area list contains only those tracking area identities (TAIs) that overlap with the area of the disaster condition.

Editor’s Note: It is FFS if there will be impacts on the tracking area update procedure.

If the UE is attached for disaster roaming services, the UE can periodically attempt to obtain service on an allowable PLMN of the same country as the current serving PLMN in accordance with the requirements as defined in the Automatic Network Selection Mode in clause 4.4.3.1.1 of 3GPP TS 23.122.

### 6.3.3 Impacts on existing nodes and functionality

The UE is impacted due to updates in attach procedure with new EPS attach type and due to enhancements in higher priority PLMN selection procedure when attached for disaster roaming services in EPS.

The MME is impacted due to updates in attach procedure to be able to distinguish the attach request for normal service from the attach request for disaster roaming service.

## 6.4 Solution #4: PLMN selection when disaster condition applies for the 5G VPLMN of the 5G-only national roaming UE

### 6.4.1 Introduction

This solution addresses the following key issue:

Key Issue #4: PLMN selection when disaster condition applies for the 5G VPLMN of the 5G-only national roaming UE

### 6.4.2 Detailed description.

In this solution, PLMNs (e.g. PLMN-A or PLMN-D) providing disaster roaming services over the E-UTRAN for the PLMN under disaster condition (e.g PLMN D) on the NG-RAN

Case A: PLMN-A is providing the disaster roaming services for the PLMN-D where UE was registered over the NG-RAN.

In this case PLMN-A can be forbidden PLMN or EPC RAT can be restricted or EPC capability is disabled or TAI(s) can be forbidden TAI(s).

PLMN selection procedure changes as follows:

If:

* UE found that the PLMN-D has disaster condition according to a solution for KI#1;
* UE found that the PLMN-A offers disaster roaming services in EPS to UEs of PLMN-D according to a solution for KI#2; and
* When the UE is searching for the normal service and unable to find suitable PLMN where it can get the normal service then (TS 23.122, subclause4.4.3.1.1, step i) to v)); and
* UE found the PLMN-A in the E-UTRAN which is forbidden PLMN list or whose S1 mode is disabled or the TAI is in the forbidden TAI list or the E-UTRAN access technology is restricted for the PLMN-A and the broadcasting the disaster related indication;

Then UE enable the S1mode capability if disabled, RAT is deemed unrestricted, if restricted, or deems the current TAI is allowed for the attach request for the disaster roaming service.

Case B: PLMN-D is providing the disaster roaming services for the PLMN-D where UE was registered over the NG-RAN.

Solution for this case is similar to the case-A, but the only difference is that PLMN-D can’t be forbidden PLMN.

Following changes are required in the PLMN selection in TS 23.122.

vi) in the E-UTRAN, PLMN combinations for any forbidden PLMN(s) or allowable PLMN(s), whose S1 capability is disabled, or whose E-UTRAN access is restricted, is broadcasting the PLMN ID of the UE determined PLMN with disaster condition (i.e PLMN-D) or broadcasting the disaster related indication and matching the below conditions:

a) if the indication of 'applicability of "lists of PLMN(s) to be used in disaster condition" provided by a VPLMN' is set to true:

- each PLMN in the "list of PLMN(s) to be used in disaster condition" stored in the ME which is associated with the PLMN ID of the UE determined PLMN with disaster condition, if any, ordered based on this list; otherwise

- if the ME does not have a stored "list of PLMN(s) to be used in disaster condition" associated with the PLMN ID of the UE determined PLMN with disaster condition, each PLMN in the "list of PLMN(s) to be used in disaster condition" stored in the ME which is associated with the PLMN ID of the HPLMN, if any, ordered based on this list.

b) if the indication of 'applicability of "lists of PLMN(s) to be used in disaster condition" provided by a VPLMN' is set to false:

- each PLMN in the "list of PLMN(s) to be used in disaster condition" stored in the ME which is associated with the HPLMN, if any, ordered based on this list.

vii) PLMN /E-UTRAN combinations for other forbidden PLMNs or other allowable PLMN(s), whose S1 capability is disabled, or whose E-UTRAN access is restricted, broadcasting the PLMN ID of the UE determined PLMN with disaster condition or broadcasting the disaster related indication, in random order.

Additionally, if S1 capability was disabled for the PLMN(s) above, then S1 capability is enabled, any RAT restriction for E-UTRAN is ignored for the PLMN(s) above, and if TAI of any cell broadcasting the PLMN ID of the UE determined PLMN with disaster condition (i.e PLMN-D) or broadcasting the disaster related indication in E-UTRAN is removed from list of forbidden TAIs.

### 6.4.3 Impacts on existing nodes and functionality

UE: Changes are needed in PLMN selection procedure defined in 3GPP TS 23.122 4.4.3.1.1.

## 6.5 Solution #5: RAT restriction under disaster conditions

### 6.5.1 Description

#### 6.5.1.1 Introduction

It is assumed that the UE and the network will support both the RAT restriction feature (ECRATU) and the Minimization of Service Interruption defined in Rel-19 (MINT\_Ph2).

This solution is mapped to the Key Issue #5: RAT restriction under disaster condition as shown in the following table:

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Key Issues | | | | | | | |
| Solutions | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| Solution #5 |  |  |  |  | X |  |  |  |

#### 6.5.1.2 Detailed description

This solution is for a UE and network under the following assumptions:

- support both the RAT restriction feature (ECRATU) and Minimization of Service Interruption (MINT\_Ph2);

- a disaster condition occurs in a specific RAT (i.e., NG-RAN) while the UE is restricted in the other existing RAT(s) or supported RAT(s) (i.e., E-UTRAN) by the UE;

- the UE is able to perform registration procedure under the 3GPP access;

- there are no other PLMN(s) available to which the UE can connect with no disaster condition, i.e., there is no PLMN where the UE can find normal service.

A detail description of the solution is as follows:

- The UE indicates support for both RAT restriction and MINT\_Ph2.

- The UE receives RAT restriction info (i.e., list of RATs restricted, including 4G) and disaster condition handling info per specific RAT, e.g., the network sends explicit disaster handling info to the UE using a new Information Element.

- UE stores RAT restriction list and disaster condition info in its memory.

- Disaster situation occurs in 5G RAT. 4G RAT broadcasts disaster condition SIB for UE(s) to get connected to 4G based on the solution reached in KI#1.

- UE removes 4G RAT from the "PLMNs with associated RAT restrictions" list and the UE NAS layer may update the RAT restriction information to AS layer for cell selection/re-selection.

- The UE connects to 4G RAT following the timers received from MINT information, i.e., wait roaming timer and removes from its memory any potential timer related to the RAT restriction.

Additionally, when the UE tries to connect to 4G RAT:

* The UE may receive 5G RAT restore indication from EPC using explicit indication or using enhanced RAT restriction information.
* The UE may initiate MRU to connect back to 5G RAT. UE may use back-off timer to connect back.

NOTE: The RAT restriction is defined under the WID ECRATU (Unique identifier: 1040042)

### 6.5.2 Impacts on existing nodes and functionality

The following impacts can be identified:

AMF/MME

- Notifying the UE over the non-restricted 3GPP access about a disaster condition and RAT restriction that impacted the 3GPP access and specific RAT;

- Providing a list of available RAT which are restricted and/or under disaster condition;

- Notifying the RAN to deliver a broadcast message indicating the RAT failure under disaster condition;

- Providing a timer related to the disaster condition to stagger UE access to specific RAT;

UE

- Handling of a notification sent by the network, e.g., SIB, over the 3GPP access about a disaster condition and RAT restriction that impacted the 3GPP access and specific RAT;

- Handling of RAT restricted information list under Disaster Condition, i.e., removing the previously restricted PLMN/RAT combination from the list of restricted RATs;

- Handling of broadcast information (SIB) from the RAN indicating the Disaster Condition in a specific RAT.

## 6.6 Solution #6: Notification that disaster condition is no longer applicable to the UEs

### 6.6.1 Introduction

This solution addresses the following key issue:

Key Issue #6: Notification that disaster condition is no longer applicable to the UEs

### 6.6.2 Detailed description

UE and MME behaviour shall follow the mechanism already specified for Rel-17 MINT.

In this solution, PLMN D is the PLMN on 5GS with disaster condition, PLMN A or PLMN-D on EPS provides a disaster roaming service for the 5G-only national roaming UE.

The UE determines that the disaster condition has ended on the PLMN-D in 5GS when:

- UE has successfully registered over non-3GPP access on a PLMN;

- UE registered for disaster roaming services in EPS receives an indication from the MME that disaster roaming has ended; or

- UE registered for disaster roaming services in EPS, when performing periodic scan determines service on PLMN D is available in 5GS. In the above situations, the periodic scan is controlled by a timer T with the range of 6 minutes to 8 hours and the default value 1 hour.

When the MME of PLMN-A or PLMN-D on EPS where UE is registered for the disaster roaming services, determines that PLMN D in the area providing 5GS services is no longer under the disaster condition then in this case the UE is notified that disaster roaming is no longer applicable as follows.

- if the UE is in the EMM-CONNECTED mode, the MME performs UE GUTI relocation update procedure with an indication that disaster condition no longer applies for the PLMN-D on 5GS. If the network and the UE support RAT utilization, then the MME can include RAT utilization control information or provide EMM cause#11 or #15 in the network initiated detach request procedure.

- if the UE in the 5GMM-IDLE mode attempts to move to 5GMM-CONNECTED mode, the MME rejects the initial NAS message with an indication that disaster condition no longer applies for the PLMN-D on 5GS (e.g. by providing cause#31 which causes UE to disable E-UTRA access in EPS and move to NG-RAN) or the MME rejects tracking area update request with EMM cause #11, #15, or the MME can include RAT utilization control information.

If the MME of PLMN-A indicate to the UE that NG-RAN of the PLMN is no longer under disaster condition through the RAT utilization control information then below apply:

* if PLMN A offers disaster roaming services in EPS only, RAT utilization control indicating restriction of at least E-UTRAN (and possibly also satellite E-UTRAN).
* if PLMN A offers disaster roaming services in both EPS and 5GS, RAT utilization control would need to indicate restriction of at least both E-UTRAN and NG-RAN (and possibly also satellite E-UTRAN and satellite NG-RAN).

### 6.6.3 Impacts on existing nodes and functionality

MME: MME sends NAS message indicating that the disaster condition is no longer applicable in 5GS.

UE: UE which is registered for the disaster roaming services determines that PLMN D in the area providing 5GS services is no longer under the disaster condition when:

- it receives the EMM cause code #11, #15, or #31 in tracking area update reject message or service reject message or detach request message or RAT utilization control information.

## 6.7 Solution #7: Prevention of signaling overload in the VPLMN providing disaster roaming services in EPS

### 6.7.1 Description

#### 6.7.1.1 Introduction

This solution is mapped to the Key Issue #7 – Prevention of signaling overload in the VPLMN providing disaster roaming services in EPS as shown in the following table:

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Key Issues | | | | | | | |
| Solutions | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| Solution #7.A |  |  |  |  |  |  | X |  |

#### 6.7.1.2 Detailed description

Once the disaster condition occurs in the VPLMN providing 5G-only national roaming the UEs currently connected to it will migrate to the VPLMN providing disaster roaming services in EPS (since it is the one that is currently available). In order to avoid congestion due to a potential large number of UEs migrating at the same time or within a short period of time to the VPLMN providing disaster roaming services in EPS it is necessary to distribute and stagger the migration of the subscribers/UEs.

Therefore the following steps are required for this solution:

- the UE supports MINT\_Ph2 in the REGISTRATION REQUEST message;

- the AMF in the HPLMN or the registered VPLMN (e.g. the VPLMN providing 5G-only national roaming access) in the REGISTRATION ACCEPT message sends a disaster roaming wait range, analogous to the one defined in MINT;

- the UE is then only allowed to perform registration attempt to the VPLMN providing disaster roaming services in EPS upon expiration of the disaster roaming wait range timer and once it has received indication or understands that the VPLMN providing 5G-only national roaming is under disaster condition.

- Consider the current overload control mechanism which are available at NAS level both for 4GS and 5GS.

### 6.7.2 Impacts on existing nodes and functionality

The following impacts can be identified:

MME/AMF:

- The AMF/MME sends a new information element that contains the disaster return roaming wait range timer to the UE in ATTACH ACCEPT, TRACKING AREA UPDATE ACCEPT, or GUTI REALLOCATION COMMAND.

UE:

- Includes the support of MINT\_Ph2 in its 5GMM capability IE;

- Reuses the timer specified for MINT, i.e., the disaster roaming wait range timer, to migrate to the VPLMN providing disaster roaming services in EPS.

- To handle a new information element that contains the disaster roaming wait range timer.

## 6.8 Solution #8: Prevention of signalling overload by returning UEs in the VPLMN providing 5G-only national roaming

### 6.8.1 Description

#### 6.8.1.1 Introduction

This solution is mapped to the Key Issue #8: Prevention of signalling overload by returning UEs in the VPLMN providing 5G-only national roaming as shown in the following table:

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Key Issues | | | | | | | |
| Solutions | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| Solution #8.A |  |  |  |  |  |  |  | X |

#### 6.8.1.2 Detailed description

Once the disaster condition is no longer applicable or valid in the VPLMN providing 5G-only national roaming the UEs will return to this VPLMN. In order to avoid congestion due to a potential large number of UEs returning at the same time or within a short period of time to the VPLMN providing 5G-only national roaming it is necessary to distribute and stagger the return of the subscribers/UEs.

Therefore the following steps are required for this solution:

- the UE supports MINT\_Ph2 in the REGISTRATION REQUEST message;

- the AMF in the HPLMN or the registered VPLMN (e.g. the VPLMN providing 5G-only national roaming access) in the REGISTRATION ACCEPT message sends a disaster return wait range, same as the one defined in MINT;

- the UE is then only allowed to perform registration attempt to the VPLMN providing 5G-only national roaming access upon expiration of the disaster return wait range and once it has received indication that the to the VPLMN providing 5G-only national roaming access is no longer under disaster condition.

### 6.8.2 Impacts on existing nodes and functionality

The following impacts can be identified:

MME/AMF:

- The AMF/MME sends an information element that contains the disaster return wait timer to the UE in REGISTRATION ACCEPT message or UE configuration update.

UE:

- Includes the support of MINT\_Ph2 in its 5GMM capability IE;

- Reuses the timer specified for MINT, i.e., the disaster return wait range, to return to the VPLMN providing 5G-only national roaming.

# 7 Evaluations

Editor's note: This clause will describe the evaluations on the solutions proposed in clause 6.

# 8 Conclusions

## 8.1 Conclusions on Key Issue #1

The following are the interim conclusions for Key Issue #1.

Solution #X for Key Issue #1 shall be progressed for normative work. The solution:

- informs the UE about disaster condition over 3GPP access; and

- broadcasts minimal information over E-UTRAN of a 4G PLMN offering disaster roaming service to UEs of a PLMN with disaster condition *and having 5G-only national roaming access to a VPLMN to obtain 4G connectivity service*, sufficient to enable the UEs to determine that a disaster condition applies to the PLMN with disaster condition.

NOTE: the design of the SIB messages with broadcast indication is defined by RAN WG2.

No further enhancement is needed for handling security risks resulting from using broadcast signalling to convey information related to disaster roaming.

## 8.6 Conclusions on Key Issue #6

The following are the interim conclusions for Key Issue #6.

Solution #X for Key Issue #6 shall be progressed for normative work.

The UE registered for disaster roaming services in EPS determines that the disaster condition has ended on the PLMN providing 5GS services when:

- the UE receives an indication from the MME that disaster roaming has ended; or

- the UE performing periodic scan determines that PLMN providing service in 5GS is available. The higher priority PLMN search can be modified under the disaster condition.

# Annex <X> (informative): Change history

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Change history** | | | | | | | |
| **Date** | **Meeting** | **TDoc** | **CR** | **Rev** | **Cat** | **Subject/Comment** | **New version** |
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