Extensions to enable wireless reliability and availability in multi-access edge deployments

Abstract

There are several scenarios involving multi-hop heterogeneous
wireless networks requiring reliable and available features combined
with multi-access edge computing, such as Industry 4.0. This
document describes solutions integrating IETF RAW and ETSI MEC,
fostering discussion about extensions at both IETF and ETSI MEC to
better support these scenarios.

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This Internet-Draft is submitted in full conformance with the
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1. Introduction

Wireless operates on a shared medium, and transmissions cannot be
fully deterministic due to uncontrolled interferences, including
self-induced multipath fading. RAW (Reliable and Available Wireless)
is an effort to provide Deterministic Networking on across a path
that include a wireless interface. RAW provides for high reliability
and availability for IP connectivity over a wireless medium. The
wireless medium presents significant challenges to achieve
deterministic properties such as low packet error rate, bounded
consecutive losses, and bounded latency. RAW extends the DetNet
Working Group concepts to provide for high reliability and
availability for an IP network utilizing scheduled wireless segments
and other media, e.g., frequency/time-sharing physical media
resources with stochastic traffic: IEEE Std. 802.15.4 timeslotted
channel hopping (TSCH), 3GPP 5G ultra-reliable low latency
communications (URLLC), IEEE 802.11ax/be, and L-band Digital
Aeronautical Communications System (LDACS), etc. Similar to DetNet,
RAW technologies aim at staying abstract to the radio layers
underneath, addressing the Layer 3 aspects in support of
applications requiring high reliability and availability.

As introduced in [I-D.ietf-raw-architecture], RAW separates the path
computation time scale at which a complex path is recomputed from
the path selection time scale at which the forwarding decision is
taken for one or a few packets. RAW operates at the path selection
time scale. The RAW problem is to decide, amongst the redundant
solutions that are proposed by the Patch Computation Element (PCE),
which one will be used for each packet to provide a Reliable and
Available service while minimizing the waste of constrained
resources. To that effect, RAW defines the Path Selection Engine

(PSE) that is the counter-part of the PCE to perform rapid local adjustments of the forwarding tables within the diversity that the PCE has selected for the Track. The PSE enables to exploit the richer forwarding capabilities with Packet (hybrid) ARQ, Replication, Elimination and Ordering (PAREO), and scheduled transmissions at a faster time scale.

Multi-access Edge Computing (MEC) -- formerly known as Mobile Edge Computing -- capabilities deployed in the edge of the mobile network can facilitate the efficient and dynamic provision of services to mobile users. The ETSI ISG MEC working group, operative from end of 2014, intends to specify an open environment for integrating MEC capabilities with service providers' networks, including also applications from 3rd parties. These distributed computing capabilities will make available IT infrastructure as in a cloud environment for the deployment of functions in mobile access networks.

One relevant exemplary scenario showing the need for an integration of RAW and MEC is introduced next. One of the main (and distinct) use cases of 5G is Ultra Reliable and Low Latency Communications (URLLC). Among the many so-called "verticals" that require URLLC features, the Industry 4.0 (also referred to as Wireless for Industrial Applications) is probably the one with more short-term potential. As identified in [I-D.ietf-raw-use-cases], this scenario also calls for RAW solutions, as cables are not that suitable for the robots and mobile vehicles typically used in factories. This is also a very natural scenario for MEC deployments, as bounded, and very low latencies are needed between the robots and physical actuators and the control logic managing them. Figure 1 depicts an exemplary scenario of a factory where terminals (robots and mobile automated guided vehicles) are wirelessly connected. Control applications running in the edge (implemented as MEC applications) require bounded low latencies and a guaranteed availability, despite the mobility of the terminals and the changing wireless conditions. An heterogeneous wireless mesh network is used to provide connectivity inside the factory.

```
                -----------
                |  PCE   |
                -----+-----
                     |
                   --+--
                  (     )
                 (       )
                  (     )
                   --+--
                     |
                -----------
                | RAW PSE |
                -----+-----
                     |
 _____+_____
|                              *( ( o ) )        |
|    RAW                      *  *    ^           |
|   network                 ****** *   / \        |
|                         *******     *   /   \    -----   |
|                   *              **  -------   |app|   |
|                 *               *   | RAW |  -------    |
|              ( ( o ) )*        *    |node |-| MEC |    |
|   -----        ^      *( ( o ) )  ------- -------    |
|   |app|      / \         ^    *               |
|   -----     /   \       / \   **              |
|   |app|   -------      /   \  *( ( o ) )        |
| -------   | RAW |   -------      ^    (o      |
| | MEC |------|node |   | RAW |     / \    -\----  |
| -------   -------   |node |    /   \  |term|  |
|    o)        o)   -------   ------- -0--0-  |
| ----/-      ----/-          | RAW |        |
| |term|     |term|           |node |        |
| -0--0-     -0--0-           -------        |
|_____|
```

        Figure 1: Exemplary scenario depicting MEC and RAW in an industrial
                              environments

   This scenario includes a wireless domain, involving multiple MEC
   platforms to ensure low latency to applications, by being able to
   host MEC applications in several locations, and dynamically migrate
   the apps as the terminals move around and the serving MEC platform
   might no longer be capable of meeting the latency requirements.

2. Terminology

The following terms used in this document are defined by the ETSI
MEC ISG, and the IETF:

MEC host. The mobile edge host is an entity that contains a
mobile edge platform and a virtualization infrastructure which
provides compute, storage, and network resources, for the purpose
of running mobile edge applications.

MEC platform. The mobile edge platform is the collection of
essential functionalities required to run mobile edge
applications on a particular virtualization infrastructure and
enable them to provide and consume mobile edge services.

MEPM. MEC Platform Manager.

MEC applications. Mobile edge applications are instantiated on
the virtualization infrastructure of the mobile edge host based
on configuration requests validated by the mobile edge
management.

PAREO. Packet (hybrid) ARQ, Replication, Elimination and
Ordering. PAREO is a superset Of DetNet's PREOF that includes
radio-specific techniques such as short range broadcast, MUMIMO,
constructive interference and overhearing, which can be leveraged
separately or combined to increase the reliability.

PSE. The Path Selection Engine (PSE) is the counter-part of the
PCE to perform rapid local adjustments of the forwarding tables
within the diversity that the PCE has selected for the Track. The
PSE enables to exploit the richer forwarding capabilities with
PAREO and scheduled transmissions at a faster time scale over the
smaller domain that is the Track, in either a loose or a strict
fashion.

3. Problem Statement

With current standards, the MEC platform(s) would have to interact
with a Path Computation Element (PCE) for data plane requests and
updates. This tremendously limits the capabilities to guarantee
real-time forwarding decisions, as it will make it challenging and
not possible to manage forwarding decisions in real or near-real
time.

RAW solutions and approaches being explored today consider the role
of the PSE, which computes at a short time scale which of the
available paths (called tracks) -- computed by a PCE -- should be
used per flow/packet and also which PAREO functions can be used, in
order to provide the flow with the required availability and

reliability features. The PSE interacts with the PCE and with the RAW nodes so they can setup the required per-flow state, to recognize the flow and determine the forwarding policy to be applied. These RAW forwarding decisions can be distributed among the necessary nodes using in-band signaling (e.g., extending Segment Routing, BIER-TE or DETNET tagging) or can be taken autonomously by each forwarding node locally (based on its knowledge of the status of the network, gained via OAM RAW-specific mechanisms).

Figure 1 shows an exemplary scenario, depicting an industrial environment where different nodes are wirelessly connected to provide connectivity to several stationary and mobile terminals (i.e., robots). Industry environments are a good example of applications where reliability and availability are critical. Ensuring this in wireless heterogeneous and multi-hop networks requires using multiple paths, using PAREO functions and even using dual or multiple connectivity. Terminal mobility makes it even more challenging to guarantee certain reliability and availability levels, due to the dynamic and fast changes that this needs at the data plane level. The short-time scale forwarding decisions that are required to ensure reliability and availability with terminal mobility cannot be managed if MEC platforms can only interact with the data plane through the PCE.

The PCE is responsible for routing computation and maintenance in a network and it is typically a centralized entity that can even reside outside the network. It is meant to compute and establish redundant paths, but not to be sensitive/reactive to transient changes, and therefore is not capable of ensuring a certain level of reliability and availability in a wireless heterogeneous mesh network, especially if some of the nodes (e.g., the end terminals) might be mobile. With currently standardized solutions, a MEC platform could only interact with the RAW network through the PCE, most possibly through the Mp2 reference point defined by ETSI MEC. This reference point is defined between the MEC platform and the data plane of the virtualization infrastructure to instruct the data plane on how to route traffic among applications, networks, services, etc. This reference point is not further specified by ETSI MEC, but it would be the one that could be used by current solutions to allow for MEC to request the data plane on the RAW network a certain behavior (in terms of availability and reliability) for MEC app traffic flows. With existing solutions, the PCE would be the entry point for configuring and managing the RAW network, probably through the Mp2 reference point. Note that the PCE might reside outside the RAW network, the path between the RAW network and the PCE might be expensive and slow (e.g., it might need to traverse the whole RAW network) and reaching to the PCE can also be slow in regards to the speed of events that affect the forwarding operation at the radio layer.

Additionally, the MEC architecture as currently defined by ETSI does not have any component designed to deal with the specifics of an heterogeneous wireless multi-hop networks (such a RAW one), and therefore, it is very limited in terms of what a MEC app (through the MEC platform) can request to the data plane of an heterogeneous wireless multi-hop network. Besides, this lack of RAW-aware component at the ETSI MEC architecture prevents any enhancement at either the MEC side (e.g., MEC app migrations triggered by RAW status updates) or the RAW side (e.g., PAREO function updates triggered by MEC app/terminal mobility).

Because of all these aforementioned reasons, it is needed to define a new RAW-enabled component at the ETSI MEC architecture, aimed at enabling a more direct interaction between the MEC platform and the RAW network, allowing the MEC platform to notify events and/or request actions to the RAW network quick enough. This involves some challenges, as the RAW PSE has to understand the needs from the running MEC applications, so it can properly configure the RAW nodes so the data plane provides the required reliability and availability.

4. RAW and MEC integration

This document defines a new entity inside the MEC platform: the RAW ctrl. This entity is responsible for computing what to instruct the RAW PSE, based on the requirements of the MEC apps, as well as to take decisions at the MEC side (e.g., migration of apps) based on information about the RAW network status.

As a result of the introduction of the RAW ctrl and the actions it is responsible of, new interactions and interface semantics are added. These interactions and semantics can be terminated at either the PCE or the RAW PSE, depending on the requirements of the MEC apps. For near real-time coordination and control between MEC and RAW mechanisms, the interactions are between the RAW ctrl and the RAW PSE. We mostly refer to this deployment model from now on, as it is the one that allow for near real-time updates on the forwarding plane, but note that an alternative deployment model in which the RAW ctrl interacts with the PCE is also possible, though only supporting non real-time interactions.

The MEC-RAW new interface semantics/extensions depicted in Figure 2 allows the MEC platform to issue requests to the RAW network, through the RAW PSE, so it can behave as required by MEC apps.
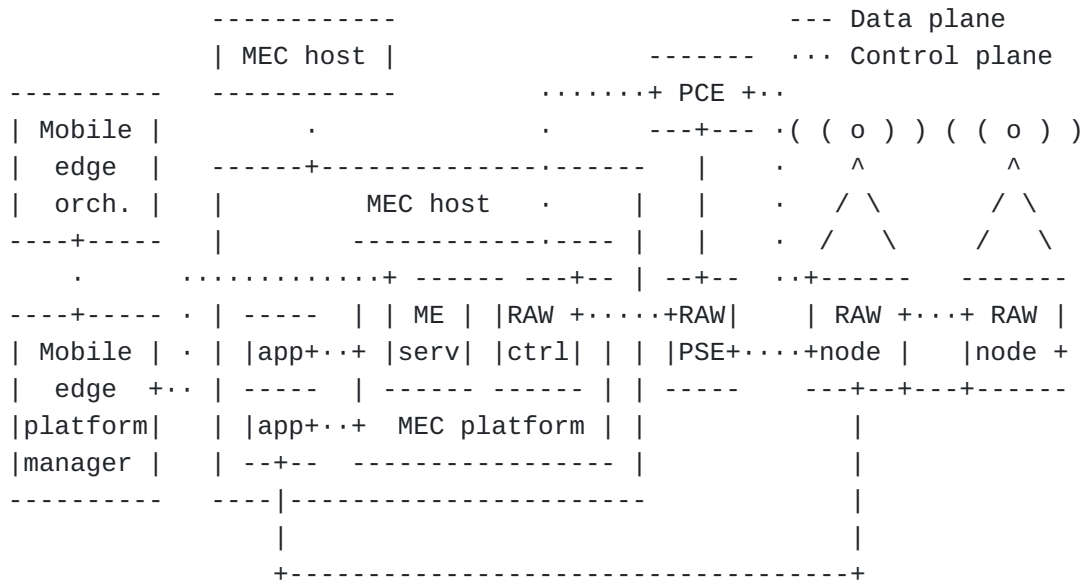
```
            ------------                        --- Data plane
           | MEC host |              ------- ··· Control plane
----------  ------------         ·······+ PCE +··
| Mobile |         ·             ·      ---+--- ·( ( o ) ) ( ( o ) )
|  edge  |  ------+-------------------   |   ·    ^          ^
| orch.  |  |          MEC host   ·    | |   ·   / \        / \
----+-----   |       ---------------- |  |   ·  /   \      /   \
    ·     ············+ ------ ---+-- | --+--  ··+------    -------
----+----- · | -----  | | ME |  |RAW +······+RAW|   | RAW +···+ RAW |
| Mobile | · | |app+··+ |serv| |ctrl| | | |PSE+····+node |   |node +
|  edge  +·· | -----   | ------ ------ | | -----   ---+--+---+------
|platform|   | |app+··+  MEC platform | |           |
|manager |   | --+--  ---------------- |           |
----------   ----|----------------------           |
                 |                                 |
               +-----------------------------------+

                  Figure 2: Block diagram
```

   The new semantics of the interface between the MEC platform and the
   RAW PSE do not only serve to convey the requests, but also to
   synchronize the status and topology of the RAW (relevant portion of
   the) network, enabling to perform real-time or near-real time
   forwarding decisions. In the sequel, we show different exemplary
   signaling diagrams for the most relevant procedures.

4.1. MEC app request for RAW

   Here we specify the interface extensions and signaling procedures
   needed to enable a MEC app describe and request its needs in terms
   of availability and reliability. As it will be further developed in
   other subsections, the wireless network conditions could also have
   an impact back on the MEC platform (e.g., by triggering the
   migration of the MEC app).

   Figure 3 shows an exemplary signaling flow diagram, in which a
   certain MEC app request a given behavior for the treatment of the
   packets the app generates. We consider an industrial wireless
   application scenario, as the one used in previous sections, as an
   example for the sake of describing the interface and specified
   interactions.

   The MEC platform is enhanced with a RAW ctrl entity, as introduced
   in the previous section. The RAW ctrl is a RAW-aware component
   within the MEC architecture that enables the required interactions
   with the RAW network, through the RAW PSE. This allows MEC apps to:
   (i) adapt to RAW conditions (e.g., if the requested reliability and
   availability is not possible), and (ii) dynamically modify the

requested flow forwarding to the RAW network, based on the MEC app
and mobility conditions.

```
+-----------+    +-----+    +----+    +----+    +----+    +----+
|    RAW    |    | RAW |    |RAW |    |RAW |    |RAW |    |RAW |
| app ctrl  |    | PSE |    |node|    |node|    |node|    |term|
+-----------+    +-----+    +----+    +----+    +----+    +----+
   |    |           |          |         |         |         |
1.MEC app req.      |          |         |         |         |
   |....>|          |          |         |         |         |
   |    |           |          |         |         |         |
   |  2a.MEC-to-RAW req.       |         |         |         |
   |(flow ID,flow spec,reqs.)  |         |         |         |
   |       |..........>|       |         |         |         |
   |    |           |          |         |         |         |
   |  2b.MEC-to-RAW resp.      |         |         |         |
   |   (flow ID,status=OK)     |         |         |         |
   |      |<..........|        |         |         |         |
   |    |           | 3.RAW control      |         |         |
   |    |           | (flow ID,flow spec,PAREO)     |         |
   |    |           |..........>|        |         |         |
   |    |           |....................>|        |         |
   |    |           |.............................>|         |
   |    |           |          |         |         |         |
   | 4a.MEC app     |          |4b.MEC app traffic w/ in-band |
   |    traffic     |          | RAW control (flow ID, PAREO) |
   |<--------------------------->|<-------------------->|     |
   |    |           |          | (example: packet replication/ |
   |    |           |          |  overhearing, elimination)    |
   |    |           |          |<-------->|<-------->|<------->|
   |    |           |          |         |         |         |
```
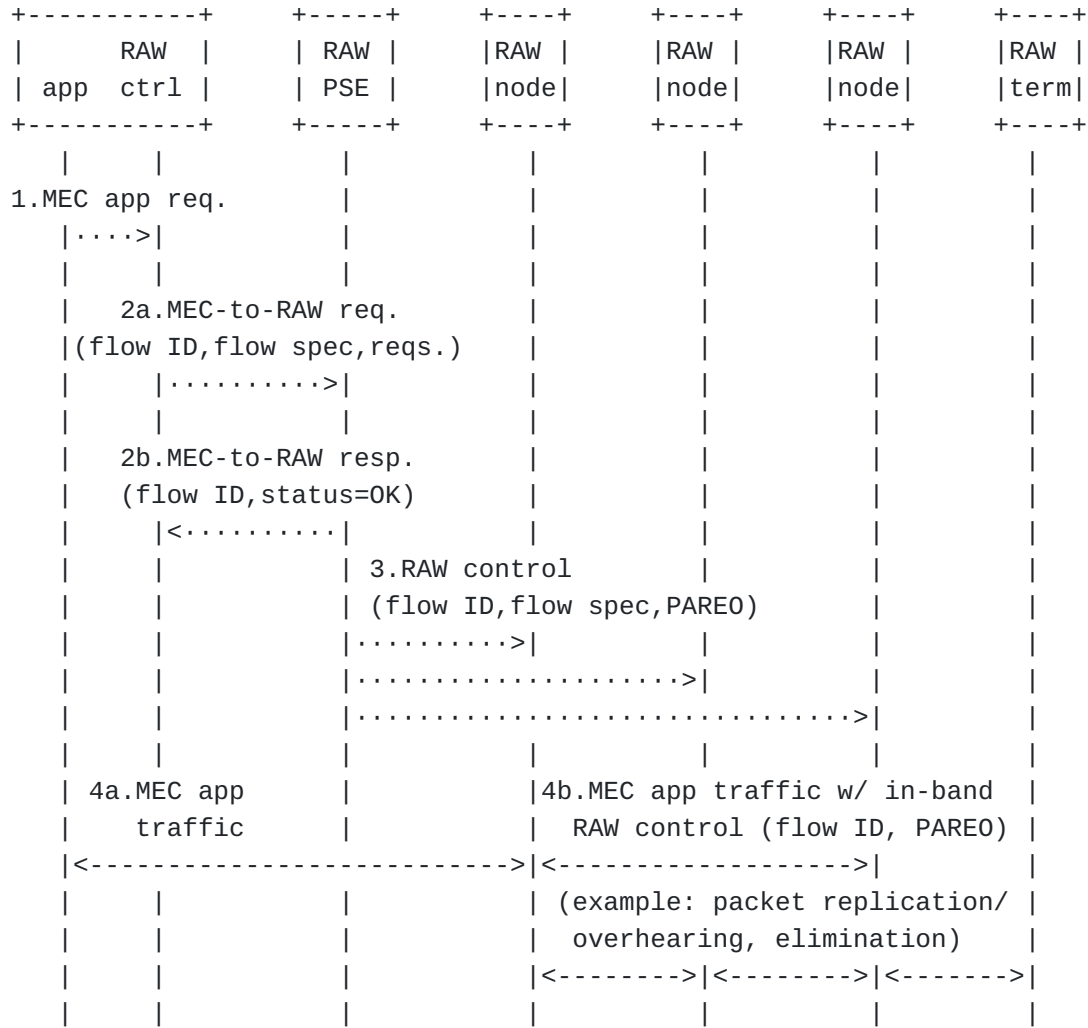
                     Figure 3: MEC app request for RAW

   We next explain each of the steps illustrated in the figure:

      1. A MEC app which is going to be consumed by a given terminal (or
         set of terminals, though in this example we show just one
         consumer), specifies to the MEC platform the characteristics of
         the traffic is going to generate and its associated
         requirements.

      2. The MEC platform -- namely the RAW ctrl component, which is
         RAW-aware and knows the characteristics of the deployment --
         analyzes the characteristics of the MEC app traffic and the
         provided requirements, and generates a new request -- over a

new interface between the MEC platform and the RAW PSE -- that
includes, among others, the following parameters:

   *An ID for the given flow, which can be used for future near
    real-time update/configuration operations on the same flow.

   *The flow specification, describing the characteristics of
    the packets, allowing an efficient identification of flow(s)
    based on well-known fields in IPv4, IPv6, and transport
    layer headers like TCP and UDP. An example of how to do this
    is defined in the Traffic Selectors for Flow Bindings
    [RFC6088].

   *The requirements of the flow in terms of reliability and
    availability.

3. The RAW PSE processes the request, and based on its knowledge
   of the network (topology, node capabilities and ongoing flows)
   computes the best way of transmitting the packets over the RAW
   network (using the available paths/tracks, previously computed
   by a PCE). Note that at this point it might be possible that
   the RAW PSE realizes that it is not possible to provide the
   requested reliability and availability characteristics, and
   would report that back to the MEC platform (which might issue a
   new request with less requirements). The RAW PSE sends control
   packets to each of the RAW nodes involved, instructing how to
   deal with the packets belonging to the MEC app flow. This
   includes:

   *assigning an ID to the flow;

   *instructing the entry point in the RAW network to tag
    packets with that ID;

   *specific PAREO functions to be used by each of the RAW
    nodes. This might be signaled to each of the RAW nodes, or
    just to some of them (e.g., only the entry point) who can
    then use in-band signaling to specify it.

4. The MEC app generates traffic (step 4a in the figure) which
   arrives at the RAW entry point in the network, which following
   the instructions of the RAW PSE, encapsulates and tags the
   packet, and might also include in-band signaling (e.g., using
   Segment Routing). Some PAREO functions are applied to the MEC
   app traffic packets (step 4b in the figure) to achieve the
   required levels of reliability and availability. In the figure,
   as an example, packets are replicated (this could be done by
   means of wireless overhearing) at one point of the network, and
   then later duplicated packets eliminated.

4.2. RAW OAM triggering MEC app migration

   Here we specify the mechanisms for MEC to benefit from RAW OAM
   information, for example, to trigger the migration of a MEC
   application to a different MEC platform, to ensure that the
   requirements of the MEC app continue to be met.

```
+----+           +--------+    +---+   +----+  +----+  +----+  +----+
|    |           |  RAW   |    |RAW|   |RAW |  |RAW |  |RAW |  |RAW |
|MEPM|           |app ctrl|    |PSE|   |node|  |node|  |node|  |term|
+----+           +--------+    +---+   +----+  +----+  +----+  +----+
  |                 |    |        |       |       |       |       |
  |                 | MEC app     |   MEC app traffic w/ in-band   |
  |                 | traffic     |   RAW control (flow ID, PAREO) |
  |                 |<--------------------->|<-------------->|     |
  |                 |    |        | (example: packet replication/  |
  |                 |    |        |    overhearing, elimination)   |
  |                 |    |        |        |<----->|<----->|<------>|
  |                 |    |        |        |       |       |       |
  |                 |    |        |    1.RAW OAM signalling |       |
  |   +--------+    |    |        |<.......|       |       |       |
  |   |  RAW   |    | 2.MEC-to-RAW |<.............|       |       |
  |   |app ctrl|    |   (flow ID,  |<.....................|       |
  |   +--------+    |      status=KO)|<...............................|
  |   |    |   |    |    |<........|       |       |       |       |
  |3.MEC app migration|       |        |       |       |       |
  |<.................>|       |        |       |       |       |
  |<.......>|    |    |    |        |       |       |       |       |
  |    |    |    |    |    |        |       |       |       |       |
  |    |    | 4a.MEC-to-RAW req.|        |       |       |       |
  |    |    (flow ID,flow spec,reqs.)  |       |       |       |
  |    |    |.................>|        |       |       |       |
  |    |    4b.MEC-to-RAW resp. |        |       |       |       |
  |    |    (flow ID,status=OK) | 5.RAW control |       |       |
  |    |    |<.................|   (flow ID,flow spec,PAREO)      |
  |    |    |    |    |        |.......>|       |       |       |
  |    |    |    |    |        |..............>|       |       |
  |    |    |    |    |        |.....................>|       |
  |    |    |    |    |        |..............................>|
  |    |    |    |    |        |       |       |       |       |
  |    6a.MEC app|    |        | 6b.MEC app traffic w/ in-band   |
  |    | traffic|    |        |    RAW control (flow ID, PAREO) |
  |    |<----------------------------------->|<-------------->|   |
  |    |    |    |    |        | (example: packet replication/   |
  |    |    |    |    |        |    overhearing, elimination)    |
  |    |    |    |    |        |        |<----->|<----->|<------>|
  |    |    |    |    |        |        |       |       |       |
```
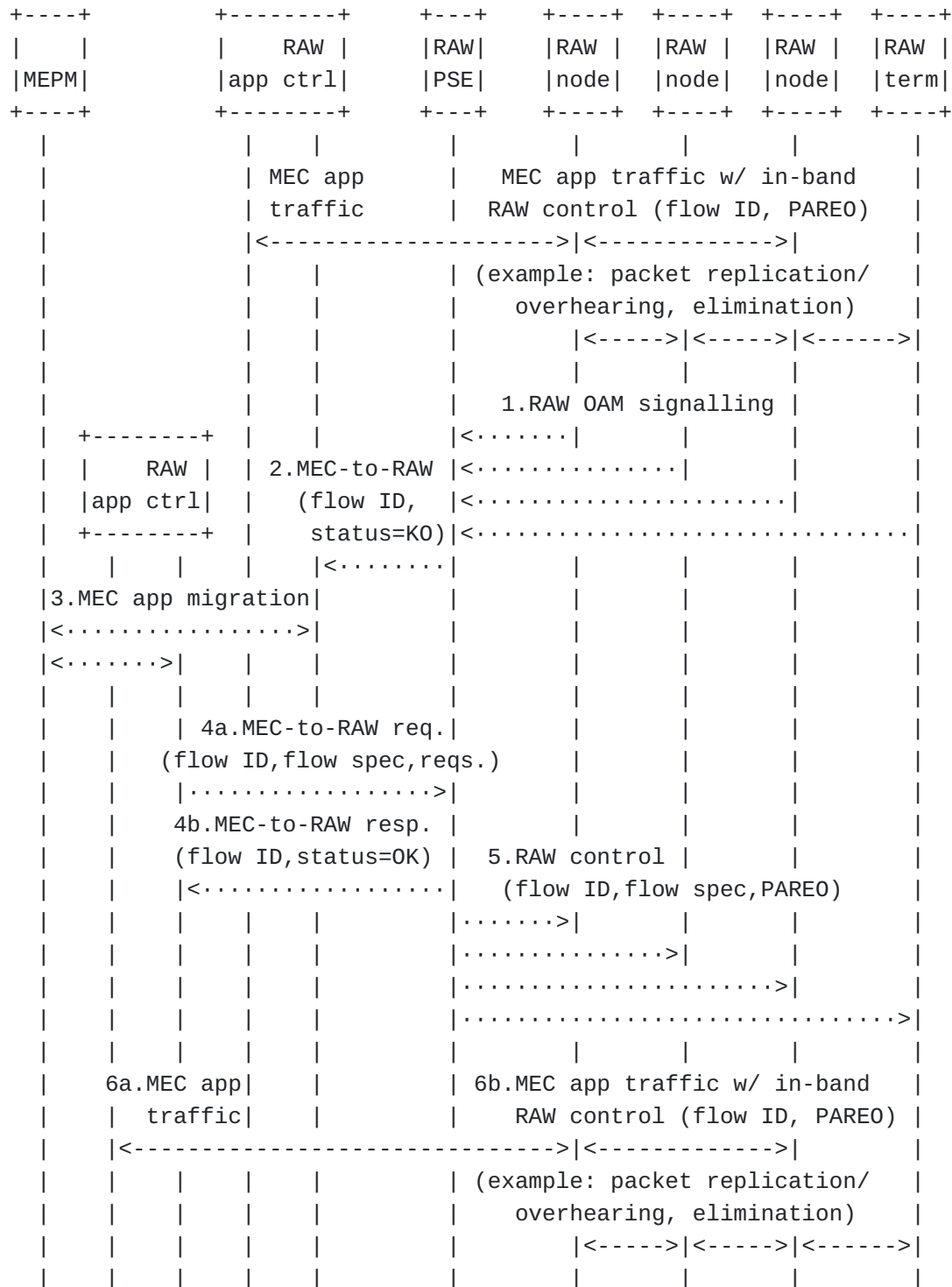
Figure 4: RAW OAM triggering MEC app migration

Figure 4 shows an exemplary signaling flow diagram, in which changes
in the RAW network, detected thanks to RAW OAM, trigger the
migration of a MEC app. We assume there is already a MEC app
deployed and traffic is already flowing (i.e., all the procedures
explained in the previous section took already place). We next
explain each of the steps illustrated in the figure:

1. RAW OAM signaling is periodically and reactively exchanged
   between the RAW nodes and the RAW PSE [I-D.ietf-raw-oam-
   support].

2. If the conditions of the network get worse (e.g., because of
   changes in the radio propagation of a critical link), making it
   impossible to guarantee the required levels of reliability and
   availability, this generates a message from the RAW PSE to the
   MEC platform, indicating that a given MEC app flow can no
   longer be served.

3. The currently serving MEC platform triggers a MEC app migration
   to a different MEC platform. This involves the MEC platform
   manager. Note that the MEC platform might provide suggestions
   regarding where to migrate the MEC app, based on its knowledge
   of the RAW network status, acquired by the RAW ctrl through
   interactions with the PSE.

4. The same steps 2-3-4 specified in the procedure described in
   Section 4.1 take place. In this step, the MEC platform
   generates a new request to the RAW PSE.

5. The RAW PSE processes the request, and based on its knowledge
   of the network computes the best way of transmit the packets
   over the RAW network. The RAW PSE sends control packets to each
   of the RAW nodes involved.

6. The MEC app generates traffic, arriving at the RAW entry point
   in the network, which following the instructions of the RAW
   PSE, encapsulates and tags the packet.

4.3. MEC OAM for RAW updates

There are scenarios and situations where -- due to the mobility of
the terminals or the nodes hosting the MEC platform hosting a given
MEC app -- it might be needed to take actions on the RAW network:
e.g., to update the paths, apply different PAREO functions, migrate
the MEC app (thus involving a change in the RAW forwarding). This
triggers the need for mechanisms enabling the RAW PSE to get and use
MEC OAM information to update traffic forwarding at the RAW network

as needed to adapt to varying conditions, e.g., due to node
mobility.


```
+---------+    +-----+    +----+    +----+    +----+    +----+    +----+
|   RAW   |    | RAW |    |RAW |    |RAW |    |RAW |    |RAW |    |RAW |
|app  ctrl|   | PSE |    |node|    |node|    |node|    |node|    |term|
+---------+    +-----+    +----+    +----+    +----+    +----+    +----+
   |     |       |          |         |         |         |        |
   | MEC app     |          | MEC app traffic w/ in-band          |
   | traffic     |          | RAW control (flow ID, PAREO)        |
   |<----------------------->|<--------------->|         |        |
   |     |       |          | (example: packet replication/       |
   |     |       |          |    overhearing, elimination)        |
   |     |       |          |<------>|<------>|<--------------->|
   |     |       |          |         |         |         |        |
   |     |1a.Mobility trigger |       |         |         |        |
   |     |(flow ID,trajectory)|       |         |         |        |
   |     |........>|          |         |         |         |        |
   |     |       |          |         |         |         |        |
   |     |1b.Mobility trigger ACK     |         |         |        |
   |     |(flow ID)|          |         |         |         |        |
   |     |<........|          |         |         |         |        |
   |     |         | 2.RAW control   |         |         |        |
   |     |         | (flow ID,flow spec,PAREO) |         |        |
   |     |         |........>|         |         |         |        |
   |     |         |.................>|         |         |        |
   |     |         |..........................>|         |        |
   |     |         |..................................>|        |
   |     |         |............................................>|
   |     |       |          |         |         |         |        |
   | 3a.MEC app   |          |3b.MEC app traffic w/ in-band        |
   |    traffic   |          | RAW control (flow ID, PAREO)        |
   |<----------------------->|<--------------->|<------>|        |
   |     |       |          | (example: packet replication/       |
   |     |       |          |   overhearing, elimination)         |
   |     |       |          |<-------->|<---->|<------>|<----->|
   |     |       |          |         |         |         |        |
```
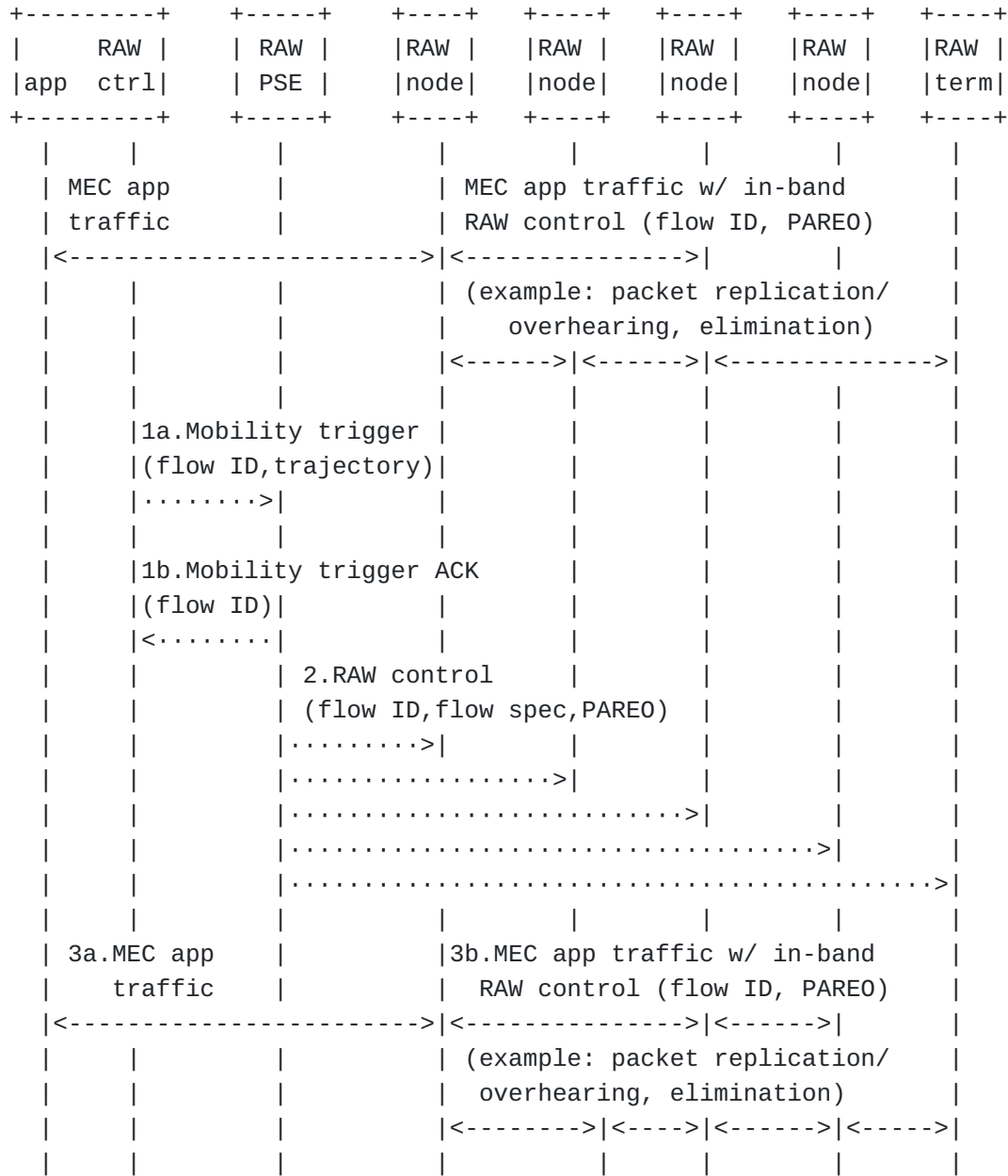
            Figure 5: MEC OAM for RAW updates

    [Figure 5](#) shows an exemplary signaling flow diagram, in which the
    mobility of the a node (in this case the terminal, but it could have
    been the MEC platform hosting the MEC app) triggers the need for
    updating RAW forwarding mechanisms. As in the previous section, we
    assume there is already a MEC app deployed and traffic is already
    flowing (i.e., all the procedures explained in Section 4.1 took

already place). We next explain each of the steps illustrated in the figure:

1. The MEC platform notifies that the terminal consuming the MEC app is moving (note that it other events can be notified, such as the mobility of the MEC platform itself), including the expected trajectory (if can be known or predicted in advance, as it will be the case in most cases in several scenarios, such as industrial use cases).

2. The RAW PSE uses this information to re-compute how to best provided the reliability and availability needed by the MEC app traffic flow, and updates the RAW nodes about the PAREO functions that they have to apply.

3. After this, traffic from the MEC app benefits from updated policies, computed according to the new conditions, and ensuring that the requirements of the MEC app continue to be fulfilled.

5. IANA Considerations

TBD.

6. Security Considerations

TBD.

7. Acknowledgments

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8. Informative References

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