UNICO I+D Project
6G-DATADRIVEN-04

6G-DATADRIVEN-04-E15

Multi-SDO RAW extensions (initial version)

Abstract

This report includes a first release of multi-SDO RAW extensions.

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List of Acronyms

3GPP: 3rd Generation Partnership Project (3GPP)

AI/ML: Artificial Intelligence / Machine Learning

CPF: Controller Plane Function

DetNet: Deterministic Networking

IEEE: Institute of Electrical and Electronics Engineers

IETF: Internet Engineering Task Force

IoT: Internet of Things

IT: Internet technology

NFV: Network Function Virtualization

OAM: Operations, Administration and Management

PAREO: Packet (hybrid) ARQ, Replication, Elimination and Ordering

PCE: Path Computation Element

PREOF: Packet Replication, Elimination, and Ordering Functions

PSE: Path Selection Engine

RAW: Reliable and Available Wireless

SDO: Standards Developing Organization

TSN: Time-Sensitive Networks

URLLC: Ultra-Reliable Low Latency Communications

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Resumen Ejecutivo

Este documento proporciona una primera versión de especificación de extensiones/soluciones RAW (*Reliable and Available Wireless*) que integran mecanismos desarrollados por diferentes organismos de estandarización (SDOs: *Standardization Development Organizations*) necesarias para entornos industriales en el proyecto 6G-DATADRIVEN-04, así como un plan de potencial adopción de algunas de las soluciones planteadas en el IETF. Se parte de la motivación e introducción detallados en el entregable 6G-DATADRIVEN-04-E9.

El documento detalla algunos mecanismos iniciales que integran soluciones de IETF RAW/DetNet y ETSI, que serán extendidas y complementadas a lo largo del proyecto.

Los principales resultados descritos en este entregable son:

- la especificación inicial de soluciones que permiten integrar de forma óptima las soluciones definidas por los grupos de trabajo RAW y DetNet (*Deterministic Networking*) del IETF y el ETSI MEC, para entornos industriales. Parte de este trabajo se ha presentado en un workshop (Carlos J Bernardos, 2023);
- una planificación de contribuciones y su potencial adopción en el IETF.

Parte de estos resultados se han enviado y presentado ya al IETF, como versiones iniciales. En concreto, se ha participado como co-autor y/o editor en las siguientes contribuciones:

- Bernardos, C. J., & Mourad, A. (2023, September). *Extensions to enable wireless reliability and availability in multi-access edge deployments*. Internet-Draft, IETF Secretariat. Retrieved from https://www.ietf.org/archive/id/draft-bernardos-detnet-raw-mec-00.txt
- Mirsky, G., Theoleyre, F., Papadopoulos, G. Z., Bernardos, C. J., Varga, B., & Farkas, J. (2023, October). *Framework of Operations, Administration and Maintenance (OAM) for Deterministic Networking (DetNet)*. Internet-Draft, IETF Secretariat. Retrieved from https://www.ietf.org/archive/id/draft-ietf-detnet-oam-framework-09.txt
- Theoleyre, F., Papadopoulos, G. Z., Mirsky, G., , Bernardos, C. J. (2023, October). *Operations, Administration and Maintenance (OAM) features for RAW*. Internet-Draft, IETF Secretariat. Retrieved from https://www.ietf.org/archive/id/ draft-ietf-raw-oam-support-06.txt

El resto del documento está redactado en inglés, de cara a maximizar el impacto del trabajo realizado en este proyecto.

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Executive Summary

This document provides the initial specification of RAW (Reliable and Available Wireless) extensions/solutions that integrate mechanisms developed by different standardization organizations (SDOs: Standardization Development Organizations) necessary for industrial environments for the 6G-DATADRIVEN-04 project, as well as a plan of potential adoption of some of the solutions proposed at the IETF. It is based on the motivation and introduction detailed in the deliverable 6G-DATADRIVEN-04-E9.

The document details some initial mechanisms that integrate IETF RAW/DetNet and ETSI solutions, which will be extended and complemented throughout the project.

The main results described in this deliverable are:

- the initial specification of solutions that allow the optimal integration of the solutions defined by the RAW and DetNet (Deterministic Networking) working groups of the IETF and the ETSI MEC, for industrial environments. Part of this work has been presented in a workshop (Carlos J Bernardos, 2023);
- planning contributions and their potential adoption in the IETF.

Some of these results have been already submitted and presented at the IETF, as first verisons. Namely, we have participated as co-author and/or editor of the following contributions:

- Bernardos, C. J., & Mourad, A. (2023, September). *Extensions to enable wireless reliability and availability in multi-access edge deployments*. Internet-Draft, IETF Secretariat. Retrieved from https://www.ietf.org/archive/id/draft-bernardos-detnet-raw-mec-00.txt
- Mirsky, G., Theoleyre, F., Papadopoulos, G. Z., Bernardos, C. J., Varga, B., & Farkas, J. (2023, October). *Framework of Operations, Administration and Maintenance (OAM) for Deterministic Networking (DetNet)*. Internet-Draft, IETF Secretariat. Retrieved from https://www.ietf.org/archive/id/draft-ietf-detnet-oam-framework-09.txt
- Theoleyre, F., Papadopoulos, G. Z., Mirsky, G., , Bernardos, C. J. (2023, October). *Operations, Administration and Maintenance (OAM) features for RAW*. Internet-Draft, IETF Secretariat. Retrieved from https://www.ietf.org/archive/id/ draft-ietf-raw-oam-support-06.txt

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1. Introduction

1.1. Multi-domain determinism

State-of-the-art Time Sensitive Communications (TSC) mechanisms such as Packet Replication, Elimination, and Ordering Functionality (PREOF), hold-and-forward, etc., are defined per technology domain. If a scenario involves multiple technologies (defined by different Standardization Development Organizations, SDOs), these TSC mechanisms should be distributed and synchronized across multiple domains (distributed TSC). For example, E2E PREOF requires that replication and elimination functions are mapped to different domains of different technologies, therefore domain specific technologies needed to be capable of activating only part of their PREOF functionality and apply them to the same set of packets (see cross-domain flow harmonization). De-jittering or enforcing on-time packet delivery through hold and forward mechanisms also requires coordination between domains.

To enable E2E deterministic services, the following requirements are identified as relevant concerning cross-domain determinism:

- Harmonization of intra-domain service configuration (e.g., scheduler parameters; bandwidth allocations; delay budgets; etc.)
- Cross-domain path selection and with path capabilities matching with E2E service requirements.
- Cross-domain PREOF inter-working (source domain performs packet replication, destination domain performs packet elimination – if the domains are implemented with different technology).

1.2. Determinism support by current SDOs

Currently there are different initiatives that provide determinism in different domains. For Ethernet (fixed) networks, IEEE provides a set of standards related to TSN defined by IEEE 802[1]. This work is a continuation of the former IEEE 802.1 Audio Video Bridging (AVG) Task Group and focuses on enhancements in Ethernet Networks for time-sensitive applications. Some relevant standards are: (i) Timing and Synchronization for Time-Sensitive Applications (IEEE 802.1AS-2020 (IEEE Std 8021AS-2020 Revis. IEEE Std 8021AS-2011, 2022)), which describes the mechanisms for improving the time synchronization in TSN; (ii) Frame Replication and Elimination for Reliability (FRER) (IEEE Std 8021CB-2017, 2017), which defines the mechanism for enhancing the reliability; (iii) Enhancements for Scheduled Traffic (IEEE Std 8021Qbv-2015 Amend. IEEE Std 8021Q-2014 Amend. IEEE Std 8021Qca-2015 IEEE Std 8021Qcd-2015 IEEE Std 8021Q-2014Cor 1-2015, 2015), with enhancements in time-based schedulers and, (iv) Forwarding and Queueing Enhancements for Time-Sensitive Streams, which specifies the Credit Based Shaper (IEEE Std 8021Qav-2009 Amend. IEEE Std 8021Q-2005, 2010)

[1] Time-Sensitive Networking (TSN) Task Group: https://1.ieee802.org/tsn/

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and Path Control and Reservation (IEEE Std 8021Qca-2015 Amend. IEEE Std 8021Q-2014 Amend. IEEE Std 8021Qcd-2015 IEEE Std 8021Q-2014Cor 1-2015, 2016).

Based on the previous standards, 3GPP defines the support of TSN in the TS 23.501 Rel.16 (3GPP, 2022), where new TSN Translators are defined in the data plane (Figure 1). The Device-Side TSN Translator and the Network-Side TSN Translator offer TSN ports in the edge of the 5G System and implement the TSN features (Time Synchronization, Hold-and-Forward, etc.) defined in TS 23.501 (3GPP, 2022).

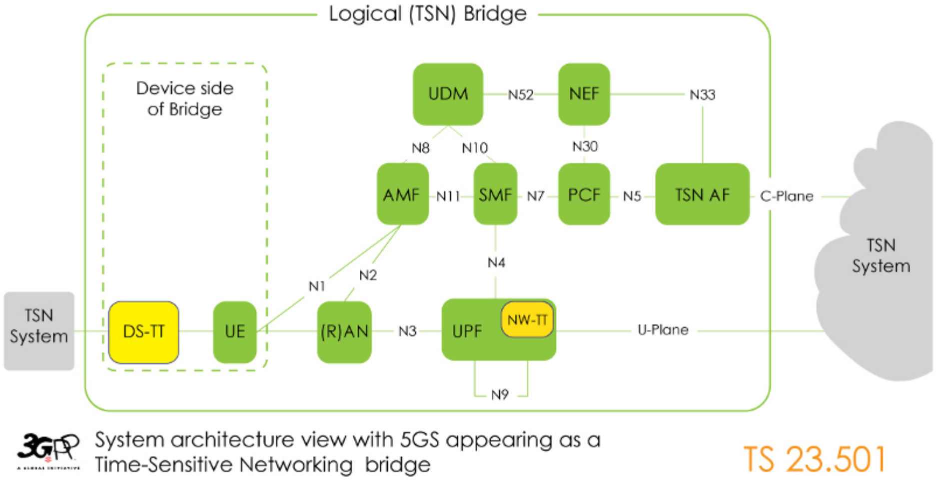

FIGURE 1: 5G SYSTEM AS A TSN BRIDGE

For IP networks, the IETF Deterministic Networking WG focuses on deterministic data paths that operate over L2 bridged and L3 routed segments, where such paths can provide bounds on latency, loss, packet delay variation (jitter), and high reliability. The scope of the DetNet WG includes: (*i*) overall architecture, (*ii*) data plane specification, (*iii*) data flow information model and, (*iv*) related YANG models. In the data plane, two standards are defined: (*i*) IP (S. B. B. Varga J. Farkas, 2020) and (*ii*) MPLS (J. K. B. Varga J. Farkas, 2021). In Rel. 18, 3GPP incorporates the support of DetNet for IP based PDU Sessions, as described in the Figure 2.

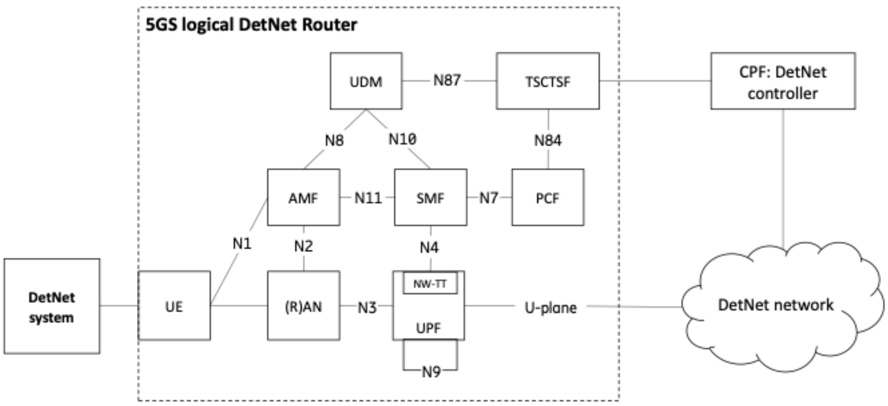

FIGURE 2: 5GS ARCHITECTURE TO SUPPORT IETF DETNET

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For Wi-Fi networks, IEEE 802.11 standardization groups have worked to enhance not only throughput, but latency and reliability too, with the addition of new features such as OFDM numerology, improved wireless time synchronization, target wake time (TWT), and multi-link operation defined in 802.11ax and 802.11be (Wi-Fi 6 and 7). These features can enable the implementation of TSN features such as time synchronization, thanks to the HW supported time stamping in time synchronization messages; time-aware scheduling, thanks to improvements in the control of the medium access to avoid long contention times by mechanisms such as OFDMA and TWT; as well as TSN redundancy through a single radio interface through multi-link operation (MLO).

1.3. Multi-SDO RAW extensions in the context of industrial scenarios

As described in the deliverable 6G-DATADRIVEN-04-E9 and in (Sofia, Kovatsch, & Mendes, 2021), industrial scenarios will likely benefit from standardized solutions providing reliable and available wireless solutions. Some of the required features are likely to involve multi-SDO integration, such as the use of 3GPP 5G network and WiFi or TSN segments, and/or the deployment of edge resources integrated with a DetNet/RAW network. This document provides some initial designs of the integration of edge and RAW networks.

The document is structured as follows. First, it has presented the current status in terms of deterministic networking support across different SDOs and domains. Then, we focus on the integration of RAW/DetNet and edge computing (taking Multi-access Edge Computing, MEC, as reference architecture). We conclude the document with a summary and potential roadmap of contributions and adoptions at the IETF and ETSI.

2. RAW and MEC integration

2.1. Problem statement

As described in more detail in the deliverable 6G-DATADRIVEN-04-E9 —we just summarize it next for clarity and completeness— a relevant exemplary scenario showing the need for an integration of RAW and MEC is the following. 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. MEC distributed computing capabilities can make available IT infrastructure as in a cloud environment for the deployment of functions in mobile access networks. Considering as well the distinct 5G use case of Ultra Reliable and Low Latency Communications (URLLC), Industry 4.0 is probably one of the so-called "verticals" that more clearly can benefit from URLLC features. As identified in (Bernardos, Papadopoulos, Thubert, & Theoleyre, 2023), 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 3 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. A heterogeneous wireless mesh network is used to provide connectivity inside the factory.

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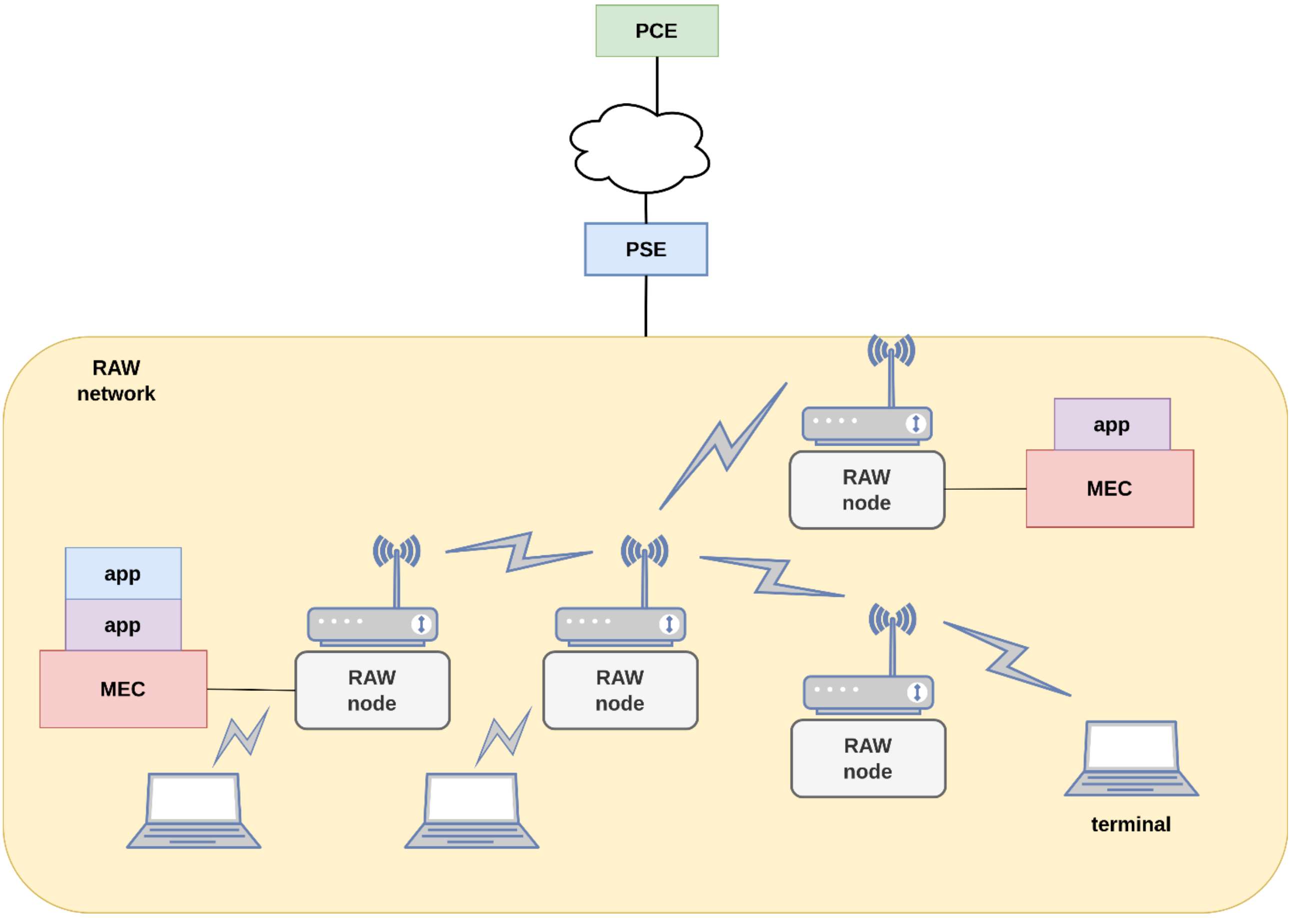

FIGURE 3: EXEMPLARY SCENARIO DEPICTING MEC AND RAW IN AN INDUSTRIAL ENVIRONMENTS

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.

2.2. Specific 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.

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- 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.

2.3. Problem Statement

For a more elaborated problem statement, please refer to section 4.2 of the deliverable 6G-DATADRIVEN-04-E9.

With current standards, solutions for the scenario depicted in Figure 3 would require the MEC platform(s) 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.

2.4. RAW and MEC integration: the solution

We define 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 4 allows the MEC platform to issue requests to the RAW network, through the RAW PSE, so it can behave as required by MEC apps.

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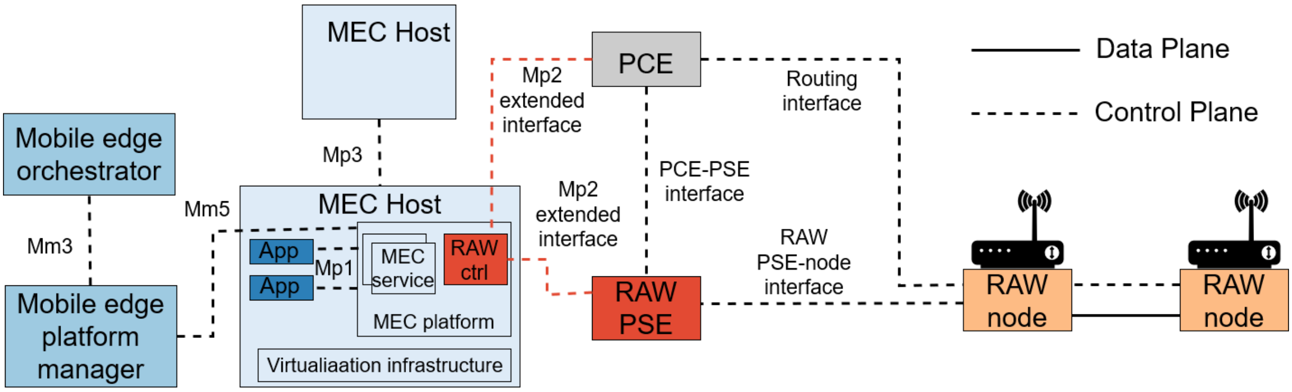

FIGURE 4: RAW AND MEC INTEGRATION: BLOCK DIAGRAM

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.

2.4.1. 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 5 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.

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```
+-----------+     +------+    +-----+    +-----+    +-----+    +-----+
|      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 5: 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:
    a. An ID for the given flow, which can be used for future near real-time update/configuration operations on the same flow.
    b. 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 (G. Tsirtsis, 2011).
    c. 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:

   a. assigning an ID to the flow;
   b. instructing the entry point in the RAW network to tag packets with that ID;
   c. 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.

2.4.2. 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.

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+-----+              +---------+       +----+     +-----+  +-----+  +-----+  +-----+
|     |              |     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 6: RAW OAM TRIGGERING MEC APP MIGRATION

Figure 6 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 (Theoleyre, Papadopoulos, Mirsky, & Bernardos, 2023).
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 transmitting 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.

2.4.3. Planned extensions

There are some additional extensions planed for the final deliverable (6G-DATADRIVEN-04-E16):

- MEC OAM for RAW updates (part of the baseline MEC and RAW integration which has been described in the present document).
- Terminal-based joint selection and configuration of MEC host and RAW network.

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3. Conclusions and IETF/ETSI contributions roadmap

This document provides a first specification of the integration of DetNet/RAW and edge computing, as a relevant example of multi-SDO extensions for Industry 4.0 scenarios. It is built on top of the deliverable 6G-DATADRIVEN-04-E9.

Initial contributions have been made to the IETF, presenting them in some meetings in 2022 and collecting very good feedback. A follow up presentation, as a result of the merger of RAW and DetNet WGs in mid-2023, is scheduled for IETF 118 (November 2023), after the delivery date of the present document.

Based on the discussions at the IETF, the adoption and progress pace of the RAW (though now it is closed, and RAW work has moved to DetNet) and DetNet WGs and the experience of the UC3M IETF delegate, we enumerate below a roadmap for contributions and potential adoption of some of these extensions:

- "Extensions to enable wireless reliability and availability in multi-access edge deployments. Internet-Draft," draft-bernardos-detnet-raw-mec (Bernardos & Mourad, draft-bernardos-detnet-raw-mec, 2023). Updates are expected in 2024. Depending on the final content of the DetNet controller framework how DetNet might recharter to take up additional RAW related work items, this document might be called for adoption in 2024.
- Additional related relevant contributions:
  - "Framework of Operations, Administration and Maintenance (OAM) for Deterministic Networking (DetNet)," draft-ietf-detnet-oam-framework (Mirsky, y otros, 2023). Updates are expected in 2023 to this document and its companion document in RAW (Theoleyre, Papadopoulos, Mirsky, & Bernardos, 2023). Publication as RFC is feasible in late 2023 or 2024.
  - "Deterministic Networking (DetNet) Controller Plane Framework," draft-ietf-detnet-controller-plane-framework (A. Mallis, 2023). This WG adopted document is expected to be updated in 2023 and 2024. Based on the discussions in the WG during IETF 118 and after that, it might be that multi-SDO requirements are also incorporated in 2024.

It is also worth noting that as part of the ETSI MEC 036 discussions and work there is the potential of some specifications including aspects similar to those specified in this document, though there UC3M is not actively participating, nor driving the discussions.

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