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Initial report on training activities

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Executive Summary

As a Marie Curie ITN project consortium, the WindMill team fully recognizes the essential role played by the scientific and career training of the young researchers (ESRs) involved in the project. This document reports on the outcomes of the various training events organized to the benefit of our ESRs, as well as the ESRs' direct feedback on these events.

1   Introduction

From the onset and owing to the project's nature as a Marie Curie ITN, WindMill's training program was considered an essential and integral part of the project's desired accomplishment. With young researchers' scientific training in mind, WindMill was conceived as an interdisciplinary and inter-sectoral project bringing the ESRs together with experienced professionals from the fields of communications and machine learning. Beyond the important career preparation aspects, the other key training elements aim at providing the ESRs with a wide palette of integrated interdisciplinary technical skills from the fields of machine learning and communications, giving them a problem based learning (PBL) edge, and making them capable of handling complex challenges arising from the design of future (beyond 5G) mobile networks.

Besides pure technical training, WindMill's objective in this workpackage is to provide ESRs top complementary skills training in areas such as business development, patent and intellectual protection, project management and collaborative team-work. We also aim to maximize the competitiveness of the ESRs on the job market by helping them enhance career awareness.

In the first year of WindMill's existence, the above objectives were tackled via a number of activities which are detailed in this document. The activities are organized around the description of the training sessions at two face-to-face project wide meetings as well as other activities which took place in remote fashion. The WindMill team also created tools to collect direct feedback from our ESR to evaluate the impact and organizational quality of our events, via questionnaires. Results from such questionnaire are also summarized in this document.

It should be noted that the bulk of planned activities did take place under conditions generally made difficult by the COVID-19 pandemic. For instance, some teams were not allowed to travel physically to the second face-to-face training event in Paris, forcing the use of alternative tools for on-line attendance. However the project team went to great length to make the most out of the difficult situation. For instance we have recorded all technical sessions and the ESR presentations and made them available to both project members as the general population through our website. We also have advertised them through LinkedIn and Twitter in order to maximize the impact. Besides serving as dissemination material, these videos proved great help to newcomers to the project and late hirees (such as the ESR with NBLF who is starting in September 2020) to help them catch up on the project work. The videos also allow the ESRs to revisit the training event content at their convinience.

2   Overview of year 1 activities

2.1   *Nature of training in WindMill*

The WindMill's training program distinguishes between **technical knowledge (TK)**, **transversal (TV)**, and **career management (CM)** categories of training contributions that are realized through various **training modules**: (A) knowledge sharing platform (or KSP), (B) network-wide training, (C) secondments, (D) local training whereby ESR are due to follow a set of technical courses made mandatory by the rules of their

respective doctoral schools (details on such courses are however not reported in this document), (E) external training, and (F) training by role-playing.

The interplay between the training modules is schematically illustrated in *Figure 1* below and described in continuation.
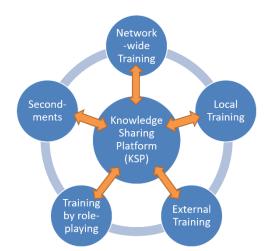

Figure 1: Inter-related ESR training actions under WindMill

2.2   *Training through face-to-face meetings*

In the year 1 of WindMill, two face-to-face network wide meetings were organized, both physically (pre-COVID crisis). The first one coincided with the project kick-off in Aalborg and took place November 2019. The second one, was hosted by NBLF in Paris, March 2020.

The content of these two training events is summarized through the two meetings' agenda which are given below. Both meetings included sessions dedicated to:

(i)   general advice to ESRs given by project's leaders,
(ii)   scientific talks of tutorial nature, often given by external invited speakers,
(iii)   career management sessions, to help boost the ESR awareness in the non-scientific domains that directly affect career developments,
(iv)   hands-on workshop sessions so ESR can collaborate while getting familiarized with leading machine learning implementation and simulation tools.

Career Management

Regarding (iii), a known external counselling agency, named Association Bernard Gregory (https://www.abg.asso.fr/en/), was hired which directly specializes in career counselling for PhD student and researchers. The focus was on the ability to identify suitable career options, ability to showcase one's research, connect with potential employers, write a proper CV etc. These sessions were organized as part of the second face-to-face meeting, in Paris.

<u>Interactive hands-on workshops</u>

Regarding (iv), an example of such hands-on session dedicated to a wireless resource allocation problem using reinforcement learning, is reported in Annex A.

Meeting #1 (November 2019)

Venue: Aalborg University

Day 1: 18 November 2019 – Introduction day

08:45-09:00   Welcome coffee and registration

09:00 - 09:20   Opening, welcome notes, orientation for the week (Elisabeth de Carvalho, AAU)

09:20 - 10:10   Visionary talk (Deniz Gündüz, Imperial College London)

10:10 - 10:40   Coffee-break

10:40 - 11:10   Introduction to WindMill: Summary of the project, e.g., key people, WPs, training events (Elisabeth de Carvalho, AAU)

11:10 - 12:00   Presentation of ESRs and their projects (Moderator, Cedomir Stefanovic, AAU)

12:00 - 13:00   Lunch break

13:00 - 14:10   Presentation of ESRs and their projects   (Moderator: Cedomir Stefanovic, AAU)

14:10 - 14:40   Coffee break

14:40 - 15:10   Presentation of ESRs and their projects   (Moderator: Cedomir Stefanovic, AAU)   Each presentation followed by a discussion with the participants

15:10 - 15:40   Rights and obligations of a MSCA fellow, Election of ESR representative (Moderator: Flora Champetier, AAU)

15:40 - 17:10   Filming of videos of ESRs and their projects (Moderator: Cedomir Stefanovic, AAU)

15:40 - 17:30   Supervisory Board meeting (TBD)   (Moderator: Elisabeth de Carvalho: AAU)

19:00   Social event

Day 2: 19 November 2019 - Transferrable and technical skills

09:00 - 09:30   ITN – a personal experience from a former ITN student (Nicola Piovesan, CTTC)

09:30 - 10:10   Scientific research: inspiration, research process, validating ideas, publishing (Petar Popovski, AAU)

10:10 - 10:40   Coffee break

10:40 - 11:10   ML for Communication Systems (Tim O'Shea, USA)

11:10 - 12:00   General introduction to AI and ML (Fernando Perez-Cruz, ETHZ)

12:00 - 13:00   Lunch break

13:00 - 14:10   Classic-not-deep-learning machine learning: SVMs, GPS, RFs, overfitting and generalization (Fernando Perez-Cruz, ETHZ)

14:10 - 14:40   Coffee break

14:40 - 16:00   Deep Learning: Deep NNs, Feedforward, Regularization from ridge to drop-out (Jakob Hoydis, NBLF)

16:00 - 17:00   Presentation of Knowledge Sharing Platform initial concept. Discussion session with ESR on how to develop the platform (Adriano Pastore, CTTC)

Day 3: 20 November 2019 - Transferrable and technical skills

09:00 - 10:10   TensorFlow (Jakob Hoydis, NBLF)

10:10 - 10:40   Coffee break

10:40 - 12:00   Exercise: Localization using deep learning (Jakob Hoydis, NBLF)

12:00 - 13:00   Lunch break

13:00 - 14:30   Writing and reviewing scientific papers (Jakob Stoustrup, AAU)

14:30 - 15:00   Coffee break

15:00 - 16:15   Data science platform Renku and research reproducibility (Fernando Perez-Cruz, ETHZ)

16:15 -16:45   Overview of website, social media channel (Elisabeth de Carvalho, AAU)

Day 4: 21 November 2019 - Transferrable skills

9:00 -10:15   Introduction to data management plan (Karsten Kryger, CLAAUDIA)

Meeting #2 (March 2020)

Venue: Institut Henri Poincaré, 11 Rue Pierre et Marie Curie, Paris, France

Day 1: 2 March 2020 – Introduction & Transferable Skills

08:45 – 9:00   Welcome, orientation (NBLF)

09:00 – 10:25 Meta-Learn to Communicate: Speeding Up Training for Communication Systems (Osvaldo Simeone, King's College London)

10:25 – 11:05 Coffee break

11:05 – 12:30 The Role of Sparsity in Big-Data Problems   (David Gregoratti, CTTC)

12:30 – 14:00 Lunch break

14:00 – 15:25 Deep learning for radio resource allocation in wireless networks (Alessio Zappone, UCAS)

15:25 – 16:05 Coffee break

16:05 – 17:30 Advanced Reinforcement Learning (Alvaro Valcarce, NBLF)

17:30 – 17:40 PhD Career Development (Bérénice Kimpe, ABG)

Day 2: 3 March 2020 – Career Counselling

09:00 – 10:25 Career Counselling (Bérénice Kimpe, ABG)

10:25 – 11:05 Coffee break

11:05 – 12:30 Career Counselling (Bérénice Kimpe, ABG)

12:30 – 14:00 Lunch break

14:00 – 15:25 Career Counselling (Bérénice Kimpe, ABG)

15:25 – 16:05 Coffee break

16:05 – 17:30 Career Counselling (Bérénice Kimpe, ABG)

14:00 – 15:30 Supervisory Board Meeting (Elisabeth de Carvalho, AAU)

19:00 – 22:00 Social event

Day 3: 4 March 2020 – ESR presentations and CommsRL workshop

09:00 – 10:25 CommsRL Workshop (Moderator: Alvaro Valcarce, NBLF)

10:25 – 11:05 Coffee break

11:05 – 12:00 Knowledge Sharing Platform (Michael Haugaard, AAU)

12:00 – 12:30 Fellows presentations (6 min each) (Moderator: Elisabeth de Carvalho, AAU)

12:30 – 13:30 Lunch break

13:30 – 14:15 Fellows presentations (6 min each) (Moderator: Elisabeth de Carvalho, AAU)

14:15 – 14:55 Communication Aspects in Industry 4.0 (Nikolaj Marchenko, Bosch)

14:55 – 15:35 Coffee break

15:35 – 17:30 Communication Aspects in Industry 4.0 (Nikolaj Marchenko, Bosch)

3   The Knowledge Sharing Platform

One of the activities planned for WP1, and one of the major milestones on Year 1, was the development of a so-called Knowledge Sharing Platform (KSP). The KSP is a new concept in itself in the context of EU projects (including ITN projects). It can be viewed as as 'Interactive Online Infrastructure' through which newly created knowledge will be allowed to circulate within and outside the network of project members.

Concretely, the KSP is a content publishing tool which promotes continued communication, first between the ESRs themselves so to keep mutual awareness of what everyone is doing research wise at any point of time in the course of the project. Another goal of the KSP is to reach out to the general public via dedicated section. The idea behind it to to sensibilize young researchers towards the value of high level communication to promote interactions and collaboration opportunities between ESRs as well as promoting high level messages arising from their research towards the external public, using blog type contents. In doing so the KSP gives a high visibility to ESRs' work and their research outputs, and serves as a showcase of their knowledge and skills in job applications. Finally, being a collaborative work concept, the KSP gives our ESRs first-hand exposure to the PBL model.

The software tool behind the KSP was developed in the recent months at AAU. The platform is now live since August 2020 and can be seen under https://ksp-windmill-itn.eu/ (caution: the contents are still under early development).

KSP and Training by role playing

An important point is related to the "training by role playing" dimension that our project wants to emphasize. Indeed we have engaged the ESRs in the design of the above platform by electing four KSP Champions amongst them during the March face-to-face meeting in Paris. These champions have the role of engaging the other ESRs in creating content on the website in order for it to really come alive.

4   Surveys and testimonies from the ESRs

As a measure of assessment of effectiveness of WindMill training program, several tools were created to the attention of the ESRs for them to react, comment, provide suggestions. In this section, we provide two example of surveys that were conducted in Year 1.

The first survey is aim to assess the quality of a specific event (the face-to-face training even, organized in Paris in March 2020. The second survey was realized in August 2020 and contains an open-ended question on ESR's view on overall training within WindMill.

4.1   Survey on training event organized in Paris, March 2020.

In the survey, and immediately following the end of our training event, the ESR were asked a set of specific questions regarding quality of presentation, relevance of the topics, quality of the organization etc. The full details of the survey results are appended in Annex B.

Based on this survey the following conclusions can be drawn. First the vast majority of ESRs seem to have greatly benefited from the training event and enjoyed it as well, giving it ratings between 3 and 5 (5 being the maximum grade) is almost all areas, with a clear majority of 4 point ratings.

Upon closer inspection it appears ESRs pay a lot of attention to the topics of the technical talks delivered by the external speakers that were invited. It is clear that they value higher topics that are directly related to their own field of PhD research, rather than neighbouring topics, albeit one might argue the role of the training event is also to expand the breadth of the ESR skills into wider range of topics, for their own career benefit.

Thirdly, their comments indicate that the notion of interactivity in the training is felt as rather important, in contrast to conventional one-way lecturing style. This comment can be debated by the project leaders and accounted for when inviting our next speakers.

4.2   Open-ended questionnaire on WindMill training programme

Over the Summer 2020 and in view of feeding the overall assessment of the WindMill training program for its first year of existence, the project's ESRs have been polled for comments and suggestions on how they see the training activities going forward, particularly in the light of the special sanitary measures taken towards COVID-19 protection and their implications on the organization of training events.

In the section below, their various responses are collected and briefly synthesized. Note that the order of appearance of the comments bears no relation with the ESR numbering in the project. Also note that the ESR feedback was not edited or redacted in any way. A synthesis follows.

Comment #1	The current seminar-like format of the training event has proven to be effective, allowing to fit numerous talks on relevant topics by prepared speakers. This is true for the first two days of the training event, whereas during the last days less technical matter is the focus. I reckon that it is necessary to discuss about Knowledge Sharing Platform and the like, but I don't think it fits the scope of a training event and therefore it should be discussed elsewhere (like conference calls). I really enjoyed the DRL workshop organized in Paris, it gave the opportunity to find out first hand how difficult could be to train a RL agent. I think learn-by-doing could play an important role in future training events. The biggest issues with having next training events online would be reduced networking opportunities due to the absence of informal talking during social events and coffee breaks.
Comment #2	So far we have had two training events, both playing a fundamental role in connecting ESRs and supervisors. First event focused on explaining/exploring different ML techniques and recent trends on wireless communication. At the same time, ESRs got to know each other and interact as a group. The second event was more interactive with a ML challenge and a poster section. This allowed ESRs to better understand each others work and contribute with basic ideas or literature references. I personally enjoyed more the second program which contained a nice ratio between technical and interactive sections. For the in-person meetings, I believe a good split for technical/interactive sections would be around 65%/35%. During interactive sections ESRs should have the time to discuss different lines of research, common problems that we all face during research, or maybe just discuss possible solutions/trends in a given topic. Take for example the coding challenge in the second event, I found the discussion aspect of that section very stimulating. There we had the opportunity to analyses different approaches for a particular problem. In the case next event happens virtually, due the current circumstances, I believe that shorter or fewer "talks" would be beneficial. I am keener to interactive discussions rather than recorded/virtual talks. However, in the case the latter are to happen, it seems interesting to allow for live questions.
Comment #3	The Innovative Training Program (ITN) for the Windmill project has provided me with a great opportunity to join a great research group, benefit from multiple training events, expanding my professional network and getting acquainted with other researchers and companies in the field of Communication systems. The two previous training events that were held in Aalborg and Paris were in particular very rich in the technical and practical aspects regarding the SOTA practices and Machine Learning (ML) applications in the Communication Systems. However, I believe the events were mostly focused on very specific applications in Communication Systems and didn't cover the subjects in ML that are directly related to my project. Therefore in my opinion the training was not sufficiently specialized and I could mostly benefit from the technical training in a general sense. I think one important piece that was missing from the first event was a lecture ML fundamentals that covers most of the topics that are relevant to the individual projects that are undertaken by the ESRs. On the other hand, The workshops on project/data management and career development were exceptionally informative and useful. While the (ITN) is mostly helpful with networking and collaborations as an early stage researcher in the field, the recent situation regarding COVID-19 outbreak will most definitely impact this aspect of it. However, there are multiple measures developed and readily applied buy organizations and universities to deal with this unprecedented situation that can be very helpful. Most of these approaches have passed their quality/convenience tests and have proven to be effective. For instance, holding virtual conferences with dedicated streaming softwares, online chatrooms and break rooms, socializing activities and poster presentation events were in particular very successful in the past few months. Therefore I believe if similar measures and methods are in place the impact will be mostly contained and not obstructive on the training events. However one important feature of the Windmill project is the secondments and the opportunity to join other

	institutions and work with different people in real life as opposed to virtually. I think this part of the program requires more care to facilitate the mobility of the early stage researchers and their adaptation to the new environment under new circumstances and regulations in different locations.
Comment #4	First of all I would like to say that I have gained good exposure through WindMill trainings. First two trainings and meeting were really appreciated. We, ESRs, asked for interactive sessions and we will still like to put forward the same suggestion. The speakers were renowned researchers of the field; we had career development trainings and it was good to meet everyone personally. However, since due to COVID-19, physical meetings are difficult, we would our career development sessions interactive with team and also on individual basis.

Moreover, we were also supposed to meet with the PO. We would also like to meet with her/him where we can all interact.

Technical speakers have been giving online sessions so it has become a norm. In this case, my suggestion would be ask speakers record their sessions and it would be good if we are given the access to the recording a day before so that we come prepared with our questions. In this case, I think it could be interactive. However, I am not sure if it would be feasible or not. :) |
| **Comment #5** | First and foremost, I would like to thank all the organizing teams for holding the training events so well. One of the best parts were the talks by experts in ML (diverse topics), however, In my opinion, if the guest talks were in line with the goal of Work packages, it would be more fruitful. The flexibility to choose topics that relate to what we want to learn right now may be a good option for ESRs . I personally, enjoy the career counseling and looking forward to the next sessions. The talk from industry was so interesting, but since it was the last talk, we could not get much out of it. The RL challenge was a very good idea, however, if we could first get familiar with a previously solved problem as a hint it would be better. All in all, I am very satisfied with the events. |
| **Comment #6** | My views on the first year of training program have been pretty satisfying. Due to the current COVID-19 crisis, I was not able to attend the Training event in Paris. I attended the Training event in Aalborg and it was incredibly informative and thought inducing as I got to interact with people across the whole consortium as well as invited guest speakers. I presented my project at the Aalborg event and received good feedback as well as suggestions which gave me more ideas in terms of research directions. Also the support regarding the administrative and technical side has been really good. The administrators have helped me in every way possible to get through the administrative and bureaucratic hurdles and my supervisor also has guided me in the technical fields consistently and eloquently. Regarding improvements for the next year, I would suggest if possible to have in person online meetings with all the consortium because it enables us to interact with the other members of the consortium aside from the ESRs. Aside from that, the training events can be made interactive similar to the training event in Paris wherein we were presented with a problem and asked to devise a solution for it before the event. It was incredibly interesting to pursue that solution. |
| **Comment #7** | I believe the Innovative Training Program (ITN) is one of a kind opportunity for researchers, and I am not an exception. So far, we have had a couple of fruitful training events in Aalborg and Paris. I have learned a lot of technical and even practical stuff and built a broad network of researchers and professors from different universities and companies. Consequently, I think the first year of the program was ultimately successful, at least from an Early Stage Researcher (ESR) perspective.

Second, given the unprecedented situation of COVID-19, I believe we need an adaptation in our strategies. I think this situation will impact the secondments as well as the training meetings sooner or later. But, I believe these two parts are two of the most fundamental objectives of the program. Regarding the secondments, I think having them online would not be that helpful. As ESRs, we need to experience doing research in other institutions and working with different people in-person to build our network and gain valuable experience. Regarding the training meetings, |

	although I think having them face-to-face would be much more beneficial for us, we also need to pay attention to the safety of the fellow ESRs, the administration team, and other people involved in the meetings. So, if the situation becomes unstable and worse, we can still have them as virtual training events.
Comment #8	My feedback regarding the training program is quite positive. I do not have anything to suggest so far since I couldn't expect any better. For the Covid situation, I expect virtual trainings as usual, but I believe there are ways to make it more interactive. For instance, a podcast manner to discuss technical subjects (instead of a common presentation followed by a QA section). A big brainstorming section for each of the ESRs could also be interesting.
Comment #9	From my opinion, the two training events we have had so far have been well addressed. The first one held in Aalborg was a first step to get in touch with the rest of the ESRs as well as the rest of supervisors. Also, from my perspective, the lectures relating state of the art machine learning applied in a wireless context were motivating. Note that making ESRs to present about their work and status is useful to see which collaborations can be made between ESRs, so the first presentation and the poster presentation of the second training event are a really positive aspect. With regards to the practical task assigned in the second event, I believe it was interesting for us to work together and have a plenary discussion afterwards. The balance between theoretical talks and practical sessions provided in the second event I think is perfect. For the future, online sessions due to corona problems, I guess it is better to stress the fact of having sessions that respect the balance between practical and theoretical ones. I think ESRs participation in terms of presentation should be taken into account. Maybe a session for discussing each ESRs topics and providing input for their PhD projects could be interesting. Theoretical lessons of course are of interest, however I think the shorter and the more direct to the point, the better. Also as a specific suggestion for the next training event, I would suggest a session of discussing resources of information for learning machine learning in a wireless context.

From the above, the following conclusions can be drawn: First, as it appeared from the first ESR survey of March 2020, the ESR generally have a very positive attitude towards the training programme and confirm the importance it carries within the overall project objectives.

As it appeared from the initial survey, ESR express a need to see talks that directly answers scientific concerns they have from their own specific PhD subject. However, the projects leaders believe there is also a need to broaden perspectives to favour inter-disciplinarity. This is a compromise that will have to be debated in the next meetings.

ESRs also stress the importance of hands-on interactive work, such as in the workshops. This needs further consideration, also accounting the fact organization of this type of events is the most affected from COVID-19 related travel restrictions, as opposed to standard lectures which are more easily organized in on-line remote fashion.

Finally, the comments express some worry at the prospect that the organization of secondments could be partly hindered from COVID-19 restrictions. The project board will take up this topic at the next meeting to make sure ESR's expectations can be satisfied and provide reassurance that secondments can be adapted and can occur.

5 Conclusions and Outlook

Despite facing a difficult worldwide sanitary context having affected the organization of meetings, the training program planned under the WindMill DoW went almost fully as planned. The project members recognized the quality of the proposed presentations as high-level expert speakers were brought in to participate to the face-to-face sessions. Educational workshops were also organized which allowed the ESR to gain the necessary confidence in testing their ideas going forward. The feedback obtained from the ESRs is quite positive. The concept of interactive workshop appears especially useful. ESR generally bring our attention on the problem of having presentation that focus more narrowly on their specific fields of research versus broader fields (still within the realm of machine learning for wireless networking) for which a debate among project beneficiaries will be organized at the next face to face meeting.

Annex A: Program of hands-on machine learning workshop (Paris meeting)

This workshop was intended as a forum to present and discuss the Reinforcement Learning solutions proposed by the participants to a well-known problem in wireless communications. The chosen problem is time-frequency resource allocation. The solutions proposed by the participants will be scored against each other and compared against several baseline non-RL solutions provided as a reference. The objective of this workshop is to reach a consensus of the characteristics that the optimum RL solution should have, how computationally expensive it would be, and how much of an advantage it would provide against well-established non-RL approaches.

The CommsRLTimeFreqResourceAllocation-v0 environment

Allocate radio resources to UEs.
On each episode of this environment, the agent must allocate N_f downlink frequency resources to User Equipments (UEs). This takes place in a free-space scenario with K UEs, where each UE has specific traffic requirements (some require high guaranteed bit rates, others low packet delivery delays, etc.). This recreates a well-known case of OFDM resource allocation, where a MAC scheduler allocates frequency resources to UEs under different radio conditions.

MDP dynamics
At the beginning of an episode, K UEs are scattered randomly throughout an empty Euclidean space containing a BTS at coordinates (0, 0). The BTS transmits with EIRP=13 dBm and the space is of size 1 km$_2$ centered around the BTS. The carrier frequency is $f_{carrier}$=2655 MHz and the system bandwidth BW=5 MHz. The transmit power is distributed equally across all PRBs. Free space propagation is assumed and the UEs move at random speeds in random rectilinear trajectories throughout the environment (bouncing off the edges at specular angles). The UE speeds are normally distributed as described in Table 2 of [1] for *Overall* pedestrians in Location 2.
Each episode begins at time step t=0 with p=0 and TTI=0, where p denotes the current PRB being allocated and TTI is the Transmission Time Interval. One TTI is assumed to last 1 ms exactly. The environment is then time-stepped and the TTI counter is increased by 1 when $p=t \bmod N_f$=0. The environment is run indefinitely (i.e. for a very large number of time steps).
When the environment starts, each UE gets assigned a random QoS Identifier (QI) class from a total of 4 QIs. This assignment is uniform (There are exactly K/4 UEs of the same QI and all QIs are assigned).
On the first time step of each TTI (i.e. when $t \bmod N_f$=0), the environment generates (or not) new traffic packets for each UE according to their QoS Identifier class (see Table 1 below). These packets are then added to the UE's traffic buffer. A packet size in a UE's buffer decreases each time step according to the UE's spectral efficiency and to the number of radio resources allocated by the agent to the UE. The maximum number of packets that each buffer can store (i.e. its buffer size) is defined as L=100.

Observation space
The state vector is a concatenation of vectors providing the following information at each time step:
Channel Quality Indicator (CQI) of each and all UEs. $q_k \in [0,15] \ \forall k \in [1,K]$
Sizes (in bits) of all packets in each UE's buffer. $S=(s_{k,l}) \in \mathbb{R}_{KxL}$, where $s_{k,l}$ is the size of the l_{th} packet of the k_{th} UE. S is flattened in row-major order in the state vector. Ages (in TTIs) of all packets in each UE's buffer. $E=(e_{k,l}) \in \mathbb{R}_{KxL}$, where $e_{k,l}$ is the age of the l_{th} packet of the k_{th} UE. E is flattened in row-major order in the state vector. QoS Identifier (QI) classes of each and all UEs as a one-hot vector. $c_k \in [0,1,2,3] \ \forall k \in [1,K]$. The QI classes are given in Table 1.

Table 1 : Traffic characteristics of each QoS Identifier class **QI classes**	**Resource Type**	**GBR [kbps]**	**Packet Delay Budget [ms]**
3 or [0,0,0,1]	GBR (*Conversational Voice*)	29.2	100
2 or [0,0,1,0]	GBR (Conversational Video)	1250	150

Annex B: Survey on quality of training even in Paris, March 2020

See next page

ID	1	2	3	4	5	6	7	8	9	10
In the WINDMILL Project you are...	An ESR	An ESR	An ESR	A supervisor	An ESR	An ESR	An ESR	An ESR	An ESR	A supervisor
How did the event meet your expectations?	4	4	4	5	4	4	4	4	3	4
Please elaborate on your rating if below '3'						All in all, the event was really good. There were some obvious improvements in comparison to the Aalborg Event. I like the career development part as well as the meta-learning talk				
How would you rate the venue for the event?	4	4	4	5	4	5	5	5	3	4
Please elaborate on your rating if below '3'						There were some renovations which caused some inconvenience.				The venue itself was nice and well-located. However, I didn't like the lunch solution: to avoid delays and for the sake of "team-building" I would have preferred we had booked somewhere, even if still paying separately.
How would you rate the information given prior to the event?	4	4	4	5	5	5	5	5	2	4
Please elaborate if your rating is below '3'					Perfect!				It is too late to get reschedule information. However, I can	
Are you satisfied with the duration of the event [3...? Please elaborate if your rating is below '3'	3	4	3	3	3	4	5	3	3	2
					It could be like 5 days. It's pretty obvious that it was					I think it's too short for the ESRs.
How would you rate the content of the event in general?	4	4	4	5	4	4	4	4	4	4
How would you rate the speakers at the event in general?	4	4	4	5	4	5	5	4	4	4
Do you feel the sessions were interactive enough?	4	4	4	2	3	4	5	4	4	4
How would you rate the social event?	5	5	3	4	4	5	5	5	5	5
Which sessions did you find most interesting or useful? Please provide the sessions title(s) and a short explanation of why.	The first presentation of Prof. Simeone was very good dictated and explained. Besides, the subject was very interesting as well.	Meta learning ==> informative.	I think career development training was good and also the sessions by Simeone and Zippone	Technical presentations during the first day were of very high quality and I enjoyed them a lot.	Meta-learning. It was closely related and really interesting for me.	Talks given by Alvaro and Simeone were highly aligned with my research interest and therefore I found them extremely interesting	I found the following topics interesting: 1. Meta-Learn to Communicate: Speeding Up Training for Communication Systems. 2. The Role of Sparsity in Big-Data Problems. 3. Model-aided Deep Learning for Radio Resource Allocation in Wireless Smart Radio Environments. They were technical and helpful for research	The Role of Sparsity in Big-Data Problems. Because it applies to my research topic and I think it was quite well structured.	Meta-Learn to Communicate: Speeding Up Communication Systems	I'll answer the other way round! I'm not sure I see a lot of value in Nikolaj's presentation, which was too focused in what Bosch does and does not. Instead of analysing communications in Industry 4.0 in a more "technical" sense.
Please rate the didactic value of the assignment	5	3	3	4	4	4	4	4	4	4
How could the assignment and the workshop be improved? Please elaborate.	Nothing to add.	First, ask ESRs if it the assignment is in line with their studies or not. Or give some more general assignments.	The workshop was nice but it was not as interactive and informative because most of the ESRs knew the background theory. We could have tried to solve the RL challenge or at least tried to discuss more about it	I did not participate to it.	Maybe be by having more interactive workshops.	I feel we may get to learn more if the problem for the assignment would be simpler than this time. Regarding the workshop, it was good.	I do not think it should be improved. It was fine.	The workshop is quite good.	The workshop is quite good.	As a supervisor, I'm answering these questions (0.15–0.7) based on my conversations with the ESRs at my institution.
Please rate the career counselling session	2	4	4	NA	5	4	4	5	3	3
How could the career counselling session be improved? Please elaborate.	I think the career counselling was too much focused on a French system, but the whole market or industry is very different of the French way. I believe it can be improved by, for example, giving more emphasis in entrepreneurship	It was fine.	It was nice interactive session. It could be more specifically targeted for the project domain instead of general. We would like to hear from such people who were from our field and if they could share their experiences as a part of career counselling, more importantly researchers who are in companies	I cannot comment on this since I did not attend it.	I have no idea)	In my opinion, there should be more interactive sessions and discussions rather than presentations.	I think it was really good. Better than I expected at the beginning.	The information provided by the speaker was too abstract to use. If we could invite some new graduated PhD to share their career planning experience, it may be useful.	We could invite more local researchers from the host institute to share their latest work or experiences.	As a supervisor, I didn't attended the counselling session. I answered 0.18 based on the feedback given by the ESRs I talked to.
Would you like to have some more longer and	3	2	3	1	5	5	1	3	5	5
How do you think the event could have been made more effective or relevant?	Bringing not only professors, but also some CEO's of big companies, Start ups, etc.		We were really looking forward to meet the project officer but unfortunately we couldn't. The event could have been better that way. I think it was still a good job by organisers to arrange sessions	I think it was good. I whished that there were more technical discussions among ESRs.	More talks. More interactive workshops		The event was good. Event could have been more effective through more interaction between the ESRs and speakers. Overall, the event was already	I think that a discussion of current papers tendency in the field could be relevant. Then we can learn how to assess quality of papers.	Plan early and invite the potential speakers as soon as possible	I think Alvaro's and David's workshops (including the assignment previous to the meeting), because the ESRs seemed to enjoy the practical aspect of it and they had probably acquired some background that made easier for them to follow the on-site part of the workshop. An other
Comments and suggestions (including activities, presentations or initiatives you think would be useful, for the future)	Creating a brainstorming session.	Planning was very good this time.	We have discussed it mostly in the sessions and during knowledge sharing platform session. Other things I have mentioned above too. But I would take the opportunity to mention here that this time we couldn't do much networking because of the lunch outside and coffee breaks outside the venue. We could've effectively interacted with speakers and other people if that was not the case. There hardly were any supervisors in the meeting. It is always good to meet them too and talk to them	NA	Having more talks by distinguished researchers and professors.	--	1. The length of presentations shouldn't be increased more. 2. Instead of printing the posters, carrying them all the way from different countries, we can show the posters or the presentations on the multimedia.	Long presentations like the last one should be provided at the beginning of the day. Poster presentation was good. Maybe more time to explain a poster in the future.	I would continue with the workshops (including the assignment previous to the meeting), because the ESRs seemed to enjoy the practical aspect of it and they had probably acquired some background that made easier for them to follow the on-site part of the workshop. An other	I would continue with the workshops (including the assignment previous to the meeting), because the ESRs seemed to enjoy the practical aspect of it and they had probably acquired some background...

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