MORPHEMIC

Exploitation Strategy

Modelling and Orchestrating heterogeneous Resources and Polymorphic applications for Holistic Execution and adaptation of Models in the Cloud

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Executive summary

This document describes the current Exploitation Strategy of the MORPHEMIC project results at the early phase of the project where industrial and research requirements have to be finalised for the MORPHEMIC technologies and provide a picture of the knowledge within the consortium at the end of July 2020. The exploitation strategy actions are grouped by the types of partner organisations within the MORPHEMIC consortium and for each of the main project results the specific paths for exploitation strategy are identified. As development of the technologies progresses and experience is gained from its use for industrial applications, further refinements to the exploitation plans described will be made by the project partners and reflected in scheduled WP8 deliverables on IPR and Exploitation Plan First and Final versions (D8.2 and D8.3) due at M18 and at M36 of the project.

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1. Introduction

1.1. Overview

MORPHEMIC proposes a unique way of adapting and optimizing Cloud computing applications by introducing the novel concepts of polymorph architecture and proactive adaptation. The former is when a component can run in different technical forms, i.e., in a Virtual Machine (VM), in a container, as a big data job, or as serverless components, etc. The technical form of deployment is chosen during the optimization process to fulfil the user's requirements and needs. The quality of the deployment is measured by a user defined and application specific utility. Depending on the application's requirements and its current workload, its components could be deployed in various forms in different environments to maximize the utility of the application deployment and the satisfaction of the user. Proactive adaptation is not only based on the current execution context and conditions but aims to forecast future resource needs and possible deployment configurations. This ensures that adaptation can be done effectively and seamlessly for the users of the application.
The MORPHEMIC deployment platform will therefore be very beneficial for heterogeneous deployment in distributed environments combining various Cloud levels including Cloud data centres, edge Clouds, 5G base stations, and fog devices. This approach allows for a path to early demonstrations and commercial exploitation of the project results.
The deliverable presented in here outlines the MORPHEMIC partners' strategy towards exploitation; the IPR table with the related exploitation plan is expected to be included at M18 and will be built on the basis of the strategy outlined in here.
The deliverable is organised as follows: In Chapter 2 we discuss the project's Exploitation activities by each partner following the partner main interests and potential benefit with the MORPHEMIC carried out work. In Chapter 3 we discuss the project's Exploitation approach outlining the Exploitation capabilities we can manage to build upon including in house open source and commercial tools that can help the team to achieve the proposed project objectives. In Chapter 4 we describe the identified MORPHEMIC Exploitable results, in Chapter 5 we outline the Exploitation Strategy Summary. Finally, we draw conclusions in Chapter 6.

2. Exploitation activities

2.1. Introduction

The MORPHEMIC project consortium comprises different types of partner organisations that will each undertake a set of actions for disseminating and exploiting the technological results from the project. The combined effect of these actions is expected to lead to the substantial take-up and adoption of MORPHEMIC technologies by the European industry.

The MORPHEMIC project consortium consists of three distinctly different categories of organisations with respect to interests and plans for dissemination and exploitation of MORPHEMIC project results. This combination of partners and interests enables the project to undertake a broad set of exploitation actions. The organisation types and the corresponding project partners are identified in Table 1.

Table 1: Organisation types of MORPHEMIC partners

Organisation Type	Partners
Research Partners	University of Oslo (UiO) Foundation for research and technology Hellas (FORTH) Institute of Communication and Computer Systems (ICCS) University of Piraeus Research Center (UPRC)
Industrial User Partners	IS-Wireless (ISW) Centre Hospitalier Universitaire Vaudois (CHUV) ICON Technology & Process Consulting Limited (ICON)
Technology Provider Partners	Engineering - ingegneria informatica SPA Activeeon Softeam 7Bulls InAccel

The exploitation actions that will be undertaken by project partners in each of the three categories are described below.

In general, the difference in targeted exploitation strategies between the three categories is found in exploitation for research partners, which focus on increasing their reputation to gain more attention in the research field in order to attract more students, post graduates and post docs as well as researchers to join the specific organisation. Research organisations can also cooperate with each other in order to perform research (either in terms of a specific research project or not). This could be in contrast to technology/industrial partners where the main issue is to sell a product or provide consulting services for a specific tool or technology.
In addition, this attracts industry to purchase R&D contracts in direct grant to such organisations. The strategy is that extended expertise being disseminated in a smart manner leads to increased contracts.

On the other hand, industrial partners both in the technology providing and in the user community target higher sales, increased market share and sustainable business with increased competitiveness as a final goal.

The following sections details the approach followed up by the different MORPHEMIC partners as though at month 8 of the project:
Section 2.2 Introduces the activities foreseen by the MORPHEMIC Research Partners
Section 2.3 Introduces the activities foreseen by the MORPHEMIC Technical partners
Section 2.4 Introduces the activities foreseen by Industrial Use Case partners and finally Section 2.5 Introduces the Alliance under evaluation to be joined to facilitate the aforementioned activities.

2.2. Research partners

The research partners within the MORPHEMIC consortium are each recognised as a leading European research organisation addressing cloud computing technologies, Faculty from these organisations routinely publishes research papers and is present at European and global events addressing cloud computing.
At the time of preparation of this deliverable in the early stage of the MORPHEMIC project, papers are already being developed describing technologies being addressed within the MORPHEMIC project by the research project partners and will be submitted for dissemination through upcoming conferences and journal publications.
The MORPHEMIC project results will lead to new research by the research partners, and these results will contribute to the continued evolution of cloud computing. The following sections detail the approach for each of the MORPHEMIC Research Organizations.

2.2.1. University of Oslo (UiO)

UiO is Norway's oldest and largest public institution of research and higher education with around 27 000 students and 7000 employees. UiO is ranked among the 100 top universities in the world, both regarding research and innovation. The University of Oslo has several National Centres of Excellence (CoEs), and is an active player in European research activities, with more than 100 projects funded so far in EUs Framework Programmes. Five Nobel Prize winners indicate the quality of the research at the University.

The Department of Informatics has a long history working on middleware engineering, adaptive systems, distributed systems, programming, simulation, and distribution abstractions for embedded systems, including Internet of Things. The informatics department has extensive research experience in Cloud computing and coordinated the Horizon 2020 project MELODIC developing a solution for Cross-Cloud management, deployment and adaptation of data intensive applications.

- Over several projects, UiO has implemented an open-source Learning Automata (LA) framework used for developing reinforcement based stochastic combinatorial optimisers. In particular, the LA solver is an exploitable asset. The framework and the LA solver are an integral part of UiO's research strategy and this legacy asset is to be expanded and used in MORPEMIC, as well as in future research projects.
- UiO will work on automatic utility function optimization. Utility captures the usefulness of the application as seen from the application owner. To be used for application management and control, it is often taken as a numerical quantity normalized to the unit interval. This value is implicitly computed as an expression over the deployment decision variables and the monitoring measurements reflecting the current application context. Prior to MORPHEMIC it was assumed that this expression was explicitly formulated as a utility function. Developing a good utility function capturing the application's business goals and value requires some

sophistication on behalf of the application owner DevOps and has proven a barrier for adopting utility based autonomic computing. UiO aims to find ways of capturing the user's goals and preferences, i.e., the application utility, through a set of *deployment policies* and parameters that will be iteratively refined using Fuzzy Set theory and the Analytic Hierarchy Process based on feedback from the user on simulated application deployments. The utility function automatically constructed from this interaction will then be further tuned against actual deployments and the measured application context. For instance, if the DevOps have indicated that the utility should balance deployment cost and application performance, then this balance is obviously wrong if the application performance is measured to be bad while the utility value stays high. It is anticipated that this work will lead to two exploitable assets: A policy interpreter generating the initial utility function for the application, and a utility function tuner. Both assets will be delivered as open-source software and promoted for use in future research projects.

- UiO will work on time series prediction applied to the measurements of the application execution context. Recent results show that the best predictions regarding both the range of prediction horizon and accuracy results from algorithms combining stochastic learning with statistical methods. However, the utility function and the constraints of the optimization problem involve many different measurement values. Each of these can be predicted individually, however there is a risk that uncertainties in the prediction will aggregate when combined in the utility expression leaving the predicted utility highly imprecise and useless for the Cloud application management. UiO will therefore investigate methods based on ensemble averaging and LA based regret theory for reducing the individual prediction uncertainties using several different prediction algorithms for each of the application context measurements. A variant of Newton's method will be derived to find the most likely point on the utility function surface as the predicted utility value. The implementation of these approaches will be made available as open source and exploited as an asset for solving complex prediction problems in future projects.
- The new knowledge generated by UiO will first and foremost be exploited in academic publications. It will also be used in training students. It is envisioned that 5 master students will be involved in the work on MELODIC.
- We envision to teach the new methods at tutorial workshops at relevant high-quality conferences like ACSOS[1], UCC[2], CloudCom[3], and CCGrid[4].
- UiO courses are traditionally focused on methods and theory and not on technology, and so it will be difficult to develop a dedicated course for Cloud computing, but UiO will actively integrate the knowledge into existing courses where possible starting from the third year of MORPHEMIC.
- UiO will definitely promote the project results as part of new, collaborative research projects and aim to create at least three new projects building on MORPHEMIC results and assets during the project duration and in the first two years after the project. Projects within Horizon Europe will be the prime target, but also projects with national funding allowing international collaboration will be an option, e.g., EuroStars and Joint Programming projects. The more fundamental research knowledge will used for applications to the Research Council of Norway.

2.2.2. Foundation for research and technology Hellas (FORTH)

The Foundation for Research and Technology Hellas (FORTH) established in 1983, is the largest and most prestigious public research centre of Greece with well organised facilities and highly qualified personnel. It consists of six research institutes located throughout Greece while its research and technological directions cover major areas of scientific, social, and economic interest. The Information Systems Laboratory (ISL), part of the Institute of Computer Science (ICS) in FORTH, combines expertise in knowledge representation and reasoning, database systems, net-centric information systems, exploratory search, provenance and access control, argumentation, and conceptual modelling. Service-Oriented and Cloud Computing constitutes a main research area of focus where many of the activities of ISL concentrate.

In the context of the Morphemic project, ISL aims to achieve the following exploitation goals which will transform to certain exploitation paths and related activities:

- *network expansion*: ISL concentrates on expanding its collaboration network through the partners of this project as well as their collaborating organisations. Such an expanded network will be then the main source

[1] https://www.acsos.org/
[2] https://dl.acm.org/conference/ucc
[3] https://2020.cloudcom.org/
[4] https://dl.acm.org/conference/ccgrid

for searching over possible collaborations that could take different forms in the near future, such as the writing of research proposals that can bring in additional funding in ISL & FORTH and well as a potential to further enhance its main research products.

- *knowledge transfer & consulting*: Knowledge transfer towards the industry is a key activity of the whole research centre of FORTH. In the context of MORPHEMIC, ISL will investigate with the assistance of its associated Praxi Network (https://praxinetwork.gr/el/) the interest of companies in Greece and Europe towards re-using and expanding on the main results of the project. To this end, it will undertake promotional activities in terms of relevant seminars and workshops so as to make companies aware of the main, exploitable results of this project. It will then engage in knowledge transfer & consulting activities with those companies interested in exploiting these results.
- *research product enhancement*: In the context of MORPHEMIC, ISL will enhance its CAMEL modelling framework towards supporting the modelling of polymorphic, multi-cloud applications as well as produce a new framework for the collection, further inference and matching of knowledge concerning software components and cloud services. Then it will follow an aggressive dissemination strategy towards communicating these results to the main research community as well as publishing them in open-source code repositories like GitHub. The dissemination strategy will enable to attract research partners that are interested in collaborating and uptaking these research results while their publishing will enable their re-use and possible enhancement by potential developers. It is expected that both activities will enable to enhance and further improve ISL's MORPHEMIC products as well as make them cater for additional domains and cases.
- *academic & internal exploitation*: The main project results will be the main sources for updating teaching materials in courses and making new courses, where possible, with respect to collaborating universities as well as for raising the interest of students towards pursuing MSc and PhD thesis with topics highly-relevant to the project results and potentially further enhancing them. In addition, training material will be also produced towards increasing the skills of both students in collaborating universities as well as R&D members of ISL in utilising the main technologies & results developed in the context of this project.

2.2.3. Institute of Communication and Computer Systems (ICCS)

ICCS is a non-profit research organization and hence doesn't focus on making profit from products or services. However, ICCS, by participating in the MORPHEMIC project, will focus on technology transfer, consulting and training, targeting both the academia and the industry. Specifically, ICCS in interested in:

- Transferring technology to industrial partners on flexible complex event processing from the perspective of monitoring complex and distributed application deployment topologies in fog computing;
- Training (i.e., education, seminars, workshops), as well as university courses through the association of ICCS with the National Technical University of Athens;
- Technology consulting in modelling, federated event processing, situation detection and reconfiguration decision making in cloud and fog computing scenarios.

ICCS intends to provide insights of the MORPHEMIC platform to enterprises and train them on how to use such a platform. ICCS can organize seminars and workshops in organizations which will aim at educating them on how to take advantage of innovative technologies to enhance modern organisations with valuable application deployments over cross-clouds and edge resources.

Training material on MORPHEMIC research areas is an internal exploitation opportunity for ICCS, through its association to the National Technical University of Athens. It is useful to have access to appropriate teaching material about up-to-date, scientifically valid, but practice-oriented topics. Parts of the MORPHEMIC software infrastructure can be used in lectures, for demonstration purposes or as practical exercises.

2.2.4. University of Piraeus Research Center (UPRC)

UPRC, as a non-profit academic institution, intends to be involved in challenging, real-life problems that extend its research interests to new areas and thus advance and proliferate scientific knowledge. UPRC addresses research in the domain of software engineering and distributed computing and collaborates with IT companies with the goal of delivering research outcomes into the business world.

Participating in the MORPHEMIC project is an opportunity for UPRC to interact with high level research/industrial partners, being introduced to real world use cases, and participating in the development of new technologies that can be exploited.

Moreover, UPRC as a research centre is interested in the advancement of cloud computing technologies, as this specific computing domain presents an ever-increasing demand and drives continuous innovation in all aspects of life and business. MORPHEMIC allows UPRC to contribute with its expertise and to interact with other partners who have experience and knowledge that will be very useful to further push on in its various research activities.

UPRC contributes to many technological projects on national and international levels. The experience gained during all those projects, our expert team comprised of passionate professors, students, PhD candidates and the technical environment are UPRC's main means for achieving the objectives of MORPHEMIC.

UPRC's participation in the MORPHEMIC project is in the context of its strategic plans in the areas of: (i) Education: the MORPHEMIC results will be proliferated among the attendants of the University activities, mainly among postgraduate and continuing education programs due to the advanced nature of the topics, (ii) Technology transfer to the Greek IT industry, offering technology transfer services to companies and public bodies through joint projects, and (iii) Technology promotion in the Greek industry as part of an effort to increase the adoption of MORPHEMIC technologies. Moreover, UPRC has close and strong collaboration with commercial, industrial and public organizations providing specialized scientific expertise and innovation to improve and enhance products and services.

2.3. Technology partners

2.3.1. Engineering - Ingegneria Informatica SPA

Engineering is the largest Software and IT Services group in Italy. A considerable portion of its business is based on the development of cloud-aware applications and the migration of legacy applications to the cloud. Within the Engineering Group, the company providing managed operation services to our customers is called Engineering D.Hub and it manages more than 21000 servers on behalf of more than 330 customers.

Engineering will benefit from Morphemic activities and results for the:

- development of new generation, cloud native applications, exploiting the best cloud resources independently from the target cloud that will host the application,
- adoption of best practises for running our data centres and providing IT consultancy services.

The knowledge and tools coming from Morphemic project will make it possible to build more accurate service delivery plans, accommodate for changes over time, tailor services for customers, deal with special and changing requirements, better target investment plans, reduce the overall operational costs and increase the performance of the migrated applications and the satisfaction of the clients.

As a Cloud provider, the adoption of Morphemic knowledge and tools will help optimize the usage of resources in Engineering data centres as well as to monitor Engineering Cloud offering, improving it with respect to its competitors and keep it always aligned with client expectations.

2.3.2. Activeeon

Activeeon is an Independent Software Vendor providing innovative solutions for IT automation, acceleration and scalability, Big Data, Internet of Things, distributed and parallel applications. It serves national and international clients in various vertical sectors such as CEA, L'Oréal, CNES, Inra, Komatsu (US), Home Office (UK), La Française, etc. The product line includes:

- ProActive, a suite of software solutions available in SaaS mode: Workflows & Scheduling is a complete workload scheduler that distributes and simplifies the execution of applications, featuring a workflow orchestrator and a resource manager, also featuring data transfer and License cost optimization.
- Parallel Scientific Toolbox is a solution that allows the distribution and the acceleration of Big Data processing in R Language, Spark, Hadoop, Matlab, Scilab and others. on clusters, grids and clouds.

- Cloud Automation automates the deployment and management of complex multi-VM applications, managing heterogeneous and hybrid clouds (private, public, hybrid, multi vendors clouds) and it is fully compatible with Docker.
- Machine Learning Open Studio permits to design Machine Learning Workflows in an open studio, govern execution and enforce an extensive resource management of computing resources.

Activeeon is willing to capitalize over the MORPHEMIC project to improve the scheduling capability of the Activeeon product line. The ProActive platform will be extended with the additional infrastructure connectors engineered to handle the computing resources managed by the MORPHEMIC platform. The infrastructure connectors are expected to provide management capabilities for resource-constrained devices, such as IoT edge devices and integrate with Function-as-a-service (FaaS) frameworks. This development will be licensed under the GNU Affero General Public License version 3 (AGPLv3), as already enforced in the open-source version of the ProActive platform (ProActive Parallel Suite). This work will be then transferred to ProActive Workflow & Scheduling (PWS) and Machine Learning Open Studio (MLOS) commercial offers.

Advanced orchestration features may be integrated in the ProActive Cloud Automation (PCA) product for a commercial exploitation. The licensing models of these features will conform with the ones currently operated for PCA. A dedicated training and helpdesk offer will be proposed as part of the Activeeon commercial support services.

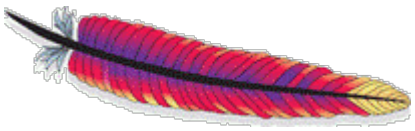
2.3.3. Softeam

Softeam plans to industrialize its modelling tool solution Modelio[5]. Modelio will be used and adapted with a new module for CAMEL modelling within MORPHEMIC.

SOFTEAM plans to use its open-source tool Modelio (www.modelio.org) and adapt it in the MORPHEMIC project in order to include new CAMEL functionalities (e.g., modelling, design and requirements) within the CAMEL modelling context. SOFTEAM's exploitation business plan will be based on an open-source solution that will help to attract the interest among open-source communities as well as on a commercial licensed solution with advanced capabilities to be provided after the project end.

The Modelio core, which is mainly the modeler and all the necessary components, is licensed under the GPL license. The GPL license requires that the destination software reusing the code also to be open source under GPL. Any distribution that includes elements of the Modelio core must therefore also be distributed under the GPL license (except the original author, who may publish his software under several different licenses).

The Modelio Module Runtime is code that is embedded within Modelio modules. It manages module lifecycle and provides a rich Modelio-handling API. This code is distributed under the Apache Public License (APL) which provides a very large degree of freedom to anyone wishing to reuse and embed the code.



Every Modelio module includes the Modelio Module Runtime. These modules can be distributed under any license, whether commercial or open source, due to the openness of the APL license. For example, they can be under APL or GPL open-source license, or sold under a commercial license, or free under a commercial license.

Modelio MORPHEMIC solution advanced features may also be offered with a commercial license. Within the SOFTEAM exploitation strategy, new functionalities could be added to a MORPHEMIC Modelio commercial module. This decision is not final yet.

[5] https://www.modeliosoft.com/en/

2.3.4. 7Bulls

7bulls.com Ltd. is a private Polish company specializing in software development and integration of IT systems. Founded in 1999, 7bulls was listed among the winners of Deloitte Technology Fast 50 Central Europe in 2012. The strongest competence of 7bulls is complex IT systems, mostly for large organizations. 7bulls is certified R&D center in Poland and France. The strongest competence of 7bulls are complex IT systems for various commercial organisations as well as R&D type of projects. Recently, 7bulls has been strongly focusing on developing machine learning and data analysis solutions for commercial customers as well as setting up start-up companies. 7bulls is therefore bringing in its experience of working with advanced, complex IT systems dealing with data processing and analysis.

European projects:

- **MELODIC:** "Multi-cloud Execution-ware for Large-scale Optimized Data-Intensive Computing" (H2020, ICT-06-2016 Cloud Computing). MELODIC enables data-intensive applications to run within defined security, cost, and performance boundaries seamlessly on geographically distributed and federated cloud infrastructures. Serving the user's needs and constraints, MELODIC realises the potential of Cloud computing for big data and data-intensive applications by transparently taking advantage of distinct characteristics of available private and public clouds, dynamically optimise resource utilisation, consider data locality, conform to the user's privacy needs and service requirements, and counter vendor lock-in. In MELODIC, 7bulls was a key technology partner, and is responsible for maintaining the framework beyond the funding period;
- **Functionizer:** "Seamless support of serverless applications in multi-cloud" (Eurostars-2). The aim of the projects is to create a unique platform that will optimize and manage the deployment of serverless applications in multi-cloud environment. The platform will be dedicated to data-intensive business applications that experience temporary workflow peaks and could benefit from: (a) cost-efficiency and scalability of serverless architecture, (b) seamless, cloud agnostic allocation of resources between multiple cloud providers. Functionizer will be an open-source platform dedicated to application developers. 7bulls is carrying out activities aimed to implement its business strategy designed on top of the open-source framework, i.e., services related to support companies in creating, managing and deploying application in an optimized model.

Individual Exploitation Plan of 7bulls

- 7Bulls will take the lead as a chief platform maintainer in the collaborative work aimed to maintain the software with clear documentation, predictable versioning, regular releases, and community support. This business interest in the MORPHEMIC results will secure the sustainability and further development of the project outcome – one of the examples is that 7bulls is committed to develop and extend MORPHEMIC project as its own investment and using public funding (MORPHEMIC extension in regional, national and European projects).
- 7bulls will release MORPHEMIC software on an open-source license and will invest further in building the MELODIC/MORPHEMIC community to maximize take-up and relevant impact in the software industry.
- By the scope of applications and scenarios that can take advantage of opportunities offered by MORPHEMIC and synergy between MORPHEMIC and MELODIC, 7bulls will be able to generate commercial, social and research benefits to a wide audience of private and public actors.

As a sustainability leader, 7Bulls will lead the activities related to maintaining the MORPHEMIC software beyond the funding period. During the project lifetime, these activities will include:

1. Setting up the project website and producing advertising materials
2. Definition and revision of a detailed exploitation strategy
3. Coordination with the MELODIC consortium
4. Communication actions
5. Alignment with relevant standardisation activities
6. Engaging first committers and contributors from outside the Consortium

2.3.5. InAccel

InAccel, is a Private company founded in 2018 in Athens, Greece. InAccel is specialized in developing accelerators for machine learning, data analytics, data processing (compression, encryption) and databases. The accelerators from InAccel are also compatible with the widely used framework for distributed data processing Apache Spark. Spark can be used for data analytics and machine learning applications. InAccel's accelerators can be deployed under Spark

without any modifications of the source code. InAccel provides all the required libraries and APIs for seamless deployment of accelerators in customer applications.

InAccel is one of the first companies that provided accelerators as IP cores in the cloud for FPGAs and is an official partner of Amazon AWS, Alibaba Cloud and Xilinx. It was the first company that provided ready-use accelerators for Apache Spark on Amazon AWS. InAccel's accelerators support the new Amazon AWS FPGA instances (AFI images for F1), and Alibaba Cloud FPGA instances.

InAccel provides both readily available IPs for acceleration of machine learning and data analytics, and it can also provide customized solutions based on the customer's requirements. It has developed a unique FPGA orchestrator that allows automatic deployment, scaling and resource management of FPGA resources. InAccel contributes on the integration of the resource manager anf the hardware accelerators on the MORPHEMIC project.

The knowledge and tools coming from Morphemic project will make it possible to develop further the resource manager and integrate it into heterogeneous cloud infrastructures and well-established frameworks like the Activeeon ProActive Workflow & Scheduling (PWS) and Machine Learning Open Studio (MLOS).

It will also allow to explore the advantages of the developed technologies on several use cases, like machine learning, HPC and neurocomputing applications. InAccel plans to further promote the technology and expertise coming from MORPHEMIC in order to increase the market share on the domain of resource management for hardware accelerators. The development of novel hardware accelerators will also help towards the growth of InAccel in terms of its FPGA-based products.

Table 2: Technology developed in MORPHEMIC vs Potential Exploitation Market

Technology developed in MORPHEMIC	Potential Exploitation Market
Hardware accelerators for ML, Neurocomputing	Machine Learning accelerators
FPGA resource manager in heterogeneous infrastructure	Resource Managers for Cloud operators/vendors

2.4. Industrial Use Case partners

The following paragraph describes the point of view of the three MORPHEMIC use case partners, as first "customers" of the project solutions. Table 3 summarizes the various industry domains potentially touched/touchable by use case partners thanks to MORPHEMIC.
The industrial user partners are providing guidance in the development of the MORPHEMIC project results that will ensure the technologies developed will address the needs of their targeted industries.

2.4.1. IS-Wireless

IS-Wireless develops and delivers 5G networking solutions. The solution includes standard-compliant software and hardware required to build 5G as well as 4G telco networks by mobile network operators (MNO), mobile virtual network operators (MVNO), private institutions, municipalities and many more.

IS-Wireless specializes in software solutions for the Radio Access Network (RAN), which is the most costly, cross-disciplinary and challenging part of a telecom network. 1000x higher capacity can only be provided with a much denser RAN network, where spectrum is reused aggressively by numerous low-power low-cost Radio Heads. There exist various challenges to achieve these goals such as interference, assured and increased QoS, which needs to be provided at lower network CAPEX and OPEX. This makes RAN the critical part of 5G.

In order to make softwarized RAN networks fulfil the promised efficiency while reducing total cost of ownership (TCO), stringent requirements regarding its deployment and operation must be satisfied. These include tight dependency between components (such as low latency communication and location dependency), the need for virtualization to achieve higher deployment flexibility as well as run-time adaptability to tackle dynamic 5G scenarios.

The MORPHEMIC platform enables ISW's SD-RAN (Software Defined RAN) to fully utilize the benefits of virtualization. This is accomplished by optimized use of multi-cloud computing infrastructure through automating the

polymorphism of virtualized network functions (VNF/CNF), continuous and proactive adaptation of the deployment in the dynamic environment, as well as support for broad spectrum of demanding networking and computing requirements spanning from cloud to the Edge.

Business related benefits, cost saving, performance, reliability:
The MORPHEMIC platform will ensure close to the optimal balance between performance and costs for ISW's SD-RAN product. On one hand, it will be able to optimize the deployment costs (CAPEX) related to the design phase of network slices, which will be automated and simplified by adopting CAMEL formalism and Modelio design tool. On the other hand, operational costs (OPEX) will be reduced due to the flexible and optimized choice of the deployment form (e.g., VM, unikernel, container, FPGA), as well as real time adaptation to changing environment including both computing realm (monitoring and acting upon cloud platform behaviour) and application realm (monitoring and acting upon application specific events). In addition, thanks to the rich modelling and performance optimization capability of MORPHEMIC, it will be possible to design custom CAMEL models for different verticals with myriads of specific scenarios. As a result, MORPHEMIC will help ISW to address and expand quicker to new markets.

2.4.2. Centre hospitalier universitaire vaudois (CHUV)

The Laboratoire de Recherche en Neuroimagerie (LREN) operating at CHUV-Unil develops and applies neuroimaging analysis methods to study the role of human brain structure and function in neurological disorders and healthy aging. Their ultimate goal is to translate new research findings into clinical applications for early detection of neurological disorders. Under one of the research projects, LREN developed a methodological platform with processing pipeline for automated MRI multivariate and machine learning analyses of neuroimaging data. It has been used to federate data collected in enormous quantities around the world (European hospitals, memory clinics and international clinics) and process it in combination with genetic data. However, the implementation of this approach into clinical routine has been challenging. There is a significant gap between the research and clinical domains resulting from the shortages in data processing know-how and access to high-performance computing resources.

Through the Morphemic platform LREN will provide direct access for researchers and clinicians to the popular neuroscience packages (such as SPM https://www.fil.ion.ucl.ac.uk/spm/) and workflows developed within the lab for brain image processing and analysis (https://github.com/LREN-CHUV). While image processing usually demands high computing power and complex configurations, not always available at the research or clinical sites, the cloud computation with software-as-a-service applications helps to overcome this problem. Proactive adaptation within the Morphemic platform will help to optimize costs, running time and other metrics, depending on demand. Last, the hybrid cloud solution will allow building federated infrastructures connecting clinical and research centres. This technology is vital to enable safe data sharing for clinical and neuroscience research.

Business related benefits, cost saving, performance, reliability:
Around the world, clinicians and neuroscientists are generating a tremendous volume of data (e.g. Magnetic Resonance Imaging (MRI) brain scans), but unfortunately more often than not most of these data are under-used. With Morphemic, our applications will allow easier, faster and more cost-effective access to tools for data processing and analyses of brain-disease related data. The key benefit of the models generated in the cloud by these analyses are the collaborative identification of biological signature of diseases for more accurate diagnoses and personalized medicine.

2.4.3. ICON Technology & Process Consulting Limited (ICON)

ICON Technology & Process Consulting (ICON) was first established as a Computational Fluid Dynamics (CFD) services provider delivering simulation consulting to industry in all related aspects of fluid flow prediction. The engineering know-how and expertise developed over 25 years is now also supported by ICON own in house software development team who industrialise and customise open and closed-source software to drive client engineering product design. ICON solution package includes traditional proprietary software components, as well as innovative open-source technology, which has become increasingly widespread and attractive. Extraordinary reductions in the maintenance costs of performing CFD have been achieved for ICON's customers while also enabling product innovation at a much faster rate.

ICON also provides fluid simulation capability through its SaaS platform (platform.iconcfd.com) to customers worldwide ranging from automotive OEMs to pharmaceutical nozzle designers. iconCFD Platform currently leverages multiple clouds in an ad-hoc manner. Generally, the same computing resource is used for all aspects. Now, deploying resources based on the application type and requirements is not fully automatic. Hi-fi simulations can be dispatched to

available HPC whilst low-fi simulations are run on cheaper alternatives. The challenge MORPHEMIC should overcome is to minimize costs for the customers, and leverage cloud computing for aspects of the process such as machine learning in order to dynamically improve the reduced models provided.

Business related benefits, cost saving, performance, reliability:
Through a seamless cloud agnostic deployment capability, MORPHEMIC platform will improve the user's cloud experience for CFD applications. Proactive adaptation of resources will have an impact on both the time to result delivery but also on costs; indeed, it will open the possibility for the users to get simulation results and to deliver their projects much faster. The ability to deploy their workflows purely on cloud rather than on-premises installations will also potentially lower the installation and maintenance costs.

2.4.4. MORPHEMIC First Industry Domains

Table 3 summarizes the various industry domains touched/touchable by use case partners thanks to MORPHEMIC. The listed industry domains have a potential for improving the MORPHEMIC use case partner businesses with the work delivered by MORPHEMIC.

Table 3: Industry Domains for MORPHEMIC Use Case partners

	Use Case 1-ISW	Use Case 2 - CHUV	Use Case 3 - ICON
Application domains			
Telematics			
Aerospace			✔
Transport			✔
Consumer Electronics			✔
Energy			
Medical		✔	
Financial			
Manufacturing			
Product offers			
Development platforms	✔	✔	
Software design tools	✔		
Software analysis tools			
Hardware platforms			
Service offers			
System customisation	✔		
Application analysis		✔	
Application validation	✔	✔	
Application development	✔	✔	
Training	✔	✔	
Telecom	✔		

2.5. Alliance under evaluation to be joined

One example of collaboration under evaluation is http://heterogeneityalliance.eu/, the Alliance for addressing Heterogeneity challenges. The Heterogeneity Alliance is a network of research projects and organizations to share common and holistic view (reference architecture) on heterogeneity related matters and challenges, to jointly promote

solutions and research results in the domain and to deliver a Catalogue of assets which can be open-source software tools, methods and knowledge which are mapped to the functional blocks of the reference architecture to provide valuable solutions. Within the Alliance Reference Architecture and Catalogue we could check out all the tools and technologies shared with the community and choose the ones which may help you to create next-generation applications with heterogeneous architectures.

Another example of MORPHEMIC cooperation is H-CLOUD Community: https://www.h-cloud.eu/about/. H-CLOUD leads coordination and support activities for the consolidation and growth of the Cloud Computing research and innovation community in Europe, bringing together innovators, policy makers, cloud computing research, industry and users into an open, participatory and sustainable forum. The H-CLOUD Forum will strengthen collaboration to address challenges and opportunities at research, technological, policy, standardisation and organisational level to unlock the potential of cloud computing for all European stakeholders. H-CLOUD organises H-CLOUD Communication Task Force meetings each month starting from 28th May 2020. It is a great opportunity to meet Cloud Computing projects leaders and Communication Managers in order to share communication, dissemination and exploitation ideas, bring novel communication concepts and invite for various events.

3. Exploitation approach

3.1. Introduction

The key principles on which the MORPHEMIC project development work is based include the following:

- Using existing open standards wherever feasible
- Publication of interfaces used within the project
- Submission to standards bodies of any extensions or refinements made to standards so that these are adopted by industry
- Identification of benefits for Morphemic final users, SMEs and other organizations gathering their feedback and input in the various organized events

These underlying principles are manifested in the dissemination and exploitation planning for each of the technologies that are being developed within the project.

Achieving a good balance in the use of different exploitation paths will increase momentum for the partners in the Adapting and optimizing Cloud Computing applications marketplace[6] using MORPHEMIC results, which in turn will provide opportunities and benefits for each of the project partners.
MORPHEMIC will offer ISW smaller DevOps teams an open-source technology that will help them derive value from data by combining various Cloud levels. ISW will be able to use MORPHEMIC as their own asset or as an asset offered to their own customers. 7Bulls will demonstrate how the pre-processor can be included in the current portfolio of Cloud adoption services offered to commercial and public organisations with less advanced computing skills. New market opportunities also result from the optimal use of computing power and storage resources that can be prohibitively expensive for data or computation-intensive applications. Further market opportunity enabled by MORPHEMIC is related to the emerging market of data centre accelerators that responds to the need for more powerful systems. Thanks to MORPHEMIC, InAccel expects to be able to further expand the FPGA manager to support the automatic deployment of the hardware accelerators through the MORPHEMIC framework. Cloud users and especially clients of InAccel will be able to easily perform a design space exploration of the available options in order to increase the performance of their systems and reduce the total OpEx. MORPHEMIC framework integrated with InAccel's FPGA resource manager will enable to investigate the benefits of using hardware accelerators in the Cloud and seamlessly integrate them in respective applications so gain competitive advantage and provide better QoS.

3.2. Exploitation paths

At the time of this deliverable as the project is completing the first requirements analysis phase, the project partners have identified the exploitable technology components from the project and the appropriate and the dissemination and

[6] Forrester: Public cloud market will reach $191B by 2020 | ZDNet

exploitation paths that are envisioned. The project partners anticipate that four primary exploitation paths will be utilised, which are summarised in the following:

- **Promotion activities** – a MORPHEMIC technology specification is made available to industry to allow others to develop technologies that are complementary or interoperable.
- **Commercial product** – the technology partners within the project will make available to industry MORPHEMIC technology as a commercial product, or embedded technology within a commercial service offering.
- **Open-source product** – the project partners will make available to industry MORPHEMIC technology as an open-source product, submitted and made accessible through an appropriate open-source repository or forge.
- **Submission to standardization bodies** – a revision to an existing standard or a proposed new standard resulting from MORPHEMIC development activities will be submitted to an appropriate standards organisation.

All the above-mentioned path can be joint exploitation paths.

3.3. Partners' exploitation capabilities

The partners fully expect to be able to achieve successful dissemination and exploitation of the MORPHEMIC project results through their combined capabilities to address each of the four exploitation paths. These capabilities of the MORPHEMIC partners are outlined below for each exploitation path.

3.3.1. Promotion activities of the MORPHEMIC project for 2020

We are planning to disseminate project outcomes through industry events, such as: industry conferences, workshops, tutorials, direct meetings, etc. In the Coronavirus period we need to face the cancellation of many events and activities. Luckily, some events were moved into the on-line space, which is another opportunity to think about the project promotion and communication. In the first period of the project (2020) we have already confirmed and planned industry activities presented in the two sub-sections below (3.3.1.1. and 3.3.1.2.).

3.3.1.1. Industry events - confirmed (2020)

(1)

Name of the event	**OW2online'20**
Place of the event (city/country/on-line)	On-line
Date of the event	17.06.2020 - 18.06.2020
Kind of the event	An independent, global, open-source software community. OW2online'20 will bring together experts from around the world who focus on open-source software and its role in modern corporate information systems.
Kind of participation: Presenter	Softeam, 7bulls.com, Activeeon

(2)

Name of the event	**IEEE International Conference on Autonomic Computing and Self-Organizing Systems (ACSOS)**
Place of the event (city/country/on-line)	On-line
Date of the event	17.08.2020 - 21.08.2020
Kind of the event	ACSOS was founded as a merger of the IEEE International Conference on Autonomic Computing (ICAC) and the IEEE International Conference on Self-Adaptive and Self-Organizing Systems (SASO). The goal of the ACSOS is to provide a forum for sharing the latest research results, ideas and experiences in autonomic computing, self-adaptation, and self-organization.
Kind of participation: Tutorial organiser/presenter	UiO

(3)

Name of the event	**Serverless Days Online**

Place of the event (city/country/on-line)	Online (Warsaw)
Date of the event	03.09.2020
Kind of the event	ServerlessDays Warsaw is a developer-oriented conference about serverless technologies. ServerlessDays Warsaw is part of ServerlessDays (formerly JeffConf), a global series of events around the world fostering communities around serverless technologies. Each ServerlessDay is unique, organised by locals and not run for profit. They are run according the following principles: • Local – Run by local community organisers • Accessible – Financially and physically accessible to the community • Representative – Be representative of the broader community within which it exists
Kind of participation: Exhibitor	7bulls.com

(4)

Name of the event	**Serverless Days ANZ 2020**
Place of the event (city/country/on-line)	Online (Australia/New Zealand)
Date of the event	04.09.2020
Kind of the event	This is a family of events around the world focused on fostering a community around serverless technologies. Each ServerlessDay is unique, organised by locals and not run for profit. They are run according the following principles: • Local – Run by local community organisers • Accessible – Financially and physically accessible to the community • Representative – Be representative of the broader community within which it exists
Kind of participation: Exhibitor	7bulls.com

3.3.1.2. Industry events – planned (2020)

(1)

Name of the event	**Big Data Paris**
Place of the event (city/country/on-line)	Paris, France
Date of the event	14.09.2020 - 15.09.2020
Kind of the event	Big Data Paris is a trade show organized by Corp Agency, the event management agency for the consumer and business worlds.
Kind of participation: Exhibitor	Activeeon

(2)

Name of the event	**Cloud Computing World Expo**
Place of the event (city/country/on-line)	Paris, France
Date of the event	23.09.2020 - 24.09.2020
Kind of the event	Paris expo Porte de Versailles is Europe's largest exhibition complex in the centre of the Capital, and is renowned for its hosting of large-scale international events. The site is currently being renovated and will soon be an incredible place to experience, open to the whole city.
Kind of participation: Participant	Softeam

(3)

Name of the event	**FIWARE Global Summit 2020**

Place of the event (city/country/on-line)	Malaga, Spain
Date of the event	28.09.2020 - 29.09.2020
Kind of the event	The FIWARE Global Summit is one of the leading open-source conferences for entrepreneurs, public administrations, academia, developers, startups, and technologists.
Kind of participation: Participant	Engineering

(4)

Name of the event	**DeveloperWeek Global: Cloud 2020 (Seatle edition)**
Place of the event (city/country/on-line)	Seattle, USA
Date of the event	28.09.2020 - 29.09.2020
Kind of the event	DeveloperWeek Seattle: Cloud Edition is Seattle's premiere cloud computing conference, where 800+ cloud engineers, IT managers, entrepreneurs, and innovators will converge to discover this year's newest cloud computing innovations.
Kind of participation: Participant	7bulls.com

(5)

Name of the event	**DeveloperWeek Global: Cloud**
Place of the event (city/country/on-line)	Seattle, USA
Date of the event	29.09.2020 - 30.09.2020
Kind of the event	Cloud Conference is the premiere international cloud computing conference, where 3,500+ cloud engineers & developers, IT managers, entrepreneurs, and innovators will converge to discover this year's newest cloud computing innovations. DeveloperWeek Global Virtual Conferences already attract 2,000 – 4,000 attendees per event, and DeveloperWeek Global: Cloud is part of the world's largest virtual software developer event series.
Kind of participation: Participant	7bulls.com

(6)

Name of the event	**Teratec Forum 2020**
Place of the event (city/country/on-line)	Paris, France
Date of the event	13.10.2020 - 14.10.2020
Kind of the event	TERATEC brings together over eighty technological and industrial companies, laboratories and research centers, universities and engineering schools, who want to combine their resources in the strategic area of Simulation and High Performance Computing.
Kind of participation: Exhibitor	Activeeon

(7)

Name of the event	**API World 2020**
Place of the event (city/country/on-line)	On-line
Date of the event	27.10.2020 - 29.10.2020
Kind of the event	The API World 2020 Conference and Expo was created with the mission to be neutral and facilitate connections, knowledge, trust and business within the developer community of API providers and consumers.
Kind of participation: Participant	7bulls.com

(8)

Name of the event	**API Dev World**
Place of the event (city/country/on-line)	On-line
Date of the event	27.10.2020 - 29.10.2020
	AI Dev World will be the world's largest artificial intelligence dev event with tracks covering chatbots,

Kind of the event	machine learning, open-source AI libraries, AI for the enterprise, and deep AI / neural networks. This conference targets software engineers and data scientists who are looking for an introduction to AI as well as AI dev professionals looking for a landscape view on the newest AI technologies.
Kind of participation: Participant	7bulls.com

(9)

Name of the event	**Cloud Expo Silicon Valley 2020**
Place of the event (city/country/on-line)	Santa Clara, USA
Date of the event	4.11.2020 - 5.11.2020
Kind of the event	Diverse collection of expert sessions from cutting edge companies, covering topics such as: cloud, security, IoT, 5G trends, digital transformation, cloud, security, and many more.
Kind of participation: Exhibitor, Presenter	7bulls.com

(10)

Name of the event	**DeveloperWeek Global: Enterprise**
Place of the event (city/country/on-line)	Online
Date of the event	10.11.2020 - 11.11.2020
Kind of the event	DeveloperWeek Global 2020 is the world's largest virtual developer & engineering conference, where thousands of participants from across the globe converge online for 100+ keynote & technical talks, developer technology virtual pitch contest, developer awards, virtual hackathon, virtual expo, and prizes for supporting the developer community.
Kind of participation: Participant	7bulls.com

(11)

Name of the event	**DEVELOPER WEEK AUSTIN**
Place of the event (city/country/on-line)	Austin, USA
Date of the event	16.11.2020 - 18.11.2020
Kind of the event	DeveloperWeek Austin 2020 is the largest developer event in Texas and the South, with 2,000+ application developers/engineers, developer managers & executives.
Kind of participation: Participant	7bulls.com

(12)

Name of the event	**Data Science Conference Europe 2020**
Place of the event (city/country/on-line)	Austin, USA
Date of the event	16.11.2020 - 19.11.2020
Kind of the event	Data Science Conference Europe is one of the fastest growing data science and AI conference communities in Europe.
Kind of participation: Participant	7bulls.com

(13)

Name of the event	**IEEE Global Communications Conference Globecom2020**
Place of the event (city/country/on-line)	Taipei, Taiwan
Date of the event	7.12.2020 - 11.12.2020
Kind of the event	The 2020 IEEE Global Communications Conference (GLOBECOM) will feature a comprehensive technical and industry program covering the latest research and innovation in communication technologies.
Kind of participation: Presenter	IS-Wireless

(14)

Name of the event	DEVELOPER WEEK NEW YORK
Place of the event (city/country, on-line)	New York, USA
Date of the event	8.12.2020 - 10.12.2020
Kind of the event	DeveloperWeek New York is the East Coast's largest developer & software engineering event with 3,000+ developers, engineers, architects, dev managers, IT professionals and tech execs. All will converge in New York City for a series of events covering the cutting-edge innovation in the developer technology industry: 6+ Conferences, Summits & Workshop Tracks, the 2-Day Expo, the DeveloperWeek New York Hackathon, Hiring Expo, and Partner Events.
Kind of participation: Participant	7bulls.com

(15)

Name of the event	Open-Source Summit Paris
Place of the event (city/country, on-line)	Paris, France
Date of the event	10.12.2020 - 11.12.2020
Kind of the event	The Paris Open-Source Summit is Europe's leading event dedicated to the fields of Open Source, free software and open innovation. Bringing together international experts, leading Open-Source companies and emblematic communities, the Paris Open-Source Summit has been a pioneer for about ten years in discovering and promoting the most innovative Open-Source technologies for digital transformation.
Kind of participation: Exhibitor	Activeeon (potential speakers Softeam, University of Oslo)

3.3.1.3. Scientific events and workshops participation planned for 2020

This section shows the scientific events and workshops planned for 2020, we identified the following conferences for promoting innovative approaches for addressing challenges and issues encountered while implementing different functionalities proposed by Morphemic. The Morphemic team will participate to the events if they take place. Due to the current covid19 situation, it is not known yet, at the time of writing this deliverable, if any of the planned events is confirmed. The consortium plans to attend and submit scientific work to the listed events in 2021 in case they will not happen in 2020.

Scientific events	
Name of the event	International Conference on Cloud Computing (CLOUD)
Date of the event	19/10/2020 - 23/10/2020
Place	Beijing, China
Name of the event	European Conference on Service-oriented and Cloud Computing (ESOCC)
Date of the event	28/09/2020 - 30/09/2020
Place	Heraklion, Greece
Name of the event	International Symposium on Cluster, Cloud and Grid Computing (CCGRID)
Date of the event	02/11/2020 - 05/11/2020
Place	Melbourne, Australia

3.3.1.4. Publication list planned for 2020/2021

We plan to disseminate project outcomes, more especially, scientific research through journals and conferences for promoting innovative approaches for addressing challenges and issues encountered while implementing different

functionalities proposed by Morphemic. The Morphemic project tackles different areas in computer science such us cloud computing, distributed systems, data-driven infrastructure and auto-adaptable systems. Therefore, there is a need to map project outcomes (publication) to journals or conferences according to the subject. A publication table has been created which contains the publication's element (author, description, added value...) to the potential journals and conferences where these assets can be presented and disseminated.

Publications	Targeted events
A Review of Real-Time Performance Monitoring Tools for Fog Computing	International Conference on Cloud Computing (CLOUD)
	MobileCloud Computing Conference
Polymorphic Modelling of Cloud Applications	European Conference on Service-oriented and Cloud Computing (ESOCC)
	International Conference on Cloud Computing (CLOUD)
	International Symposium on Cluster, Cloud and Grid Computing (CCGRID)

3.3.1.5. Social media

For the MORPHEMIC project a social media strategy has been designed and is being executed:

- LinkedIn, due to its professional nature, is the preferred MORPHEMIC social media channel. The MORPHEMIC presence on LinkedIn is carried out through a show case page dedicated to the project - the information on LinkedIn is published at least weekly, usually with 2 to 4 posts per week;
- Due to the fact that Twitter only allows its users to provide short messages, it is very efficient and the most popular social media channel for short announcements and messages – thus Twitter is strongly used as a MORPHEMIC social media channel. The MORPHEMIC presence on Twitter is carried out through a Twitter account dedicated to the project - the information on Twitter is published at least weekly, with a usual frequency of 2 to 4 posts per week. The information posted on Twitter is carefully structured to meet the message size limit;
- Facebook is the most popular social network in the world, so it is almost obligatory for any project to be present on that channel. The MORPHEMIC presence on Facebook is carried out by the Facebook page dedicated to the project - the information on Facebook is published at least weekly, with a usual frequency of 2 to 4 posts per week.

3.3.1.6. MORPHEMIC website

For the creation of the MORPHEMIC portal, modern web site construction methods have been used. The key method is RWD (Responsive Web Design). RWD consists of a combination of flexible grids, flexible images and media queries. RWD allows to create scalable web pages which are presented well on various web connected devices, both mobile and stationary ones, like smartphones, tablets, and monitors with, e.g., different screen resolutions. In addition, a web page can be viewed in both horizontal and vertical orientation. As a consequence, there is no need for different web page versions as a single version could be used on various devices.

The portal utilizes so-called “flat-design”. The MORPHEMIC portal is designed using a minimalistic approach, with a limited number of colours, gradients and graphic elements. Minimalistic, simple graphic elements are preferred and most widely used. This allows for the rapid loading of the content of the web pages, as well as the saving of bandwidth on mobile devices.

There are two deliverables directly related to the information about social media and websites:

- **D8.4 “Initial Project Website and Advertising Materials” [M4]** reports on information and activities related to the initial MORPHEMIC project’s web presence. It includes the creation of the MORPHEMIC website, the LinkedIn showcase page, Twitter activities, the Facebook page and activities. The document also briefly describes the methodology used for web presence creation with justification for its selection;
- **D8.5 “Final Project Website and Advertising Materials” [M34]** is the final version of the sustainability plan for a complete web presence of MORPHEMIC outside of the project. This deliverable will include the final statistics for the communication and dissemination channels.

There are two deliverables directly related to the dissemination and communication of the project:

- **D7.1 "Initial Dissemination and Communication Report and Plan" [M18]** which will describe and define measures, strategies and indicators that will be used for informing and increasing the impact of MORPHEMIC. An important aspect of the plan is to ensure stakeholders and participants alike get the most out of being engaged in the project. Furthermore, this deliverable will provide a roadmap for the dissemination activities carried out by all partners throughout and beyond the project;
- **D7.2 "Final Dissemination and Communication Report and Plan" [M36]** will be a full, updated version of the D7.1 including all activities implemented by consortium partners within the project, e.g., web presence, social channels, various media, scientific publications, scientific and commercial conferences, workshops, trade fairs, as well as on-line activities, like webinars.

3.3.2. Commercial products

The following section introduces the commercial product already identified as helping out the MORPHEMIC team exploitation capabilities.

3.3.2.1. IS-Wireless: Software Defined- Radio Access Network

The RAN developed by ISW will be utilized by end users or customers for a range of vertical applications under categories such as ultra-low latency critical communication, enhanced mobile broadband, device to device communication, massive machine type communication, cellular IoT applications etc. The software defined eNB/gNB will be implemented according to 3GPP defined 7.x split and utilized to enable the services as mentioned above. The software defined eNB, gNB includes layer 1, layer 2 and layer 3 of protocol stack which creates different set of network functions (NFs), including physical network functions (PNFs) and virtual network functions (VNFs) towards specific services. The formulation, as well as placement, of NFs contributes towards efficiency of network automation and services.

The MORPHEMIC project, by bringing means for customization and automation into network planning and provisioning, will provide the opportunity to ISW to enhance above mentioned aspects and deliver a more flexible and adaptable product. In particular, ISW's SD-RAN product will be able to reduce the deployment costs (CAPEX) but also operational costs (OPEX) through adaptive and proactive adjustment of the RAN deployment. Moreover, thanks to MORPHEMIC it will be possible to create multiple, CAMEL based, descriptors for various types of networks (e.g., private network, eMBB network, URLLC network, dense network) depending on the individual client needs. It will allow to address various vertical markets (eHealth, automotive, public safety, smart factories, smart cities), as well as telco operators' or integrators' policies regarding network scaling and evolution process.

3.3.3. Open-source products

3.3.3.1. Softeam's Modelio Modelling Tool Open-Source Version

Softeam will use and extend the capabilities of its Modelio modelling tool (www.modelio.org) in the context of MORPHEMIC. Modelio's yearly development budget is about €1 million and currently, the estimated number of users is about 80,000. Amongst others, Modelio is used by the European Parlement in Luxembourg and by several French administrations: ARSOE Bretagne, Asipsanté, CG 44, CNRS, CRP Henri Tudor, CA de la Rochelle, CTG (Bureau du 1er Ministre), Cemagref, DIRECCTE (Ministère du Travail), DGME, Gendarmerie Nationale, IFREMER, IGN, INRA, INRIA, INSEE, Hôpital St Louis, Infobiogen, John Hopkins PAL, Ministère du Budget – DGME, Ministère de la Défense – DIRISI, Ministère de l'Intérieur, and Météo France. Softeam's Open source Modelio tool (www.modelio.org) is composed of several modules, in this context the following Modelio modules could be used in open source:

Table 4: MODELIO Modules

Modelio Open Source Module	Description
Java Designer	Support of UML2 and Java 6, providing Java code generation and reverse functionalities, Javadoc generation and Java automation.
XSD Designer	Graphical modelling of XML schemas (XSD models), transformation of UML class diagrams into XSD models and generation of XSD

	documents from an XML model.
WSDL Designer	Graphical modelling of web services (WSDL models) and generation of WSDL code from a WSDL model.
TOGAF Architect	Support of the TOGAF Enterprise Architecture Framework, with dedicated editors for use in enterprise architecture modelling and TOGAF catalogue and matrix production.
SysML Designer	Support of the Systems Modelling Language - SysML for short - used to specify, analyse, design and validate systems and systems-of-systems.
UTP	Support of the OMG's standard test modelling language, providing test-specific concepts, dedicated artefacts and sequence diagram generation templates.
SoaML Designer	Support of SoaML, the SOA architecture modelling standard, with specific editors dedicated to SOA architecture modelling and architecture implementation model generation.

Modelio will be extended in the context of Morphemic with a new CAMEL Designer module. The extension will be very interesting for Modelio customers, as Modelio will extend its architecture modelling capabilities by embracing new advanced Cloud computing models based on a polymorphic combination of Cloud services of any type. By leveraging these new features, Modelio will help existing and new customers unlock value and drive their business forward at a faster pace. It will also become applicable to the new customer segment of public sector and e - government.

3.3.3.2. Melodic Platform

Melodic multi-cloud platform was developed in the H2020 project Melodic (31.12.2016-31.01.2020). Full title: “Multi-cloud Execution-ware for Large-scale Optimized Data-Intensive Computing”. It is a solution for autonomic and secure cross Cloud deployment, monitoring, and context adaptation of big data applications that require frameworks like Apache Hadoop or Spark by constantly watching their execution and ensuring an optimised mapping to the application’s goals and requirements. It is the DevOps companion for anyone who wants to benefit from the capabilities and the scalability of Cloud application execution without hassle, and at the same time be confident that the application’s data location respects the necessary privacy requirements and that the data can only be accessed by those authorised. Melodic, therefore, supports a mix of private and public Cloud platforms, and enables to execute application jobs where the data are located, thus reducing the job and overall application latency. At the same time, the application will stay responsive while jobs will be scaled as specified by the deployment goals of the application’s owning organisation.

Melodic is a tool that supports automated deployment of both data and application jobs processing the data based on the constraints set by the organisation owning the data and the application. It overcomes the difficult placement decision, it monitors the running application to ensure that it stays with the set constraints, and automatically adapts the application aiming to maximise the application’s utility for the owning organisation in the current execution context. Hence, Melodic is a DevOp robot that continuously tries to maximise the business value of the data. Melodic provides a level playing field where big companies, SMEs, and academia alike can all benefit from the cost reduction of the commercial Cloud offerings and scale their computations when needed. If you can conceive and develop an application that extracts value from data, then Melodic will take care of running your application! To profit from the value of available data entails running applications that process potentially large data sets, which may require significant investments in both storage and computing capabilities.

Alternatively, the application can use rented infrastructures in the Cloud, although it requires mastering the offerings of one or multiple Cloud providers and increases the complexity of maintaining the running application over time. In particular if the application needs to react to external events resulting in temporary needs for more computationally expensive analysis of the data. Not all data can be stored with third parties in the Cloud. There are legal constraints on personal data and consumers' privacy concerns, and there is commercial data. In addition, many providers charge if data is transferred in and out of their own Cloud than within their own infrastructure. Hence, it is a complex puzzle to find the right location for data with sufficient computing power. The above obstacles may prevent many companies from profiting from the value of their data or develop new businesses on commercially available or open data. In particular, it may make it difficult for Small and Medium sized Enterprises (SMEs) to compete in the data driven economy.

The Melodic solution is developed and extended after the project finalisation. 7bulls, as exploitation leader of Melodic project, is coordinating and supervising joint exploitation and sustainability of the Melodic solution beyond the project lifecycle using two possible options:

- independently
- by establishing a dedicated company named MELODIC solution Ltd., which is coordinating and controlling all exploitation activities for MELODIC-based offering to SMEs and big companies

Apart from the market extension of the Melodic solution, project extension will be done by partners' own investment and using public funding. Besides the commercial exploitation consortium of Melodic project built an open-source community for the maintenance and the extension of Melodic platform.
It will be based on the collaborative work of the partners coordinated by 7bulls.com that is a maintainer of the MELODIC platform and a leader of an open-source community around it. Melodic is not only integrating the already existing open-source frameworks into a unique easy to use framework but will also invest heavily in developing new critical features for optimizing and deploying cloud/hybrid applications. This investment will allow SMEs/large companies to focus on their services rather than implement from scratch the functionalities of Melodic into their applications. This makes it possible for SMEs/large companies to enjoy the benefits of multi-cloud deployments at affordable cost, massively, realising high economies of scale at the ICT industry level.

3.3.3.3. Federated Event Management System

ICCS will provide the Federated Event Management System at the edge with self-healing capabilities. It involves the extension of the Event Management System[7], developed in MELODIC H2020 project as flexible open-source framework which is able to cope with an unknown and unbounded number of monitoring events, aggregate, filter and correlate them in order to guide application adaptations according to any detected service level violations. The mechanism will be released for efficiently distributing over several virtualised resources that may span multiple cloud providers to monitor the deployment of multi-cloud applications and reconfigure them based on the perceived workload fluctuations and health status of the underlying infrastructures. This mechanism is flexible enough since it uses a hierarchical event processing approach to avoid message flooding incidents that may stall the processing of monitoring events and may delay the detection of optimisation opportunities in fog environments. ICCS will promote and exploit the Federated Event Management System through the association to the National Technical University of Athens, as part of undergraduate and post-graduate university courses. Moreover, the innovations of this system will be explained to industrial partners as part of the technology transfer from the research institute to Greek SMEs, regarding flexible complex event processing for reconfiguring complex application deployment topologies in fog computing.

3.3.3.4. ProActive Parallel Suite

Activeeon will provide the ProActive platform as a key enabler for the multi-infrastructure scheduling and resource management capabilities of the MORPHEMIC platform. It will support the consortium in this technology usage and integration through the implementation of the required features and consulting.

Two main components of the ProActive Parallel Suite will be used to support the Morphemic project:

- The ProActive scheduler will sustain the execution of the Morphemic pre-processor and the application reconfiguration process in the context of Edge environments,
- The ProActive Resource Manager will contribute to the management of operated infrastructure resources.

[7] https://bitbucket.7bulls.eu/projects/MEL/repos/upperware/browse/event-management

These two components integrate with each other and will be jointly used to facilitate the integration effort of the MORPHEMIC platform.

Activeeon provides and will continue to provide a free Community version with an AGPL License, as part of the OW2 Open-Source Consortium. Activeeon provides as well an Enterprise version to his customers and partners, for which the source code is as well available. With respect to the Morphemic project exploitation, Activeeon will provide an access to its needed background knowledge under the conditions agreed in the Consortium Agreement, allowing the exploitation by each partner of its project foreground results.

Activeeon is actively committed in the OW2 community, which provides an extensive support for ProActive technology development and industrialization. This community is a key enabler for the dissemination of MORPHEMIC project to the open-source development community and industrial actor interacting with it.

Activeeon customer base represents the spearhead of the dissemination and exploitation activity. The product line of Activeeon is a viable ground for implementing and a commercial transfer for the MORPHEMIC project outcomes. More specifically, the outcome of the Morphemic project will serve as a technical baseline for the deployment of large-scale and cross-centre applications. For this purpose, it will be implemented as an extension of the ProActive Cloud Automation product providing facility to deploy and control distributed architecture. The business model addresses the market of cloud automation and is based on licencing and support.

Finally, the project will also benefit of the exposure of Activeeon in technology fairs for the dissemination among actors of the public and private sectors to consolidate the platform commercialization.

3.3.3.5. Hardware Accelerator (FPGA)

The integration of hardware accelerators like FPGAs in the MORPHEMIC project will allow users to speed up their application seamlessly. The option to offload their applications on FPGAs, will allow higher throughput, lower execution time and better energy efficiency.

InAccel's unique FPGA orchestrator allows easy deployment, scaling and automated resource management of FPGA resources. InAccel will provide as open source the API that allows easy integration with high-level framework like python, Java, Jupyter and the MORPHEMIC platform. InAccel will also provide as open source the API for the runtime integration that will allow easy integration of FPGA accelerators to any other runtime system.

InAccel will promote the solutions and technologies developed during MORPHEMIC in the FGPA community and the cloud community. Specifically, InAccel will promote the new resource manager to FPGA-related conferences and venues like FPL, FCCM and FPGA. It will also promote the results of the project to cloud exhibitions with heterogeneous infrastructure.

InAccel will also commercialize the new hardware accelerators developed during MORPHEMIC like the ones for machine learning, HPC and neurocomputing.

3.3.3.6. Proactive performance modelling (UPRC)

Runtime analysis is a very important step for enabling any type of optimization and trade-off investigation. Moreover, all applications tend to be composite applications that consist of microservices. In this context and given the random nature of all possible application deployments, the performance model will allow the identification of resource usage patterns between atomic and composite services as well as the estimation and prediction of the required infrastructure resources related to the deployed application. Proactive performance model enables a data-driven infrastructure to plan the most suitable configuration of a cloud application within an acceptable interval of time in order to optimize cloud application for meeting application's objectives. UPRC's aim is to exploit methods, mathematical properties and engineering techniques of the proactive performance model approach for further scientific studies. Additionally, it will be utilized in different contexts (i.e., beyond MORPHEMIC) and applications / use cases in order to boost the potential exploitation opportunities. To this end, it will be applied to data-intensive banking and insurance related applications, following the bilateral collaboration of UPRC with various banks (e.g., Bank of Cyprus).

3.4. Provisions for the protection of intellectual property

Effective exploitation of project results can only occur if proper management of intellectual property is performed; for this reason, in the MORPHEMIC project a specific task is dedicated to IPR, viz., Task 8.2 Knowledge Management (IPR). IPR management activities have started right from the beginning of the project with two main activities which have seen the project partners discussing and agreeing upon:

- The Background brought by partners in the projects and information on how to access this specific background and if there are any limits or restrictions on such access.
- General rules regarding the ownership of results outcoming from the project.

The results of this first activity are going to be part of the Consortium Agreement.
To keep track of IPR and collect information about the exploitable assets the project produces, the Consortium maintains an *Exploitable asset and IPR registry* including all the exploitable assets and components being developed. For this purpose, the *Exploitable asset and IPR registry* is made up of two parts, one dedicated to the exploitable assets and one to the single components. For each exploitable asset the following information is collected:

- Name – the name given to the exploitable asset to identify it;
- Owner – the partner/s owner/s of the exploitable asset;
- TRL – Technology readiness level before the project start and at the moment of collecting the information;
- Hardware dependencies/constraints - if there are any dependencies related to the use of specific hardware for the exploitation of the specific asset;
- Dependencies with other MORPHEMIC assets – dependencies that need to be taken into consideration when planning exploitation strategies and analysing IPR;
- Licence – the licence the asset is released with;
- Short description – a short description of the asset including general non-technical information, i.e., who the asset is for, what it is for, why it is innovative and what makes it different from other existing solutions.

At the level of single components, the registry collects the following information:

- Name – the name given to the component to identify it;
- Part of Exploitable asset – The name of the exploitable asset the component is part of. In some cases, the asset and component may correspond, in other cases one asset may be composed of more than one component;
- Partner responsible – the partner responsible of the component;
- Licence – the license the component is released with;
- Third party subcomponents - any subcomponents owned by a third party that is used or is part of the specific component described;
- Subcomponent owner – the owner of the subcomponent which is used or is part of the specific component described;
- Subcomponent licence – the licence of the subcomponent which is used or is part of the specific component described;
- Subcomponent license conflict – if any conflict with the subcomponent licence has been identified and which kind of conflict.

The *Exploitable asset and IPR registry* are kept up to date with all the relevant information throughout the project lifetime.
The project is going to follow an open-source approach; for this reason, to support the IPR management activities the following table was prepared to provide the project team with a high-level picture of the currently most common licenses, providing some elements that need to be taken into consideration when choosing a license and when using other components:

Table 5: Available licenses

License	Acronym	Viral	Derivative work	Sublicensing	Allows code closure	Conflicts with other licenses
APACHE Public License	APL	NO	Allowed	YES	YES	YES Allegedly conflictive with GPL

GNU public License	GPL	YES	Must be GPL	YES	NO	YES Incompatible with EPL, APL and others
MIT	MIT	NO	Allowed	YES	YES	NO
Eclipse Public License	EPL	PARTLY	Must be EPL	YES (with restrictions)	NO	YES Cannot incorporate source code from MPL, GPL, LGPL
Lesser GPL	LGPL	YES	Must be *GPL	YES	NO	YES Incompatible with EPL, APL and others
Mozilla Public License	MPL	PARTLY	Must be MPL	YES	NO	YES Cannot incorporate source code from EPL, GPL, LGPL

Activity performed and results of Task 8.2 Knowledge Management (IPR) will be detailed in D8.2 Initial IPR and Exploitation Plan.

4. MORPHEMIC exploitable results

The main exploitable results from the MORHEMIC project are described below and grouped by the type of exploitation paths intended by the partners at this initial phase of the project. The groupings are as follows:

- Promotion activities
- Submission to standards body
- Commercial products
- Open-source products

4.1. Promotion activities performed

The following table summarize the dissemination activities occurred so far.

Table 6: List of public dissemination activities

No	Type of activity	Title	Leaders	Audience	Date	Place	Size of audience	Countries addressed
1	Ow2Conf Online	MORPHEMIC presentation	Softeam & Activeeon,	Industry, Academia	June 2020	Paris/virtual meeting	250	Europe, USA
2	Society for neuroscience	MORPHEMIC-Ebrain Science	CHUV	Academia	11-15 July	Glasgow	2000	Worldwide

4.2. Submission to standards body

During the first eight months of the project, the consortium focused on identifying those standardisation bodies which will be explored in terms of submitting proposals for extending existing standards or even promoting new ones. The bodies are the following:

- OASIS: this standardisation body was already identified during the project proposal writing as it includes a specific standard called TOSCA focusing on the modelling of (multi-)cloud applications. TOSCA is a potential candidate for extension in terms of following the type-instance pattern (models@runtime) and covering additional relevant domains which are already captured by CAMEL.
- OMG: Softeam is already an OMG member and participates in the task forces of OMG standards.
- W3C: FORTH is a member of W3C and hosts the W3C office in Greece.

During the second project year, after identifying the potential standardisation bodies of focus, the MORPHEMIC consortium will attempt to identify standards being promoted by them so as to potentially extend them. Once this takes place, the extension potential will be explored by directly communicating with the task forces of the identified standards; respective teleconferences might take place focusing on presenting the standards extension ideas that the MORPHEMIC consortium will have. Through such a communication, the most promising standard will be selected where more intensive actions will take place on its potential extension.

4.3. Commercial products

The following project results will be made available as commercial products from one or more of the technology partners within the project, or through establishing collaboration agreements with third parties.

4.3.1. Enhanced Softeam's Modelio

Softeam will exploit its Modelio modelling tool to develop the Camel Morphemic model in open-source mode firstly, a commercial version is possible and under study. Modelio is an open-source modelling environment available from www.modelio.org with a commercial version with advanced features available at modeliosoft.com. It delivers a broad range of standards-based functionalities for software developers, analysts, designers, business architects and system architects. Modelio is first and foremost a UML modelling environment, supporting a wide range of models and diagrams, and providing model assistance and consistency checking features. BPMN support is integrated with UML with Modelio combining Business Process Modelling and Notation (BPMN) and UML support in one tool, with dedicated diagrams to support business process modelling.

Figure 1 – Modelio.org web site

Modelio provides an XMI import/export feature that enables the exchange of UML models between different tools, as well as HTML model publishing to publish models in HTML format. Internal considerations are carried out for an enhance Camel Module to be offered with a Commercial licence.

Softeam will develop the CAMEL model within MORPHEMIC, being the first on the market to offer CAMEL 3.0 and being able to offer customizations to potential customers just after the end of the project.

4.3.1.1. IS-Wireless: Software Defined- Radio Access Network

The RAN developed by ISW will be utilized by end users or customers for a range of vertical applications under categories such as ultra-low latency critical communication, enhanced mobile broadband, device to device communication, massive machine type communication, cellular IoT applications etc. The software defined eNB/gNB will be implemented according to 3GPP defined 7.x split and utilized to enable the services as mentioned above. The software defined eNB, gNB includes layer 1, layer 2 and layer 3 of protocol stack which creates different set of network functions (NFs), including physical network functions (PNFs) and virtual network functions (VNFs) towards specific services. The formulation, as well as placement, of NFs contributes towards the efficiency of network automation and services.

The MORPHEMIC project, by bringing means for customization and automation into network planning and provisioning, will provide opportunity to ISW to enhance above mentioned aspects and deliver a more flexible and adaptable product. In particular, ISW's SD-RAN product will be able to reduce the deployment costs (CAPEX) but also operational costs (OPEX) through adaptive and proactive adjustment of the RAN deployment. Moreover, thanks to MORPHEMIC it will be possible to create multiple, CAMEL based, descriptors for various types of networks (e.g., private network, eMBB network, URLLC network, dense network) depending on the individual client needs. It will allow to address various vertical markets (eHealth, automotive, public safety, smart factories, smart cities), as well as telco operators' or integrators' policies regarding network scaling and evolution process.

4.4. Open-Source products

4.4.1. MORPHEMIC platform

The main outcome of the project will be a proactive model manipulator integrated as a pre-processor for the existing MELODIC framework to extend its deployment and adaptation capabilities to the Edge, 5G, and Fog. Consequently, the exploitation plan will be aligned with the exploitation of the results of MELODIC.

MELODIC is an open-source software framework supporting Multi-Cloud deployment of data-intensive applications. It is released under MPL 2.0 (Mozilla Public License) and hosted on the OW2 platform, available as a core building block exposed to external parties. As a partner with cloud-centric strategy, 7Bulls took the lead as a chief platform maintainer and is still committed to exploiting it for commercial purposes. 7Bulls has been active in further development and extending the framework using both their own investment and public funding. The subsequent releases confirmed the benefits of MELODIC for the application providers and the exploitation strategy has been proven successful. On top of the project use case implementations, 7bulls has used the framework in three other commercial implementations. The community around MELODIC is gaining momentum and two extensions are already under development. 7Bulls is also an important partner of the MORPHEMIC consortium and will remain a chief maintainer of the platform leading the collaborative work aimed to maintain the software with clear documentation, predictable versioning, regular releases, and community support. This clear leadership and business interest in the results will secure the sustainability and further development of the project outcome.

As a sustainability leader, 7Bulls will lead the activities related to maintaining the MORPHEMIC software beyond the funding period.

The project is on OW2 forge already and all consortium is reasoning on plans for an open-source way exploitation strategy with training, consultancy etc. More details on that will be given in the IPR and exploitation plan Deliverable due at M18.

4.4.2. Modelio Camel Module

Softeam has created Modelio, an open source-modelling environment based on UML and BPMN standards. It has a track record of more than 25 years and has been constantly improved and innovated by a community of 80 000 users. Modelio delivers a broad range of standards-based functionalities for software developers, analysts, designers, business architects and system architects. The core Modelio UML Editor is extendable with multiple add-on modules and tools available under commercial license. Softeam is also offering consulting and training services in related technical (languages, techniques, tools) and methodological areas.

Modelio will extend its architecture modelling capabilities by embracing new advanced cloud computing models based on a polymorphic combination of cloud services of any type (IaaS, PaaS, SaaS, and FaaS). Furthermore, we will

pursue the implementation of adaptive provisioning, prediction capabilities, and new security components in the modelling architecture. By leveraging these new features, Modelio will help existing and new customers unlock value and drive their business forward at a faster pace. It will also become applicable to the new customer segment of the public sector and e-government. A new open-source module, Softeam will exploit is Modelio modelling tool to develop the Camel Morphemic model. Modelio is an open-source modelling environment available from www.modelio.org.

Softeam will develop the CAMEL model within the MORPHEMIC being the first on the market to offer CAMEL 3.0 within its open-source version being able to offer consultancy and training on it just after the end of the project.

4.4.3. BRAIN science platform

There exist widely used codes dedicated to brain science like Statistical Parametric Mapping (SPM) that allow to perform analyses using a MATLAB environment. These tools are not always available for clinical research and almost never applied to clinical routine data. CHUV will implement cloud ready tools into the MORPHEMIC pre-processor as a data processing workflow making the data on populations of patients broadly available for research use, by providing software-as-a-service to clinicians, neuroscientists, epidemiologists and pharma both for diagnosis and research in clinics and for collaborative neuroscience research using clinical data. Within project, we will offer centralised access to software and data deployed in private execution environments and enable analysis with Machine Learning / Deep Learning, lesion detection, individual and collaborative analysis, openness and greater extensibility, and accessibility to new European Open Science Cloud (EOSC) | Open Science –Research.

5. Exploitation strategy summary

Raising demand for multi-cloud management, lack of direct market competition, versatility and operational cost savings are the main drivers supporting the adoption of MORPHEMIC. The recent report by Synergy Research Group shows that the operators and vendors revenues in Cloud services and infrastructure market passed $250 billion milestone in 2018[8], having grown by 32% from 2017. Cloud platforms and applications are proliferating across enterprises today. According to the Rightscale 2019 State of Cloud Report, 84% of enterprises already have a multi-cloud strategy. Cloud users are running applications in almost 5 public and private clouds an average, compared to 3,2 in a similar report published in 2016. At the same time, companies find keeping track of the multi-cloud rather complex and time-consuming. This is driving the adoption of third-party management and monitoring tools and the Managed Cloud Services that can handle the distributed Cloud set-ups. This complexity is one of the reasons for digitization in the EU still lagging, particularly among SMEs. According to IDC report published in 2018, European organisations are 18 to 24 months behind the US when it comes to Cloud adoption. Europe is also facing a Cloud skill gap that was acknowledged by 40% of businesses according to a survey completed by the European Commission in 2017. The problem gets even bigger with the upcoming shift toward parallel computing in AI data centres and the growth of cloud-based services such as serverless and edge computing.

Existing computing systems are overloaded with data, driving the demand for enhanced performance and superior compute capacity. Innovative HPC solutions and 5G networks are coming to the fore, empowering organisations to push the boundaries of their capabilities and enabling them to glean faster, more accurate insights from their data. New modelling techniques and mechanisms are needed to compose and coordinate resources across heterogeneous clouds and computational infrastructure allowing for multivariate deployment of applications. These emerging concepts are just another proof that solutions like MORPHEMIC are in high demand. Additionally, data and computing overload is driving the emerging data centre accelerator market, which is also of relevance with the approach proposed by MORPHEMIC. This market segment is expected to grow at a CAGR of 49.47% from 2018 to 2023[9].

Table 4 lists the exploitable results expected form the project and current plans for how these results will be disseminated and exploited to benefit the European cloud computing community. The mentioned results will be further updated in D8.3, IPR & Exploitation due at M18.

[8] https://www.srgresearch.com/articles/half-yearly-review-shows-150-billion-spent-cloud-services-and-infrastructure
[9] https://www.researchandmarkets.com/reports/4615161/data-center-accelerator-market-by-processor-type

Table 7: MORPHEMIC exploitation planning summary

Exploitation Path	Exploitable Project Result
Promotion activities	Lead by 7Bulls will focus on relevant events to create awareness of the MORPHEMIC work
Standardisation	Lead by FORTH will focus on relevant standardization efforts linked to the MORPHEMIC work
Publication of specification	Methodologies and tools (papers listed in Chapter 3) All technical result from WP2, WP3, WP4 and WP5
Open-Source products available from MORPHEMIC partner or third party	• MORPHEMIC Platform • EMS • Modelio Open Source CAMEL Module
Commercial products available from MORPHEMIC partner or third party	No final decision has been taken at this stage for Commercial products. Modelio Commercial version enhanced with MORPHEMIC Modelio Module is under study
Internal exploitation	CHUV, ISW and ICON use cases Further Research and Knowledge Transfer

6. Conclusion

The present document, a deliverable of the MORPHEMIC project, funded by the European Commission's Directorate-General for Research and Innovation (DG RTD), under its Horizon 2020 Research and innovation program (H2020) reports the results of the activities carried out by WP8 on the Exploitation Strategy reported at M8 of the project.
The MORPHEMIC project partners believe the results from the project will substantially address key challenges facing European Cloud industry.
Overall, the pillars that underpin the dissemination and exploitation planning for the project are the following:

- Publish the interfaces and methodologies used for the MORPHEMIC technologies
- Make the technologies available as open-source products using the well-established exploitation and dissemination channels of the project partners to encourage their broad take-up by industry
- Management of intellectual property rights for an effective handling of IPR issues and needs.

Furthermore, this deliverable reports on the comprehensive promotion activities of MORPHEMIC for the project month 1-6. It reports on communication activities including industry events (Events, Workshops, Direct Meetings), Scientific Events and workshops, publications, social media and MORPHEMIC website. Taking into the consideration that many business and scientific events have been cancelled or postponed being on-line due to the Covid-19 emergency, MORPHEMIC consortium is focusing much on the communication through the social media, MORPHEMIC web portal, publications and participation in on-line events and Cloud Communities.
Within this deliverable, we outlined the first version of our individual and joint exploitation at M8 of the project, while the IPR issues will be tackled further in D8.3, the following points will be covered by the next version of the Exploitation Deliverable:

- Refinement of individual partner exploitation capabilities in support of exploitation plans.
- Positioning of exploitable results towards target audiences of application software developers, tools suppliers and platform providers.
- Summary of collaborations with other projects and external organisations.

- Licensing details along with information related to third party technologies used in results.