D1.1 DEMAND ASSESSMENT FRAMEWORK

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Authors	Martin Sundblad (IDC), Leonardo Freitas (IDC), Nuria de Lama (IDC)
Reviewers	Brendan Rowan (BLU), Jacob Nielsen (SDU)

Abstract	This report proposes the initial draft of the LeADS ADS Framework composed by three major elements; identification and definition of technologies in scope; skills included under those technologies, and definition of job roles, where other skills frameworks are considered for comparison and alignment. The report summarises the first workshop held by the project with external constituencies even though the feedback will be incorporated in the final version of the framework, where the layer of job roles will be completed, and the others revised according to additional input. This framework serves as reference for the next step in LeADS: the assessment of the demand and the supply.
Keywords	Skills, technologies, roles, jobs, framework, Artificial Intelligence, Business Intelligence, Data Science, Cybersecurity, IoT, Quantum, Cloud

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EXECUTIVE SUMMARY

This report proposes the initial draft of the LeADS Avanced Digital Skills (ADS) Framework composed by three major elements: a) identification and definition of technologies; b) skills included under those technologies, and c) job roles, where other skills frameworks are considered for comparison and alignment. Definitions of all the items in each of the elements of the framework are included as part of it. Technologies selected as part of the scope of LeADS include Cloud technologies, Business Intelligence and Data Science, Security technologies, Quantum, Artificial Intelligence and Internet of Things. Skills therein have been grouped for better understanding.

Further analysis and definition of the layer related to job roles, together with a revision of technologies and skills as part of the feedback cycle set up with external constituencies will be integrated in the final version of the framework, to be released as a white paper at the end of January 2023 and formally included in the D1.2 First draft of ADS Demand and Forecast Report.

LeADS has run a session with experts of the Steering Committee as well as a workshop on the 15th of December with experts in various technologies. Initial feedback has been analysed (and reported as part of Annex I) but will be incorporated into the final version of the framework, since the process to capture input from external experts is open at the time of submitting this deliverable and more activities are planned for this purpose.

This framework is the starting point for LeADS, since it serves as reference for the next step of the project: the assessment of the demand and the supply in the EU and the forecasts for the next 5-7 years.

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ABBREVIATIONS

ADS	Advanced Digital Skills
ADT	Advanced Digital Technologies
AI	Artificial Intelligence
CEN	European Committee for Standardisation
DEP	Digital Europe Program
EC	European Commission
e-CF	European e-Competence Framework
EQF	European Qualifications Framework
ESCO	European Skills, Competences, Qualifications and Occupations framework
ESSA	European Software Skills Alliance
EU	European Union
ICT	Information and Communication Technologies
ISV	Independent Software Vendor
IT	Information Technologies
IoT	Internet of Things
SW	Software

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1 INTRODUCTION

One of the main goals of LeADS is to provide recommendations to the European Commission, Industry and the Education and Training Community on how digital skills development could be adapted to the evolving needs of the market. This entails both educational courses and masters but also continuous training at companies, including upskilling and reskilling people. Any recommendation or proposed action has to be backed by a solid knowledge on the current state of play in Europe, which means understanding the supply, the demand and their evolution so that a better understanding of the skills gap can be gained. That is why LeADS includes specific areas of work to assess both supply and future demand. Quantitative research on digital skills requires as starting point what we call a *reference framework*. This document focuses precisely on that initial part of the work and describes the initial version of the ADS Framework generated by the project. The LeADS team has not started from scratch and builds upon extensive work done in the past by different stakeholders and in particular IDC, whose existing taxonomies have been used as basis for this work. As it is explained in the corresponding chapter, other frameworks are also considered looking for alignment, comparison, and wider acceptance. This applies specifically to job roles.

There are two major challenges for the project in this initial phase: a) **scoping the area of work** and b) gathering enough **external feedback** so that the framework and subsequent work can be considered representative enough and useful to the different users, thus leading to widely acceptance and adoption, which is an ultimate objective of this project.

Definition of the scope has led to long discussions in the project on where boundaries should be put. On the one hand, technology is evolving very rapidly, with a myriad of new technologies emerging in the last years (e.g. Quantum); on the other hand, the digital transformation path most companies are going through brings new needs (and requirements for additional skills) not only in IT companies, as it used to be the case in the past, but almost in any type of organisation, be it public or private, big or small and belonging to most sectors of the EU economy. The document shows how some of the skills can be considered of general, cross-sectorial purpose while specific skills are defined in the context of specific application domains that demand for new, sector-based knowledge.

The collaboration and interaction with external constituencies opens up opportunities to extend the knowledge of the consortium and work towards the acceptance and validation of a basic pillar of LeADS. Due to the fact that this deliverable comes very early in the project plan, this document makes a proposal of an initial version of the framework, which has already considered inputs from various communities and sources, but it is expected that a revised version will be ready by the end of January and formally released as part of D1.2 First draft of ADS Demand and Forecast Report. This margin will allow us to run additional sessions and incorporate potential modifications in the current version of the framework.

1.1 Target Audience

This document provides a description of the different elements that compose the reference ADS framework generated by LeADS. As such, it is the basis for the assessment of the skills supply and demand in the EU and should be of interest to any stakeholder involved in skills generation or consumption, since both aspects will be mapped against the framework. LeADS has already interacted with suppliers of skills, including Universities, research organisations but also centres specialised in providing training for workers. In addition, the demand side has been involved in the discussions, looking at different levels and positions in companies, starting with Human Resource department leaders and representatives and following with heads of departments and other decision makers included in recruitment processes or providing insights on the evolution of skills needed by companies (typically IT leaders that know in detail the technology areas tackled by the project). Policy makers will also be a relevant audience for

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this initial piece of work and its evolution, since it will provide a decision-making support tool for the definition of future policies, actions and investments.

1.2 Role of the ADS Framework in LeADS

The ADS Framework provides the basis to understand which skills will be analysed in the project. It gives us the reference of the study, providing a scope with respect to the different elements that will be assessed in the project (which technologies and skills therein) and through its definitions enables a common understanding of all the terms. The next step in the project is the assessment of the supply and the demand, including qualitative and quantitative aspects. Definition of the models will depend on a stable version of the skills and their relationship to job roles. Validation of all the elements of the framework will also allow us to understand which data is available for the supply and demand assessment and which data is currently missing, for which primary research will be needed (notice that a survey is envisaged for this purpose).

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2 SCOPE OF THE LEADS ADS FRAMEWORK

The framework, as described later on in the document, is composed by **three major elements or layers: a) Technology; b) Skills; c) Roles.**

The current version includes the structure for Technology and Skills together with complete definitions and anticipates some information about the roles dimension, even though this part is still draft and requires further work for completeness and validation; for example, the current version points out other skills frameworks to relate to but additional mapping is needed. LeADS has used the knowledge available in the consortium and has consulted a wide number of data sources to come up with this version of the framework (see methodology for more details).

In addition, we have gathered feedback from experts through the Steering Board of the project and through a workshop held in December with a varied set of experts in the different technology areas included in the framework. The project will run additional workshops at the beginning of 2023 to gather more feedback. Input will be analysed and considered for a new version of the framework to be released between January and February. That one will be considered as final version of the ADS Framework to initiate the work on demand and supply assessment.

2.1 Existing Frameworks for ADS and added value

The quantitative research on digital skills proposed by LeADS will use IDC taxonomies for defining scope and references to other existing frameworks for job and skills definitions. To define them statistically, IDC uses the International Standard Classification of Occupations (ISCO-08), selecting categories where data professionals may be included, together with the ESCO[1] definition of occupational skills, where a high level of digital skills can be derived. This means that even though IDC sources are very prominent in this phase of the project, they already build upon and relate to mostly accepted frameworks and suit market requirements.

Section 3 of this document revolves around the details of the methodology and its baseline. The layer where IDC taxonomies will be mapped to other frameworks is mainly the one related to (job) roles. Section 4 identifies the main ones considered by LeADS, such as ESSA[2] (European Software Skills Alliance) and E-CF[3] (European Competence Framework). This work will be further developed in the final version of the framework, as previously anticipated.

[1] https://esco.ec.europa.eu/en
[2] https://www.softwareskills.eu/library/essa-educational-profiles-for-software-roles/
[3] https://itprofessionalism.org/about-it-professionalism/competences/the-e-competence-framework/

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3 METHODOLOGY

The first two major elements of the framework are explained here from a methodological point of view while section 4.4 depicts the initial work on roles that will be completed for the final version of the ADS Framework to be provided as a white paper at beginning of 2023, which will also include the analysis of the input from the various workshops and activities and the potential impact on the final version of the framework.

3.1 Technology

This section describes the methodology behind identifying potential technologies and limiting the number of technologies to be usable for the LeADS project.

Technology is in this section synonymous of skill area, functional area or technology area, and represents the highest level in which the project describes advanced digital skills.

The methodology for selecting technologies in scope was done in two steps:

1. **Identifying technologies**: in this step potential technologies (skill areas / functional areas / technology areas) were listed to have an initial and complete set of potential technologies to represent.

2. **Selecting technologies in scope for LeADS**: in this step the technologies listed in step 1 were evaluated and reduced to a list determined usable for the project in terms of value to the European ICT community, sise and complexity.

3.1.1 Selection of Technologies for LeADS Scope

The following criteria have been considered for the selection and filtering of technologies for the study:

- **Relevance to the proposal**. **I**. The technology / skill area should have been named or indicated in the proposal to be relevant for the report, i.e. priority has been given to those technologies already referred to in our contract, some of them aligned with the explicit presence of related communities in the LeADS project (e.g. IoT through AIOTI or data science and BI through BDVA).
- **Relevance to Europe as a digitally advanced region**. For this criterion, the LeADS consortium considers several sources and notably taking as an initial scope the priorities highlighted by EC strategies (e.g. Digital Decade[4]), and the technologies covered within the Digital Europe Programme[5] corroborated with market research and insights developed along extensive research on the impact of technologies on the EU economy (e.g. IDC report and studies carried the “Advanced Technologies for Industry”[6]).
- **Qualify as Advanced.** The term Advanced Digital Skills defines the scope in the sense that the consortium should look for the skills that not only impact the region and its competitiveness, but also are advanced, difficult to develop, and where the assumption is that the gap between demand and supply is the largest, and where thus research and mitigation activities are the most important.
- **Importance in short to mid-term**. The scope of the report is a forecast for 5-7 years. In that sense the consortium will not be looking for skills and technologies that may

[4] https://digital-strategy.ec.europa.eu/en/policies/europes-digital-decade
[5] https://digital-strategy.ec.europa.eu/en/activities/digital-programme
[6] https://ati.ec.europa.eu/

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impact Europe and its competitiveness 20 years from now, but more the immediate skill gaps and skills development measures required for technologies that are in high demand in the near future.

Based on this process, and looking at the potential impact on enterprise and society, the technology scope was determined by selecting the following technologies or technology areas:

- Cloud technologies
- Business Intelligence / Data Science
- Security technologies
- Quantum technologies
- Artificial Intelligence (AI)
- Internet of Things (IoT)

Initial input from the preliminary validation workshop and discussions run with external stakeholders suggest potential changes or add-ons that will be further analysed and considered accordingly in the final version of the framework.

In particular, the elements of edge computing, partially envisaged by IoT, seems to be of high relevance and may require reformulation of technologies like IoT and Cloud, or complementing skills already defined under some of those technologies. In addition, some new trends around concepts like the metaverse have emerged even though our initial positioning on that is that it is an application enabled by a combination of some of the included technologies.

Our starting point for the framework also included AR/VR, possibly transformed into XR, it was however seen as a sub-technology related to human-device interface such as for IoT and Edge or a combined application of the already identified technologies. Analysis of additional feedback expected from discussions with external stakeholders will guide us towards the final positioning of the LeADS framework with respect to the technologies.

3.1.2 Identification of Technologies

Technologies have been identified using IDC full set of taxonomies, as IDC has a proven track record of research within ICT hardware, software and services, and has published a large number of taxonomies. Although IDC carried a referencing towards other skills taxonomies (albeit limited), IDC taxonomies (for the purpose of selecting technologies) were deemed the most suitable approach as these would allow the consortium to link skills with spending guides and forecasts to establish a quantitative approach to the mapped skills within these technology areas. The taxonomies applied can be found in Annex 1 to this report.

IDC taxonomies are structured to meet the demand from the market on detailed market and forecast information and represent IDCs best estimates of the market spending by sector, industry, use case, and technology. The data presented is the combination of qualitative and quantitative data from several primary and secondary sources, including IDC's worldwide industry and company size market model, the research tanks of IDC's Insights businesses, IDC's AI Tracker, and IDC's annual ICT survey of end-user organisations.

IDC models the breakdown of total IT spending by industry and company size, using a combination of available data on the number and revenue of companies within each vertical and company size class.

The basic components of the models used to determine market size and forecast for a specific product area by vertical market include supply-side data, demand-side data, industry trends, and the economic outlook to generate a model of IT services spending. IDC methodologies integrate these elements into a framework to determine the market segmentation for a base year and the forecast assumptions.

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The respective links to the market forecasts at IDC for the taxonomies are important as the quantification of the skills need to relate to the market demand of the related technology areas. The methodology for quantification will use and leverage the research within IDC and within the consortium regarding quantification of technology spending, to put the demand of technology related skills – the advanced digital skills – into context.

In addition to proprietary IDC information, several external sources were used to cross-check the collected data, such as the E-Competence Framework (E-CF). E-CF provides a reference of 41 competences as required and applied in an IT professional work context, linking these to specific job roles which are listed and explained above on section 4.4 (Reference Layers).

Although E-CF provides a comprehensive link between certain competences and job roles within IT, it does not map specific skills that will be required to enable digital transformation in advanced areas such as (but not limited to) Artificial Intelligence (AI), Internet of Things (IoT) and Quantum Technologies. Therefore, skills listed in the LeADS framework intend to reach a higher level of granularity and aim to reflect more specific competences versus other digital competence frameworks currently available.

3.2 Skills

3.2.1 Identification of Skills and Skills Grouping

The methodology for selecting appropriate skills within a technology uses multiple sources to compare and combine in order to reach accuracy, clarity in definition and depth.

The guiding principles of the methodology are:

- **Need for consensus**. As there is a wide variety of definitions of technology related skills within the ICT industry and in other industries, combining and comparing different sources is essential. The framework should provide clarity, paired with an ability to trace the underlying contributions.
- **Usability**. The skills identified need to be generic enough to cover the needs for European skills development, both in the LeADS work for demand and supply of skills, and in enterprise and scientific skills development in the coming period. Furthermore, the skills identified need to be detailed enough to be specific and measurable.
- **Ability for further depth and variety**. The skills identified need to act as starting point for further depth, as there may be need for further in-depth skills in certain industries or for certain purposes.
- **Technology driven**. The skills identified are all technology related. It does not mean that softer skills, such as leadership, team work, social capacity etc are not important for European technology development, but should be interpreted as that major focus initially proposed by LeADS is of technology related, measurable skills.

In the current version, the skills identified remain on the highest level where these three criteria are fulfilled. As the project progresses, the ability for further depth will become important and will allow for additional skills definitions underpinning the current high level skill definitions.

3.2.2 Skills definition sourcing methodology

The following sources of skills and skills taxonomies have been used:

- e-CF, the European competency framework
- ESCO, European Skills, Competences, Qualifications and Occupations framework
- O*Net, the Occupational Information Network
- Publications and open databases by Lightcast / Burning Glass Technologies

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- Role definitions and related descriptions provided by Bureau of Labor Statistics and ISCO-08

The approach for selecting and prioritising among different levels of detail and definitions is demand-driven:

- **Technology and technology sub-market**. If a certain technology or technology sub-market is in high demand and in high growth, the skills related to that technology (market) are deemed relevant for additional detail.
- **Use case**. Skills definitions are linked to use cases where demand and demand growth can be quantified or estimated.
- **Industry**. Certain skills are related to a specific industry, or a sector of industries. Where the demand for the respective industries could be quantified or estimated, the related industry related skills are deemed relevant for additional detail.

Quantification and estimations were based on publicly available resources from Bureau of Labor Statistics, Eurostat, and ILOSTAT, but the primary source for quantification of technology demand has been proprietary market data from IDC, especially where it comes to industry or use case specific skills.

For each technology a long list of 20-30 skills were selected, which were grouped into 10-15 primary skill groups, that was reviewed internally and is under finalisation.

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4 THE LEADS ADS FRAMEWORK

4.1 Elements of the Framework

As it was previously pointed out, the LeADS framework includes three major elements or layers: a) technologies, b) skills and c) (job) roles. This section provides details on each with the recognition that the development of the third section, roles, is currently underway.

4.2 Technologies

The purpose of this section is to describe the scope of the LeADS framework. The technologies selected uniquely define the scope, and the skills defined herein are all related to the technologies in scope.

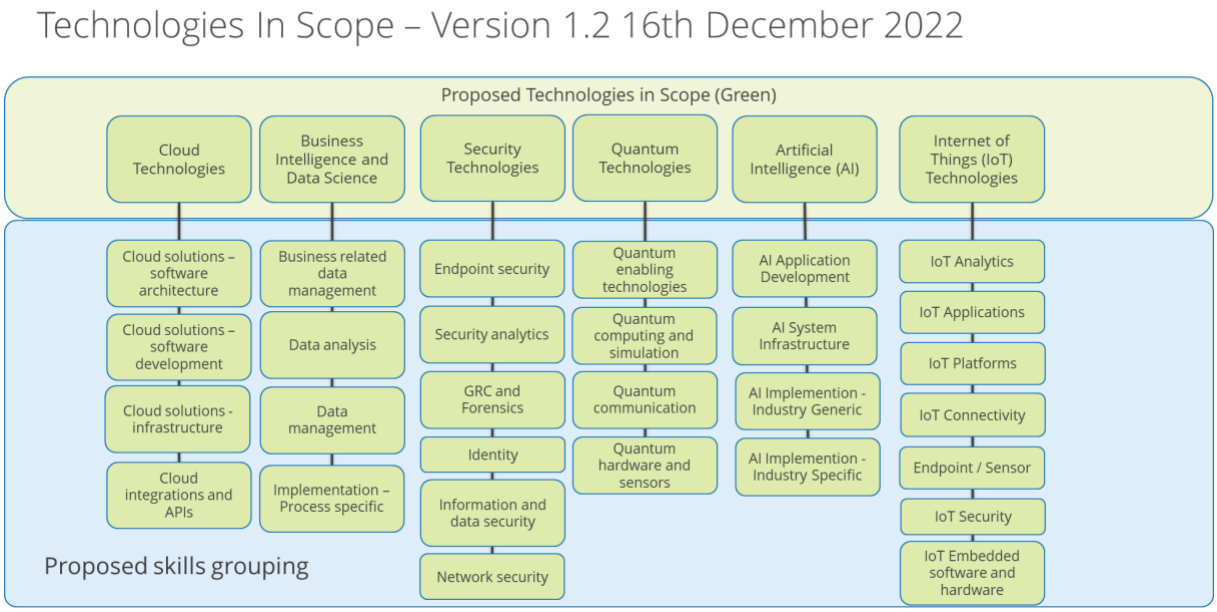

Figure 1: Technologies selected for LeADS ADS Framework

Note: Discussions carried out with external experts but also internally in LeADS suggest that some technologies may be renamed to become more explicit about their content. As a matter of example, addition of specific skills under IoT associated to edge computing may lead us to rename this technology area as IoT Technologies & Edge Computing. We understand that the set of technologies could grow for the sake of completeness, but as mentioned above, some boundaries have been defined in the framework looking at the availability of data and effort needed for the quantification of the demand, and based on the criteria for prioritisation explained in section 3.

Cloud technologies

Cloud solutions/technologies refer to servers that are accessed over the Internet, and the software and databases that run on those servers. Cloud servers are located in data centres all over the world. By using cloud computing, users and companies do not have to manage physical servers themselves or run software applications on their own machines. Cloud is formally defined through a checklist of key attributes that an offering must manifest to end users of the service.

"Public" cloud services are those shared among unrelated enterprises and/or consumers, open to a largely unrestricted universe of potential users, and designed for a market, not a single

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enterprise. Public cloud services software is based on a service composition and delivery model made up of a utility computing environment in which unrelated customers share a common software managed and hosted by Independent Software Vendors (ISVs) or hosted in the cloud. Here, the software code or intellectual property is owned by the ISVs. This subscription provides customers with access to and consumption of software functionality built specifically for network delivery and provisioned and accessed by users over the internet.

Skills related to cloud solutions/technologies include services, software and hardware related to both public cloud and private cloud.

Business Intelligence / Data Science

Business intelligence/data support a broad range of analytic techniques across the descriptive, diagnostic, predictive, and prescriptive spectrum. Products in this category are mostly used by information consumers, business analysts, and data scientists rather than by professional programmers. Examples include query, reporting, multidimensional analysis, dashboarding, data mining, statistics tools, and spatial information management software.

Business Intelligence (BI) / Data Science skills relate to the strategies and technologies used by enterprises for the data analysis of business information. BI technologies provide historical, current, and predictive views of business operations, and relate to, and often use, technologies within Big Data and Analytics (BDA).

Security technologies

Security technologies and services involve a holistic view of all activities necessary to plan, design, build, and manage information security across the enterprise information technology infrastructure.

Skills related to security technologies involve architecting, designing, developing and maintaining application, information and data security. It involves a wide variety of technologies to enhance the security of an organisation's networking infrastructure — including computers, information systems, internet communications, networks, transactions, personal devices, mainframe, and the cloud — as well as help to provide advanced value-added services and capabilities.

Quantum technologies

Quantum technologies are core quantum computing systems, platforms, and technologies in a top-level segment that details the hardware, software, and tools needed for preparing models to solve intractable problems using quantum computing systems. This technology comprises two subsegments: quantum computing systems, and quantum computing platforms and technologies.

Quantum computing contains a radically different building block than classical computing - the qubit. In quantum computing, a qubit has a theoretically unlimited number of states: 0, 1, and both 0 or 1 simultaneously. This property is referred to as superposition. A second characteristic differentiating qubits from bits is entanglement. Through qubit entanglement, a pair of qubits is connected or linked. Change in the state of one qubit results in a simultaneous, predictable change in the other qubit. Combined, the quantum properties of superpositioning and entanglement provide qubits the ability to process more data faster, cheaper, and better (more accurately or precisely) than a classical computer.

Artificial Intelligence

Artificial intelligence (AI) is the study and research of providing software and hardware that attempts to emulate the processing capacity of humans. The AI taxonomy is split into three main segments: AI Hardware (server and storage), AI Software (platforms, application

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development, applications and system infrastructure software and AI Services (Business services and IT services)

Skills within the technology relate to systems that learn, reason, and self-correct. These systems hypothesise and formulate possible answers based on available evidence, can be trained through the ingestion of vast amounts of content, and automatically adapt and learn from their mistakes and failures.

IoT Technologies

IoT is defined as a network of uniquely identifiable endpoints (or "things") that autonomously connect bidirectionally using IP connectivity (the IoT ecosystem encompasses a complex mix of technologies and services including, but not limited to, modules/devices, connectivity, IoT platforms, storage, servers, security, analytics, IT services, and security).

Skills related to IoT technologies involve a system of interrelated computing devices, mechanical and digital machines (with unique identifiers (UIDs)) and with the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction.

Note: The label “IoT Technologies” currently includes references to edge computing, while this will be revised in the next version.

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4.3 Skills

The purpose of this section is to provide the list of skills and the definitions for the respective skills in the technologies in scope.

Skills have been grouped into Skill groups, but this grouping has less relevance than the skills themselves – the grouping is used mainly to create a structure and a hierarchy and are therefore not provided with a definition.

4.3.1 Cloud Technologies

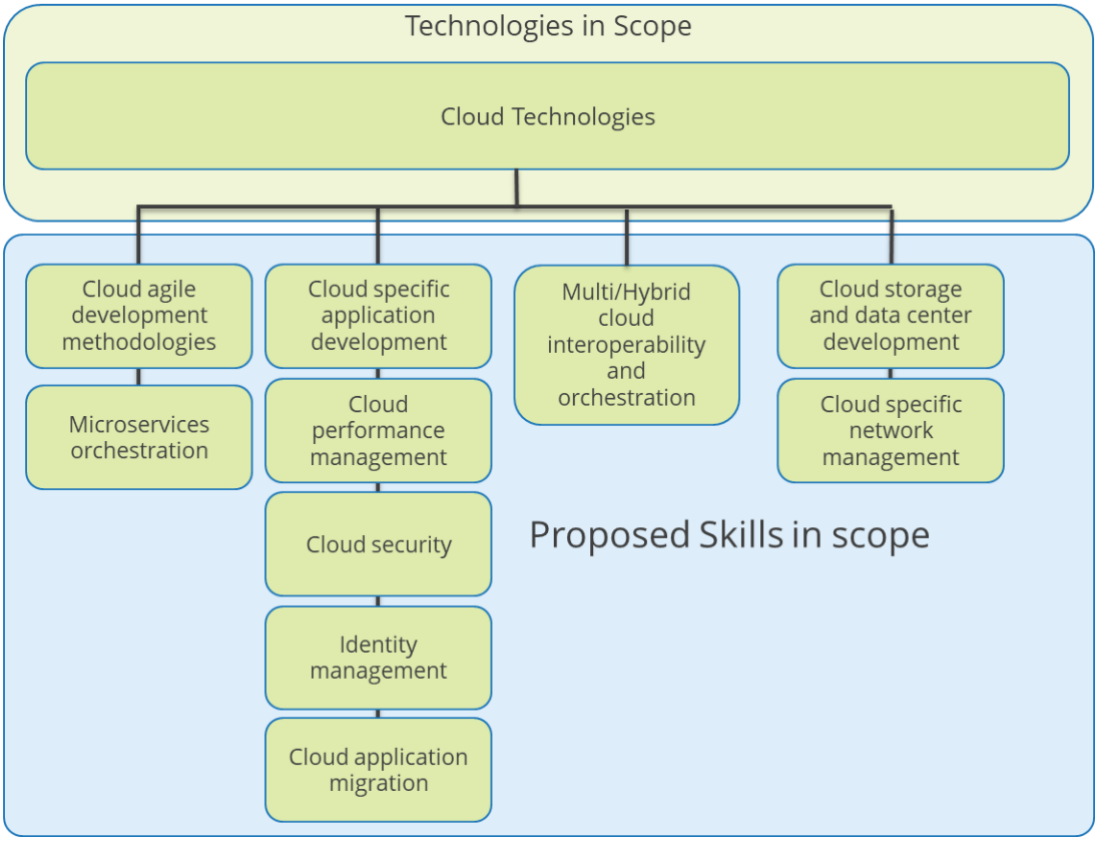

Figure 2: Skills in Cloud Technnologies

Cloud solutions - software architecture

Cloud agile development methodologies

Skills in this category include agile development techniques and the application of the same. Skills include knowledge on agile frameworks, such as Lean software development, Rapid application development (RAD), Scrum, Scaled AGILE framework (SAFe). Deployment-centric application platforms are on-premises and cloud software that host application logic and provide common services that allow the application to operate effectively.

Skills include understanding of connectivity between the presentation layer, software services, data sources, and infrastructure. It also includes understanding of QoS capabilities, including transaction processing reliability, availability, throughput, scalability, security, and management.

Microservices orchestration

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Knowledge and abilities within the architectural method of coordinating microservices for software systems and applications, in which loosely coupled services receive commands from a central controller, referred to as the orchestrator.

Cloud solutions – software development

Cloud specific application development

The development languages, environments, and tools for cloud specific application development include development-side tools such as integrated development environments and code editors as well as programming language compilers and client-side, mobile, and embedded application development tools; runtimes; and frameworks, including web frameworks and browsers. Also included in this skill area are standalone tools used during the code construction process such as debuggers and code profilers.

The skill area also includes business rules management - discrete systems that define, manage, and execute conditional logic in concert with other IT processes and actions. The skills also include modelling and architecture tools and techniques and understanding of software construction components (SCCs) - specific software subassemblies and libraries sold apart from a programming development environment that may or may not be designed for use with a specific programming development environment.

Cloud performance management

Cloud Performance Management skills relate to the monitoring of resources that support software application performance in cloud (public, private and hybrid) environments, and ultimately taking actions to resolve issues and maintain optimal performance. Includes the ability to create and analyse audit logs, combine data from disparate monitoring siloes into correlation engines, measure response times, traffic level, and quicky diagnose/troubleshoot performance issues once while the cloud-based application is up and running.

Includes proficiency skills of specific tools such as (but not limited to) AppDynamics (Cisco), SignalFx (Splunk), Datadog, Dynatrace, New Relic, Micro Focus and Broadcom.

Cloud security

Cloud security includes a wide range of skills used to improve the security of computers, information systems, internet communications, networks, and transactions related to cloud and data centre implementations. Cloud security skills provide organisations with security management, access control, authentication, malware protection, encryption, data loss prevention (DLP), intrusion detection and prevention, vulnerability assessment, and perimeter defence. Cloud security has six primary functions: identity and digital trust; endpoint security; governance, risk and compliance; identity and digital trust; information and data security; and network security.

Identity management

Identity and digital trust skills relate to technologies and processes used to identify users (employees, customers, contractors, robots, and IoT devices) of IT services and to control their access to resources within that service by associating user rights and restrictions with an authenticated user account. Identity and role-based access cover identity management including B2C identity management and identity governance. Digital trust includes authentication and privileged access management.

Cloud application migration

Cloud migration is the process of moving a company's digital assets, services, databases, IT resources, and applications either partially, or wholly, into a public or private cloud.

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Cloud migration skills include data integration and intelligence necessary for the migration - enabling the access, blending, and movement and providing intelligence about data among and across multiple data sources. Cloud migration skills also include database administration and architecture in order to re-architect changes in application and infrastructures migrating to the cloud.

Multi/Hybrid cloud interoperability and orchestration

Skills within this area enable the interaction and secure operations between different and disparate on-premise, private and public cloud environments. Cloud interoperability and orchestration contain three areas: business-to-business (B2B) interaction and middleware, integration and managed file transfer, and data integration and intelligence.

B2B interaction and middleware consists of software and services used to receive, route, and convert standards-based structured inter-enterprise files and messages related to transactions. Those standards can be community-based standards or between party-agreed-upon formats.

The integration and managed file transfer include tools and techniques used by developers and integration specialists to integrate applications, exchange business transactions between enterprises, transfer files inside and outside organisations, publish and process events, and monitor the business and process performance of these applications and automated processes.

Data integration and intelligence enables the access, blending, and movement and provides intelligence about data among and across multiple data sources. The purpose of data integration and intelligence software is to ensure the consistency of information where there is a logical overlap of the information contents of two or more discrete systems. Data integration is used to capture, prepare, and curate data for analytics. It is also the conduit through which new data types, structures, and content transformation can occur in modern IT environments that are inclusive of streaming, relational, nonrelational, and semistructured data repositories.

Other cloud skills

Cloud storage and data centre development

This area contains skills specifically related to the storage architecture and construction of virtual environments for cloud storage.

Data centre management and storage includes the tools and techniques for production application configuration, deployment, patching, and automation for physical and virtual servers, container platforms, and public cloud IaaS environments. The solutions that these skills cover enable dynamic automated physical and virtual server and application provisioning, workload and VM allocation, governance and reclamation, self-service cloud provisioning portals and cloud service brokers, runbook automation, workflow orchestration, software-defined datacentre control, infrastructure as code, and hybrid cloud resource optimisation and provisioning.

Cloud specific network management

These skills cover the networking within the cloud infrastructure as well as the network communication architecture between cloud environments and between the cloud environment and its users.

Network infrastructure encompasses software that enables virtualised networking, optimisation, orchestration, and related network infrastructure functions across enterprise, datacentre, and communication service provider networks. As networking technologies transition into software-based architectural approaches that encompass software-defined

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networking and network functions virtualisation (NFV), the networking skills used for such deployment are included here.

4.3.2 Business Intelligence/ Data Science

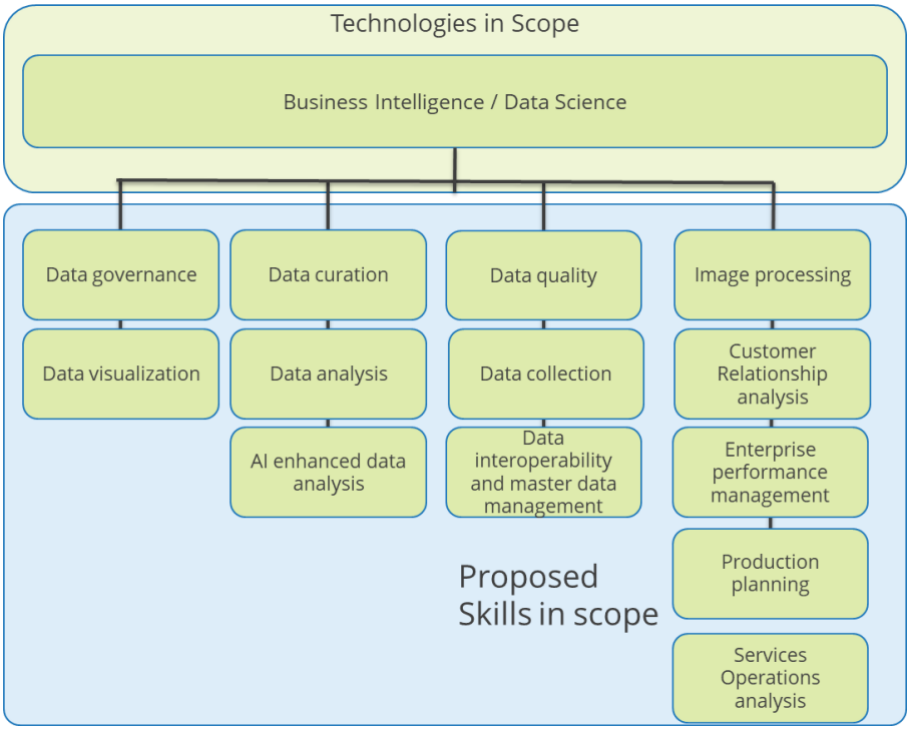

Figure 3: Skills in Business Intelligence/Data Science

Business related data management

Data governance

Data governance is the collection of processes, roles, policies, standards, and metrics that establish the processes and responsibilities that ensure the quality and security of the data used across a business or organisation. Data governance defines who can take what action, upon what data, in what situations, using what methods.

Skills within data governance include thorough understanding of the governing regulations within data privacy, such as GDPR and Sarbanes-Oxley act.

Data visualisation

Skills within data visualisation include the tools and techniques for visualisation and presentation of data, information and decision support, but also the thorough understanding of the business and processes that the visualisation will be used for.

The skills area includes understanding of end-user query, reporting, and analysis tools for ad hoc query and multidimensional analysis tools as well as dashboards, data visualisation, and production reporting tools, which provide users with business intelligence and analytics capabilities. Query and reporting tools are designed specifically to support ad hoc data access and report building by either IT or business users. The skills area includes also development and implementation of self-service data preparation functionality as well as a range of AI/ML-based features to automate specific steps in the business intelligence and analytics visualisation process.

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Data curation

Data curation is the process of creating, organising and maintaining data sets so they can be accessed and used by people looking for information. It involves collecting, structuring, indexing and cataloguing data for users in an organisation, group or the general public.

Skills within this area enable the access, blending, movement, and integrity of data among multiple data sources. It includes skills within data integration – ensuring consistency of information where there is a logical overlap of the information content of two or more discrete systems. Data curation skills also include the ability to curate new data types, structures, and content transformation that can occur over time as data management technologies evolve.

Data analysis

Data analysis is a process of inspecting and modelling data with the goal of discovering useful information, informing conclusions, and supporting decision-making. Data analysis skills includes understanding of the purpose for which the data will be used, be it for business or scientific purposes.

The area includes the understanding of data mining, data collection, data processing and data cleansing, even though in-depth knowledge and expertise is not required. The area also includes techniques both for structured data analysis, content analysis, real-time analysis and predictive analysis.

Content analysis relate to recognising, understanding, and extracting value from text or use similar technologies to generate human readable text. Content analysis includes language analysers and automated language translation as well as text clustering and categorisation tools.

Real-time analytics is in motion technology that continuously receives and transforms data in real time and in micro batches within streaming integration and streaming analytics.

Predictive analysis includes data mining and statistics. These tools and techniques use a range of techniques to create, test, and execute statistical models. Predictive analysis is used to discover relationships in data and make predictions that are hidden, not apparent, or too complex to be extracted using query, reporting, and multidimensional analysis.

AI enhanced data analysis

Skills within this area develop, configure and maintain data analysis enhanced by artificial intelligence (AI). The skills area provides the solutions to analyse, organise, access, and provide advisory on structured and unstructured information.

The technology components of AI enhanced data analysis include text analytics, rich media analytics (such as audio, video, and image), tagging, searching, machine learning, categorisation, clustering, hypothesis generation, question answering, visualisation, filtering, alerting, and navigation.

Data management

Data quality

The skill area represents the ability and responsibility of accuracy, completeness, consistency, reliability of data and whether it's up to date across multiple data sets.

Similar to data curation skills, skills within this area enable the access, blending, movement, and integrity of data among multiple data sources. It includes skills within data integration – ensuring consistency of information where there is a logical overlap of the information content of two or more discrete systems.

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Data collection

The skills area manages detection, collection and transfer of data into relational and non-relational transactional databases, data warehouses, data lakes etc. The sources for data collection are a wide variety, including other structured or non-structured databases, consumer devices, IoT devices, networks, event-based applications.

The skills also include quality assurance and quality control through established methods and techniques, including transfer protocols, and data representation translation. It also includes enforcing and implementing fraud prevention and security mechanisms in data transfer.

Data interoperability and master data management

These skills manage the consistency of information across multiple sources and the hierarchy of core information assets.

Master data management ensures the uniformity, accuracy, stewardship, consistency and accountability of an organisation's shared master data. Master data is the core information assets that are common across systems and information sources, and where the organisation needs to define how these information assets are created, maintained and distributed. Examples of master data are customer, item, citizen, chart of accounts, supplier.

Data interoperability ensures the distribution of master data and ensures that systems can receive and interpret received master data. It also ensures the consistency and operations of the receiving systems when master data is interpreted. The purpose of data interoperability is to ensure the consistency of information where there is a logical overlap of the information content of two or more discrete systems.

Skills in this area include understanding of analytic data integration - capture, prepare, and curate data for analytics.

Implementation – process specific

Image processing

These skills involve the development and management of systems used for recognising, identifying, and extracting information from images and video, including pattern recognition, objects, colors, and other attributes such as people, faces, cars, and scenery. These tools are used for computer vision applications and clustering, categorisation, and search applications.

Customer Relationship Analysis

This skills area involves decision making and analytic functions for customer facing business processes within an organisation, irrespective of industry specificity (i.e., sales, marketing, customer service, and contact centre). The skills and technologies in this area provide decision automation functionality to manage the entire life cycle of a customer — including the process of brand building, conversion of a prospect to a customer, and the servicing of a customer — and help an organisation build and maintain successful relationships. Interactions in support of this process can occur through multiple channels of communication. Channels of communication include but are not limited to email, phone, social media and website.

Enterprise Performance Management

Skills in this area provide decision support for performance indicators for an organisation.

It involves business / organisational process support - automation of a group of tasks pertaining to review and optimisation of business operations or the discovery and development of new business. The skills area also supports a time-based dimension for analysis of past and future trends.

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Production Planning

Skills in this area support and automate activities related to the collaborative forecast and continuous optimisation of manufacturing processes. Production planning span supply planning, demand planning, and production planning within organisations. These skills are involved in the development and maintenance of systems to identify demand signals, aggregate historical data that informs short- and long-term demand expectations and provide supplier capabilities across multiple manufacturing sites. These skills are also involved in the automation and support of logistics activities relating to moving inventory or materials of any type, such as managing physical inventory, whether direct or indirect; raw, in process, or finished; as a result of, or flowing into, a product supply chain–specific business process; or in support of performing a service. It also involves asset management activities related to management of an organisation's physical assets and product data management to coordinate, manage, and share product data throughout the product life cycle.

Services Operations Analysis

These skills support decision making and analytic functions in the services supply chain. These industry-specific skills cover activities such as analytics supporting claim processes (as applied to insurance functions), admissions/discharges and transfers of patients (as applied to healthcare functions), student retention and recruitment in higher education, or energy trading (as applied to energy and utility functions). Other examples of industry-specific analytic skills are those that enable decision support of real estate, legal services, banking and finance, government, social services, and transportation.

These skills also support workforce analysis – decision making and analytic functions across human capital management processes that cover the entire span of an employee's relationship with the corporation as well as management of other human resources used by the enterprise (e.g., contingent labor, contractors, and consultants), including human resources employed by suppliers and customers.

4.3.3 Cybersecurity/ Data Security

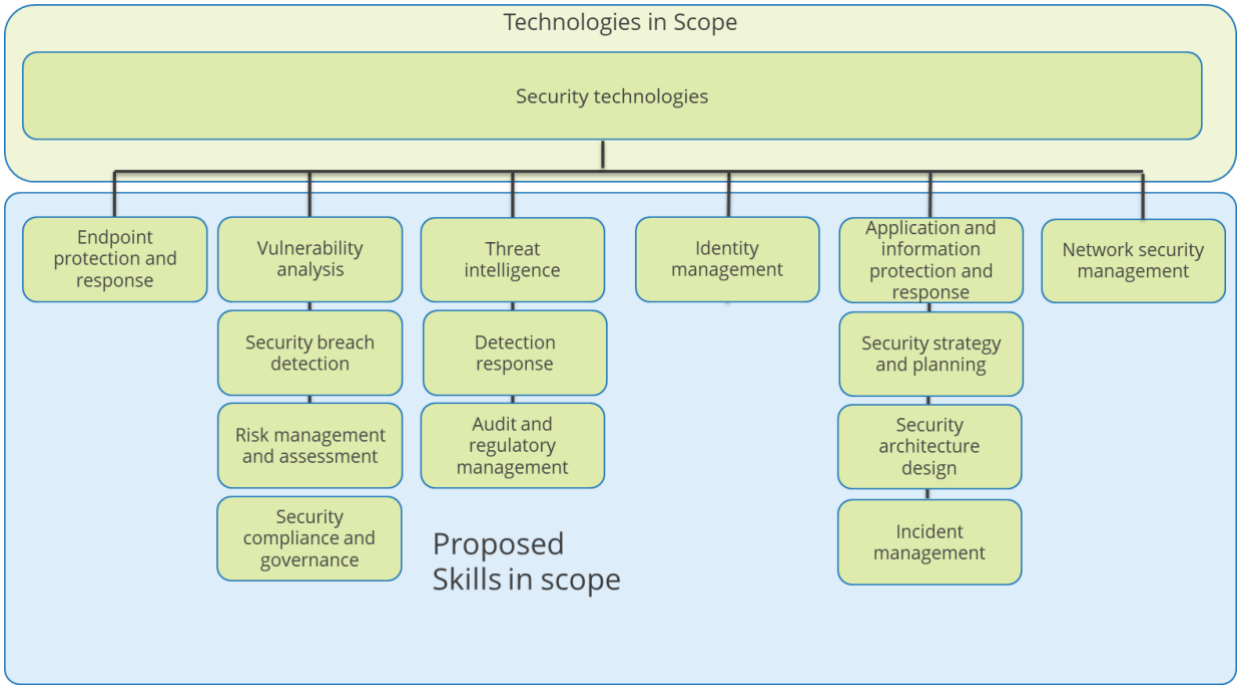

Figure 4: Skills in Cybersecurity

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Endpoint Security

Endpoint protection and response

The skills area for Endpoint Detection and Response (EDR) is related to the ability to use, set up and deploy tools that continuously monitors end-user devices to detect and respond to cyber threats like ransomware and malware. It includes (but not limited to) web filtering, correct use of antivirus software, Virtual Private Network (VPN) configuration and end-user security skills.

Security analytics

Vulnerability analysis

Skills related to analysing vulnerabilities with data by performing scanning, prioritisation and workflow management through the collection of telemetry data from the many other security tools in use such as firewalls, endpoint systems, cloud security systems, network detection systems, email security systems, and identity systems.

Security breach detection

Security breach detection skills, differently from endpoint security, are related to the protection of internal and custom-built applications and application infrastructure. Includes the understanding of Distributed denial-of-service (DDoS) mitigation against both infrastructure-based attacks and application layer attacks. Knowledge of Web application firewall, API protection (WAAP) and bot management that provides more specialised protection in complex systems.

Risk management and assessment

Risk management and assessment skills are related to planning threat models and scenario analysis. Includes the ability of operating cybersecurity sandboxes to emulate possible future threats and create a culture of cyber-readiness within organisations.

Security compliance and governance

Skills related to the governance, and compliance of cybersecurity and data security include the ability of establishing security taxonomies, quantification and the key approaches for an organisation to protect itself against external threats. One of the key market acronyms related to this skill and security area is Governance, Risk and compliance (GRC).

GRC and Forensics

Threat intelligence

Skills related to the gathering of information on external threats before these come to fruition within the organisation to help the security team prepare for a future attack. Related to risk management skills when it comes to preparing for breaches as information gathered externally can be used to run simulations of attacks with malwares and other malicious codes.

Detection response

Skills related to the containing and recovery from cybersecurity breaches by halting the effects of the attack before it causes further damage; this includes network and system's knowledge, containerisation and coding knowledge.

Audit and regulatory management

The ability to ensure that board-approved cybersecurity audit directives are implemented and simplify and organise the workflow and collaboration processes of compiling audits. This

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includes the overseeing of the implementation of cybersecurity standards and regulations for operations that are put in place by government agencies, allowing a business entity to remain in compliance with those regulations.

Identity

Identity management

Identity management skills relate to technologies and processes used to identify users (employees, customers, contractors, robots, and IoT devices) of IT services and to control their access to resources within that service by associating user rights and restrictions with an authenticated user account. In cybersecurity, the general skill applies for both cloud and on-premise environments.

Identity and role-based access cover identity management including B2C identity management and identity governance. Digital trust includes authentication and privileged access management.

Information and data security

Application and information protection and response

Skills related to the ability of safeguarding information within different applications and systems by applying methods such as: Privileged access management, authentication, managing sensitive data. This skill is related to identity management – however, it goes beyond managing credentials and identities of users as it enables the creation of secure channels of communication within a system.

Security strategy and planning

Skills related to the planning of a longer-term security strategy. They require a deeper knowledge on cybersecurity tools, staff and protection methods to plan the strategy ahead

Security architecture design

Secure access and segmentation skills include capabilities that protect internal network resources through use of policy enforcement and threat protection. This also includes knowledge of zero trust network access (ZTNA), network access control (NAC) and micro segmentation tools to provide granular access control and segmentation for users, devices, and applications that are operating primarily within the network perimeter.

Incident management

Skills related to the handling of cybersecurity incidents and breaches. Skills within this area are widely used by first line IT security analysts who are the first point of contact (POC) when handling an incident within an organisation or to end-user clients. This requires the knowledge of systems, CRM tools to log incidents and communication with other analysts/devs to solve the issues.

Network security

Network security management

Skills related to the management, setup and deployment of the network security within an organisation. Includes knowledge of firewalls, VPN, Secure Web Gateways, Zero Trust Network Access. When compared to security architecture design, network security management skills are more operational whereas the first is related to the planning and strategy of the security architecture.

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4.3.4 Quantum Technologies

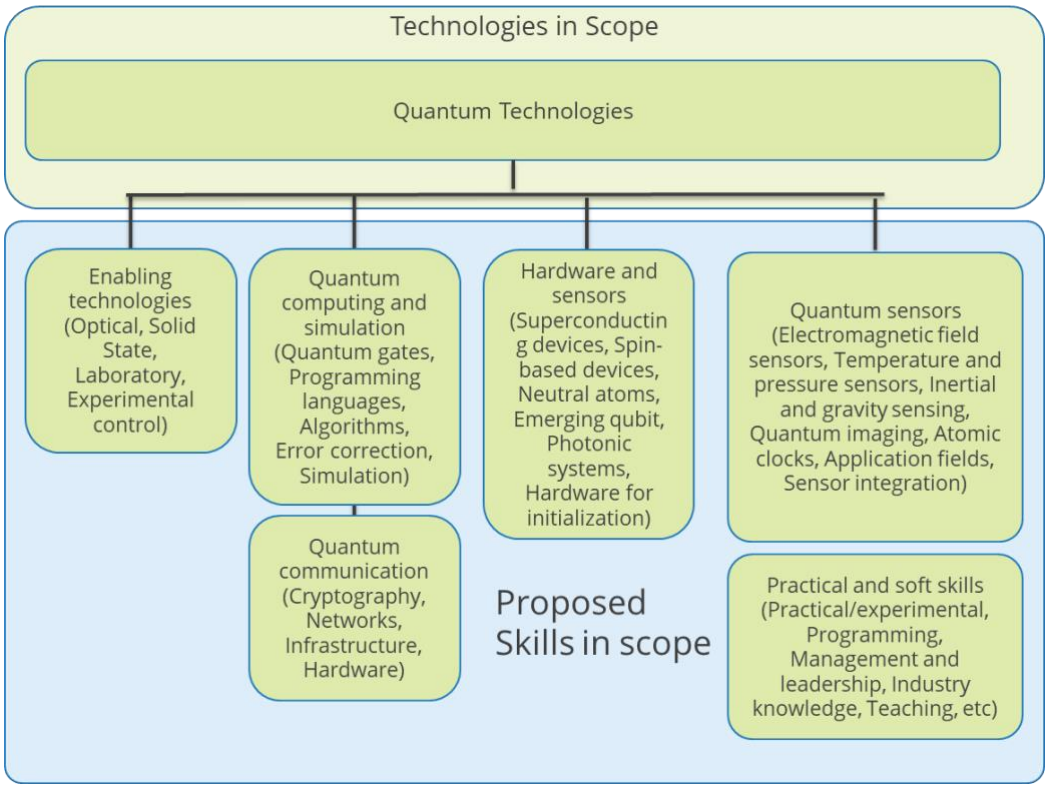

Figure 5: Skills in Quantum Technologies

Enabling technologies (Optical, Solid State, Laboratory, Experimental control)

Quantum skills on enabling technologies are the backbone of the quantum field and relate the abilities needed for the development of hardware systems that capture photons lights and measure its interaction with matter. It includes advanced knowledge of physics, material engineering and IT skills.

Quantum computing and simulation (Quantum gates, Programming languages, Algorithms, Error correction, Simulation)

Quantum computing skills are essential to the functionality of quantum computing hardware, specifically the execution of quantum operations such as optimisation analyses, error correction, and use case development. However, quantum programming languages and algorithms vary in complexity compared with those used for classical computing and many are still in early development. Skills within quantum computing include the development of workload-based applications and services that deliver a quantum advantage to businesses and organisations.

Quantum simulation skills relate to the development of high-performance devices or programs that enable a classical computer to execute programs written for quantum computers. In doing so, end users can compare how a program will run on quantum computers in relation to classical computers. Using this technology, end users can test, optimise, and prototype quantum circuits and solutions to be used on current or future quantum computing systems.

Quantum communication (Cryptography, Networks, Infrastructure, Hardware)

Quantum communications skills are related to enabling the transmission of data between quantum physics and quantum mechanics (i.e., superpositioning) to protect (using quantum cryptography) and transfer data (using teleportation) via quantum networks. Due to the unique

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quantum properties of quantum computing (i.e., superpositioning and entanglement) usual network and communication channels will not be able to share tomorrow's quantum data. Further, current encryption methods protecting the internet will not be resilient against quantum cyberbreaches. Therefore, quantum communication skills will be needed to develop the internet of the future that will be able to transport quantum data.

Hardware and sensors (Superconducting devices, Spin-based devices, Neutral atoms, Emerging qubit, Photonic systems, Hardware for initialisation)

Skills related to the development of Quantum-inspired computing platforms and technologies that enable quantum computations to be executed on quantum computing systems or quantum-inspired computing systems. This segment also includes skills that enable the utilisation and integration of quantum mechanics principles (i.e., superpositioning, entanglement) within quantum computations.

Quantum sensors (Electromagnetic field sensors, Temperature and pressure sensors, Inertial and gravity sensing, Quantum imaging, Atomic clocks, Application fields, Sensor integration)

Quantum sensing skills will enable the development of a quantum system and quantum properties (i.e., superposition, entanglement, interference, quantum state squeezing, and quantised energy levels) to perform highly sensitive measurements. While quantum sensors are still under development, possible use cases include:

- **Quantum gravimeter** used by geophysicists for mapping ground density by recording gravitational fluctuations such as those used to monitor volcanic behavior.
- **Quantum gradiometer** used by civil engineers when conducting underground surveys to identify dangerous structures (sewers, sinkholes, etc.) and utilities prior to starting construction.
- **Quantum gyroscopes** used to build commercial quantum navigation technology (these devices are more accurate and reliable than traditional GPS and GNSS. Portable quantum navigation systems are highly advantageous compared with GPS and GNSS, which are vulnerable to technical outages, cyberattacks, disruptions due to atmospheric or reflection effects, and interference. Current proof of concepts indicate that quantum sensing devices experience twice as much movement sensitivity compared with traditional sensors, leading to improved accuracy.)

Practical and soft skills (Practical/experimental, Programming, Management and leadership, Industry knowledge, Teaching, etc)

All soft skills related to the research and commercial scaling and commercial development of quantum solutions in a business and organisational level. This includes business management, communication, industry knowledge, academic expertise, etc.

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4.3.5 Artificial Intelligence

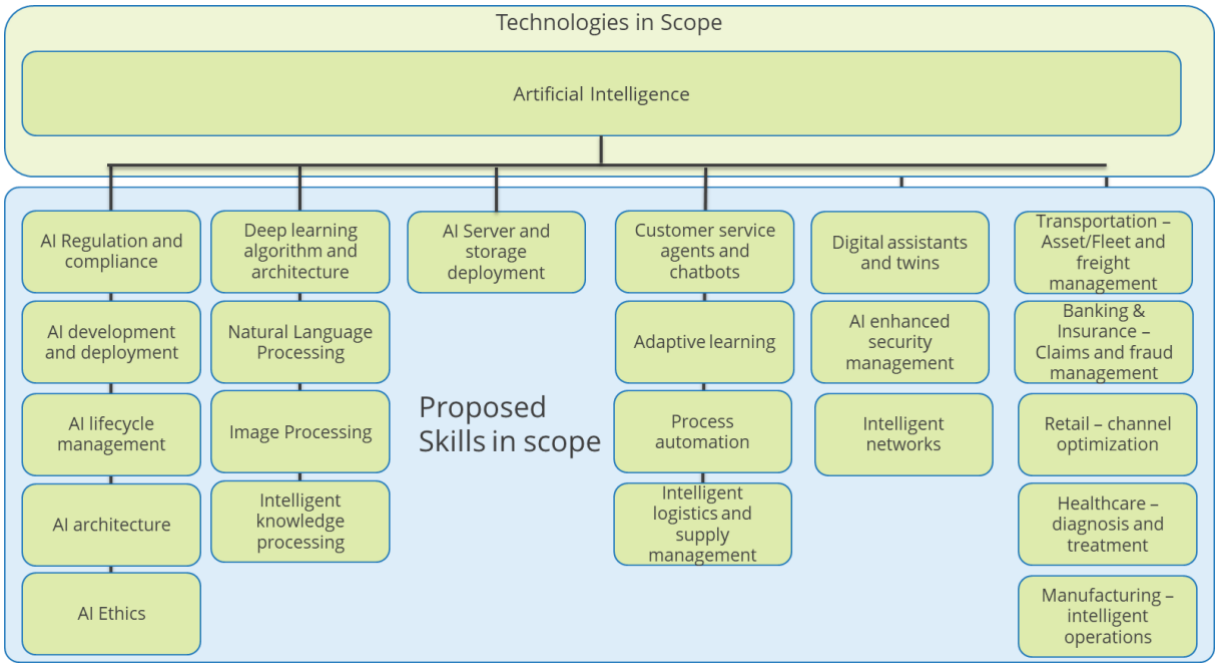

Figure 6: Skills in Artificial Intelligence

AI Application Development

AI Regulation and Compliance

Skills in this category allow organisations to efficiently address their immediate regulatory compliance, moving beyond the use of traditional structured data to leverage unstructured information and external data. This can be applied in real time to help deliver actionable insights, limit exposure, and reduce the impact of compliance and conduct issues that arise.

AI Development and deployment

Application development and deployment (AD&D) skills build, test, and deploy software as well as process, integrate, govern, and analyse data. Roles within AD&D use both AI-centric and non-AI-centric tools.

Skills within AI-centric tools are included in this skill category, and is where AI technologies are central and critical to the function of the tool, and if you eliminate these, the function would cease to exist. The tools need machine learning (supervised, unsupervised, reinforcement, etc.) and user/data interaction (e.g., NLP/NLG, Q&A processing, image/video analytics, and vision) or knowledge representation capability.

Skills within non-AI-centric tools are excluded from this category as they are tracked as a generic skill.

AI Lifecycle management

AI life-cycle management skills cover the tools and technologies used by data scientists and machine learning developers from experimentation to production deployments of AI and ML solutions. These technologies and capabilities facilitate key functions in four submarkets: data labelling, AI build, machine learning operations (MLOps), and trustworthy AI. Data labelling provides a skill set for businesses to turn unlabelled data into labelled data and build corresponding AI algorithms.

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AI build capabilities facilitate the ability to build, train, and tune advanced machine learning models. It typically includes the algorithms and models that data scientists and machine learning developers could use as starting point to customise and build their own models.

MLOps includes technologies and capabilities used to support model deployment and model management (including the monitoring of data and concept drift).

Trustworthy AI includes the tools and technologies used for model validation and assessment and for ensuring the safety and security of the models. It supports the foundational elements of trust for AI models, including software that helps with fairness, interpretability and explainability, robustness, lineage, and transparency.

AI Architecture

Skills within this category define the structure of AI development itself, but also how AI is positioned and used within other software development structures, methodologies, but also within the hardware architectures generic for cloud and on-premise applications. AI architects envision, build, deploy and operationalise an end-to-end machine learning (ML) and AI pipeline. AI architects can help build a robust enterprise wide architecture for AI and collaborate with data scientists, data engineers, developers, operations and security.

AI Ethics

As AI becomes more powerful, skills within AI Ethics define the policies and boundaries for the AI architecture, development and human interaction. The skills area contains ability to understand and define governmental regulations, as well as company policies for the implementation of AI in decision support, business processes, scientific research and deployment, human-machine interaction, etc.

Deep learning algorithms and architecture

Deep learning is a subset of AI and machine learning - a neural network with three or more layers. The neural networks attempt to simulate the behavior of the human brain, allowing it to “learn” from large amounts of data. While a neural network with a single layer can still make approximate predictions, additional hidden layers can help to optimise and refine for accuracy.

Skills within deep learning algorithms and architecture contain the ability to develop, deploy and maintain deep learning algorithms, and also to put the algorithms into business and organisational context. The skills area includes the ability to modify and develop the algorithms and architecture based on business and organisational outcomes. It also includes awareness of rules, policies and regulations concerning AI bias and AI ethics.

Natural Language Processing (NLP)

Natural language processing is the ability to extract people, places, and things (aka entities) as well as actions and relationships (aka intents) from sentences and passages of unstructured text. Natural language generation is the ability to construct textual/conversational narratives from structured or semi-structured data. Skills include the development, use and maintenance of NLP technologies, as well as the understanding of the generic software development context NLP is part of.

Image Processing

Image and video AI processing includes computer vision technologies that use AI and ML/DL techniques to process, understand, and extract information from digital images or videos. Image and video AI tasks include methods for acquiring, processing, analysing, and understanding digital images and the extraction of high-dimensional data to produce numerical or symbolic information (e.g., in the forms of decisions). Understanding in this context means that the transformation of visual images into individual components and associated metadata

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descriptions can be used in applications and can elicit the appropriate action. Image data can take many forms, such as video sequences, views from multiple cameras, and multidimensional data from a 3D scanner or medical scanning device.

Intelligent knowledge processing

These skills are related to finding, locating, and providing answers and pertinent information to knowledge workers. This includes traditional search and information retrieval/access systems as well as knowledge discovery systems that use AI, NLP, embedded knowledge graphs, and ML/DL to analyse various structured and unstructured forms of data from different repositories and to surface contextualised insights proactively within the flow of work to augment human intelligence. It includes departmental, enterprise, and task-based search and discovery systems as well as cloud-based and personal information access and general-purpose question answering systems. This capability also includes unified information access tools and systems that combine text analytics, clustering, categorisation, and search into a comprehensive information access system.

AI System Infrastructure

AI Server and Storage – architecture and deployment

These skills manage and enable bare metal infrastructure hardware resources to host higher-level AD&D software and application software and provide the virtualisation and management software used to configure, control, automate, and share the use of those resources across heterogeneous applications and user groups.

Primarily these skills manage the foundations for AI-centric software (*AI-centric software is where AI technologies are central and critical to the function of the software, and if you eliminate these, the software function would cease to exist. The software needs machine learning (supervised, unsupervised, reinforcement, etc.) and user/data interaction (e.g., NLP/NLG, Q&A processing, image/video analytics, and vision) or knowledge representation capability). Non-AI-centric software is managed by generic skills categories.

AI – Industry generic

Customer service agents and chatbots

Augmented customer service agents provide guidance for customer service via a learning program that understands customer needs and problems and reduces the time and resources spent in achieving customer issue resolution.

Skills in this category relate to the specific tasks and capabilities required for the functional development, deployment and operation of the AI portion of this specific use case.

Adaptive learning

This skill modifies the presentation of material in response to student performance. Intelligent AI adaptive learning adapts trends in real time based on every interaction a student makes, both within and between lessons. These skills include both learning in the education system and adult learning as part of enterprise continuous learning practices.

Skills in this category are related to the specific tasks and capabilities required for the functional development, deployment and operation of the AI portion of this specific use case.

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Process automation

Skills under Process automation or Intelligent Process automation relate to the automation of complex administrative tasks and back-office processes and operations. These complex tasks typically vary in frequency, are nonrepetitive in nature. The objectives of the skills related to this use case are optimising and streamlining complex business tasks that will allow a knowledge worker to make better decisions by incorporating more data into the decision-making process and by learning patterns that are outside the knowledge worker's purview. Examples include automated invoice processing, automated expense submission, and automated supplier qualification. AI systems orchestrate the linking of IT systems to become self-acting and self-regulating and automate mundane software maintenance activities. The automation engine can perform decision making and execution tasks of IT systems. New events are learned from IT human operators, not programmed by software programmers. The objectives are optimisation, streamlining, predicting, and automating core IT processes and back-end IT operations.

Intelligent logistics and supply management

AI is used to optimise and augment digital supply chain operations, resulting in end-to-end supply chain visibility. The objectives are predicting and optimising the flow of goods, using artificial intelligence to track raw material and completed products and to predict supply chain risk from planning and execution system data, allowing for supply chain resiliency. Skills and tasks related to this category include but are not limited to demand planning/forecasting, intelligent inventory management, smart warehousing, transportation optimisation, procurement and logistics optimisation, intelligent buying, smart capacity allocation, and production and cost optimisation.

Skills in this category are related to the specific tasks and capabilities required for the functional development, deployment and operation of the AI portion of this specific use case.

Digital assistants and twins

Skills in this category are related to the AI portion of the functional development, deployment and operation of digital assistants and twins.

Digital assistants help workers answer questions, predict future events, and provide recommendations internal to the workplace. Digital assistants help surfing over information related to a knowledge worker's ongoing daily efforts. Examples may include a worker completing a presentation with the help of a digital assistant going through existing files, notes, and presentations to provide additional content. Digital assistants perform actions on behalf of their users, unlike chatbots that generally don't.

Digital twins are continuously learning systems that can be queried automatically, or even by voice, for specific outcomes. The objectives are higher levels of design effectiveness, faster time to market, better customer requirements satisfaction, and lower engineering change costs. A true integrated model or digital twin of every item will be designed, produced, and maintained by manufacturers. The use of deep learning (DL) and AI results in a virtual model that is essentially the intelligent counterpart of an actual physical object.

AI enhanced security management

Skills in this category enable processing the intelligence reports, extract the critical pieces of information, structure information in a fixed format, and push the information into the pipeline of making connections between different pieces of information, and identify threat to database, systems, websites, and organisations.

It includes development, deployment and operations of tools and techniques that are related to the use case.

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Intelligent networks

Skills and capabilities in this category provide the design and implementation of rules and parameters governing the routing of inbound calling through the network. It also provides expanded use of real-time analytics to make the network smart, which includes rules to specify how calls are distributed according to the time and/or date of the call as well as the location of the caller. AI systems provide a customised experience for the caller and maximise the efficiency of inbound call handling.

AI – Industry specific

Transportation - Asset/Fleet and Freight Management

Skills related to this use case involve AI for freight management logistics (air, rail, land, and water) combined with supply chain logistics that intelligently monitors and provides end-to-end visibility; optimises truck loads, container management, spare parts planning, dock availability, and customer experience management; and provides intelligent insight to suppliers on the type of product, place, and time of delivery to guarantee best pricing.

It uses AI infrastructure for the visibility of assets and control systems, remote management, and real-time operational intelligence offering route optimisation, actionable responses to vehicle condition (remote diagnostics), and driver behaviour (tracking of idle or stopped time).

Banking & Insurance - Claims and Fraud management

Skills within this area involve AI for detection of illegal/illicit financial acts involving intentional deception and/or misrepresentation across different areas (i.e., operational and financial) of an organisation. AI systems may use rule-based learning to identify transactions that indicate fraudulent activity or the heightened risk of fraud. Typical cases where the skills are used are:

- Banking: Corruption (i.e., money laundering), cash thresholds, billing fee waivers, check tampering, larceny, and financial statement fraud
- Insurance: Analysis of claims adjusters' reports for anomalies using statistical and text analytics
- Securities and investment: High-yield investment fraud (i.e., pyramid and Ponzi schemes), broker embezzlement, late-day trading schemes, and market manipulation

The skills area also provides support, help, and guidance in intelligent data capture and analysis for investigators and adjusters to investigate and adjudicate insurance claims.

Retail - channel optimisation

This skills area involves AI that understands customer context in real time and recommends actions to the sales agents that are most relevant to the specific interactions, including recommendations on the "next best action" sales process to try and qualify or close a sale.

It also involves AI analytics to make sure the right product is in the right place at the right time.

Healthcare - diagnosis and treatment

This skills area involves AI to extract insights from the intersection of diverse data sets, including medical records, lab tests, clinical studies, medical images, and other sources, to assist in diagnosis and provide personalised treatment at the individual patient level.

The skills area also involves AI aimed at finding correlations among genomic, clinical trial, and electronic medical records to assist with research and analysis of pharmaceutical research and discovery.

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Manufacturing – intelligent operations

The area includes the use of machine learning algorithms to build an accurate predictive model of potential failures. Higher levels of asset availability results in less factory downtime and lower capital appropriation spending, including lower maintenance costs. The objectives are lower time and cost to repair, longer mean time between failure (MTBF), higher first-time fix (FTF) rates, and lower factory downtime.

The skills area also involves AI for manufacturing systems that perceive "out of specification" changes in the manufacturing process. These process changes could be detrimental to the quality of the product. AI systems recognise and know how to respond to these dynamic fluctuations by adapting the production to stay within quality targets.

4.3.6 Internet of Things

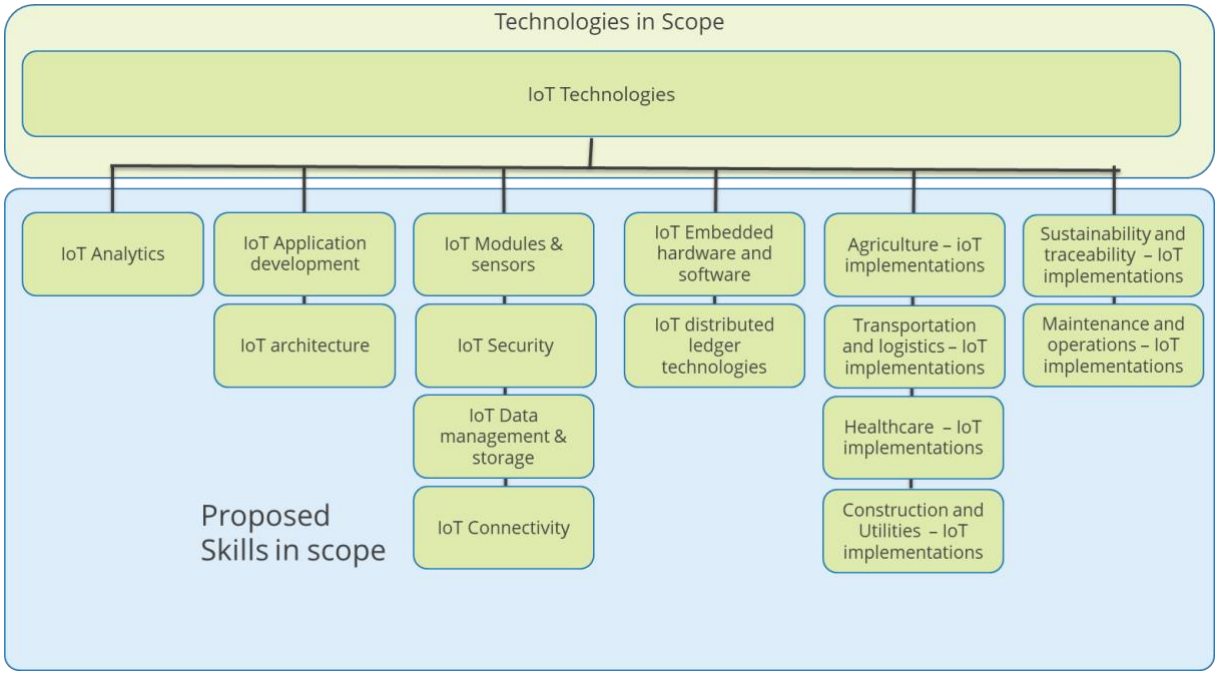

Figure 7: Skills in IoT

IoT Analytics

IoT Analytics

The IoT analytics skill provides the bridge between simply gathering IoT data and being able to use the information for business advantage. On top of knowledge in analytics and deep understanding of datasets, the skill requires the liaison with different sectors within an organisation as IoT data flows throughout the whole value chain.

IoT Applications

IoT Application Development

IoT application development skills include knowledge of software, tools, and development environments used by developers, business analysts, and operations professionals to create both web-based and traditional integrated applications. This includes knowledge of rapid application development and IoT modelling tools which are integral components of some IoT platforms. Skills within IoT application development may also converge with existing (non-IoT-specific) tools and environments to build IoT applications.

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IoT Architecture

IoT architecture skills are related to the planning, preparation, system integration and mapping of an IoT system. IoT architecture requires knowledge of building proof-of-concept of IoT systems before these are deployed, as well as understanding the general strategy behind the system and wider business plan being implemented.

Endpoint / Sensor

IoT Modules & Sensors

Skills related to the development and deployment of modules and sensors that capture live data and feed into the wider IoT system. On top of IT knowledge, IoT sensor specialists require engineering knowledge to develop the most suitable hardware for the business case organisations aim to complete.

IoT Security

IoT Security

IoT security skills, in addition to general cybersecurity skills, enable the monitoring, protection and incident response within IoT systems. The complexity of IoT systems create many possibilities for possible data breaches and attacks. Therefore, a wider knowledge of multiple security approaches is needed to secure an interconnected environment.

IoT Data Management & Storage

Data Management skills within IoT enable the management and consistency of information across multiple sources, as well as the hierarchy of core information assets. As IoT usually handles a vast amount of different datasets that need to be stored and treated to become interoperable, data management and storage skills are paramount for the functioning of IoT and usually require more advanced levels of expertise when compared to general data management.

IoT Connectivity

IoT Connectivity

Connectivity skills enable the interconnection between different monitors, sensors and servers within an IoT system. Requires knowledge of different network connectivity methods such as LAN, WAN and Bluetooth to enable the transmission of information across the system, as well as Data Acquisition Systems (DAS or DAQ).

IoT Embedded Hardware and software

IoT Embedded Hardware and Software

IoT Embedded Hardware and Software skills relate to the development of native applications that will operate within the IoT installed hardware to capture the needed information for the system to work. It may include knowledge on (but not limited to) mobile app development, API automation and testing and cloud development.

IoT Distributed Ledger Technologies

IoT distributed ledger skills enable the development, maintenance and deployment of databases that are shared, replicated, and synchronised among the members of a decentralised network. The distributed ledger records the information/transactions, such as the exchange of assets or data, among the participants in the network and work differently than a usual database as the data cannot be changed or tampered once a registration is done.

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Agriculture - IoT implementations

IoT implementation skills specific to the agriculture industry. Therefore, on top of the IT advanced skills, industry specific knowledge is required for its implementation. Within this skillset, there are two more widely known use-case examples:

- **Agriculture animal tagging**: refers to IoT skills that enable the development and deployment of sensors and tags to locate and identify animals grazing in open pastures, count numbers, determine theft, or determine their location in paddocks, large stables, and/or distributed environments
- **Agriculture field monitoring**: IoT skills that enable the integration of technology that supports farming and permanent crop cultivation through soil management. Improved crop yield, pest management, and soil management are direct benefits of this technology.

Transportation- IoT implementations

IoT implementation skills specific to the transportation and logistics industry. Therefore, on top of the IT advanced skills, industry specific knowledge is required for its implementation. Within this skillset, there are a few widely known use-case examples:

Air traffic monitoring: Skills related to monitoring, recording and integrating air traffic condition information (such as location, speed, and wind direction) impacting aircraft at diverse locations to minimise air risk based on real-time, continuous data.

Fleet Management: Refers to IoT skills to develop, deploy and enable the tracking of transportation assets (trucks, railroad cars, and ships) and determines/controls optimal routes to offer route guidance, track idle or stopped time, offer geo-fencing, and can include remote diagnostics for engine and other systems.

Intelligent Transportation: Refers to Iot skills related to the management of automated public transport, from buses light rail, subway systems, commuter rail, and other systems that provide public transportation. Includes skills on operating and integrating Global Positioning Systems (GPS), other sensors, and intelligent systems, which relay data about the vehicle or rail location, speed, and internal functions and aim to further optimise traffic control, boarding and maintenance of vehicles.

Healthcare - IoT implementations

IoT implementation skills specific to the healthcare industry. Therefore, on top of the IT advanced skills, industry specific knowledge is required for its implementation. Within this skillset, there are four more widely known use-case examples:

- Bedside telemetry: IoT implementation skills that support hospitalised patients whose physiological status requires close attention, allowing patients to be constantly monitored using IoT-driven, non-invasive monitoring. This includes the knowledge of sensors to collect comprehensive physiological information and integration with cloud-based systems to analyse and store the information.
- Health and wellness: Skills that bridge healthcare companies and consumers with IoT technology (such as the development of gadgets and health wristbands) that monitor an individual's physical condition.
- Hospital asset tracking: Skills that enable the location monitoring of high-value medical assets within a medical facility enabled by pervasive wireless LAN (WLAN) networking and beacons or active RFID (RTLS) associated with each piece of equipment, person, or tracked item.
- Remote health monitoring: Skills related to the development and deployment of home or remote healthcare that uses the IoT technology platform to improve quality of life

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and care through accurate and focused medical home monitoring. Typical devices considered are glucometers, blood press cuffs, oximeters, and data gateways.

Construction and Utilities - IoT implementations

Construction and Utilities IoT implementation skills enable the remote tracking, monitoring, and maintaining heavy construction machinery assets with the aim to improve uptime, eliminate unnecessary maintenance and improve process efficiency and reliability for construction companies.

Sustainability and Traceability - IoT implementations

IoT implementation skills specific to sustainability, including the development, deployment and maintenance of systems that focus, for example, on environmental monitoring detection and food traceability from harvesting to packaging and sale. On top of the IT advanced skills, specific knowledge on sustainability is required for its implementation.

Maintenance and Operations - IoT implementations

Skills related to the implementation of IoT systems that enable the tracking and monitoring of industrial operations in large factories that are part of the production value chain. This entails regularly assessing the equipment conditions and being able to remotely diagnose an equipment failure before it happens by analysing the live stream of data produced by the machine (predictive maintenance).

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4.4 Technology roles

The purpose of this section is to describe and define the scope of the LeADS technology job roles considered as in scope for the project. The purpose of including technology roles in the LeADS framework is to be able to link the advanced digital skills to a number of job roles widely used and that are reasonably common in the labor market.

However, there are a number of frameworks and definitions of ICT job roles that are used in parallel for a number of different purposes.

This section thereby serves three purposes:

1. To uniquely define job roles that are included and define ICT Professionals.
2. To link to relevant and widely used frameworks for ICT job roles.
3. To identify individual job roles that overlap the unique definitions in bullet 1 above, but that can be used to elaborate and bring further understanding.

The job roles framework will thereby be defined in layers:

- A **base layer** with unique definitions of non-overlapping roles. This base layer needs to be consistent and stable over time.
- A **reference layer** linking the unique definitions to other existing frameworks.
- **Additional layers** with relevant job roles and descriptions overlapping the base layer, but commonly used. These additional job roles are typically shorter in lifespan, but nevertheless widely accepted.

The mapping of skills to job roles will only use the base layer. The following picture shows a representation of how different layers relate to the model.

Figure 8: Layered representation of the job roles framework

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4.4.1 ICT job roles in scope – base layer

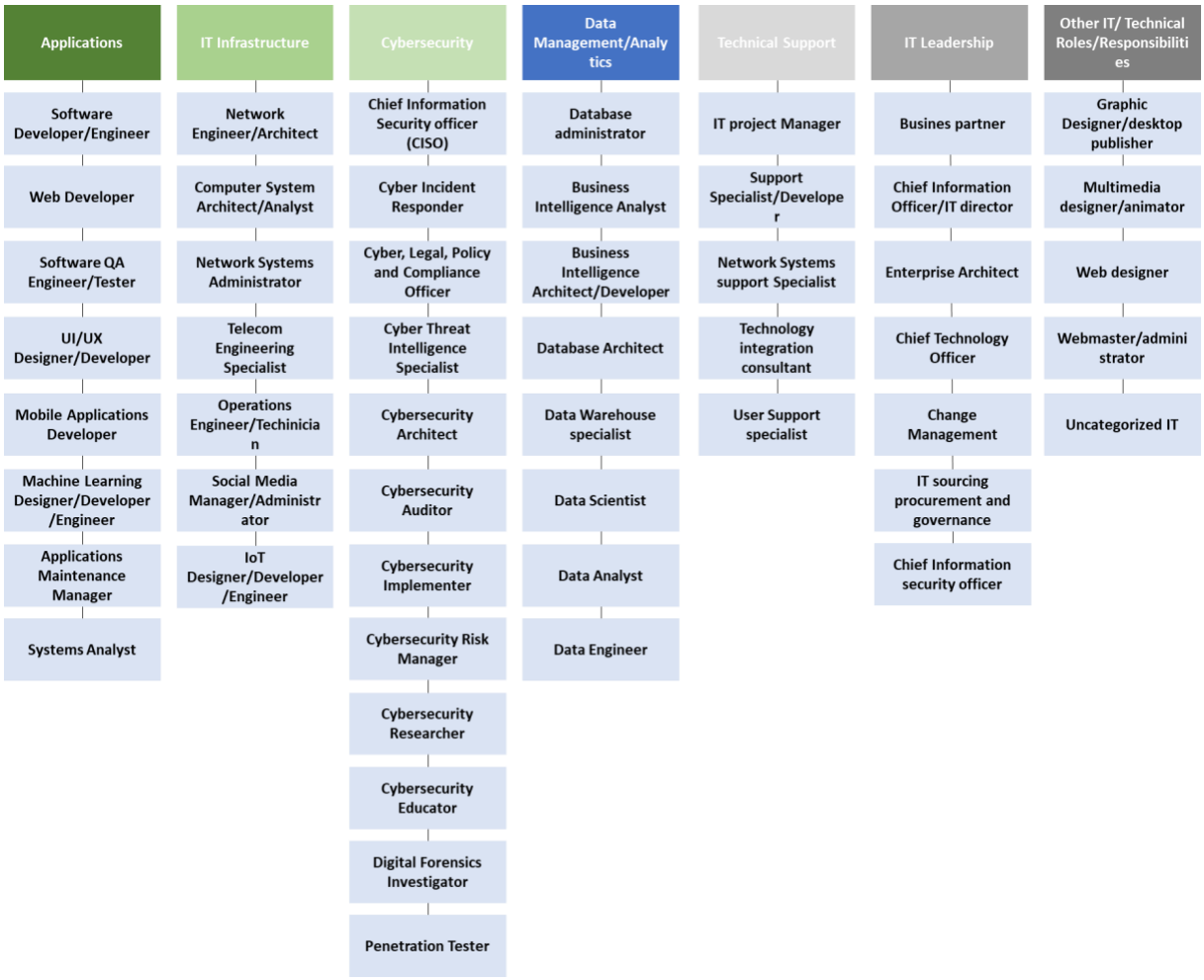

Figure 9: ICT Job Roles: base layer

As previously described, this base layer, based on IDC taxonomy, will help us to relate job roles that are used in industry with the associated skills, therefore providing a link for the quantification of the demand for Advanced Digital Skills. The table below provides a comprehensive presentation of definitions for each of the job roles in terms of responsibilities and establishes additional relationships with related jobs. Such definitions are not only important for wide understanding of the content as such, but to establish bridges with other frameworks that may use different terms of vocabularies, as depicted in section 4.4.2.

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Job role group	Job role	Responsibilities	Related jobs
Applications			
	Software Developer/Engineer	Research, design, and develop computer and network software or specialised utility programs. Analyse user needs and develop software solutions, applying principles and techniques of computer science, engineering, and mathematical analysis. Update software or enhance existing software capabilities through programming languages. Includes activities engaging with computer hardware engineers to integrate hardware and software systems, and to develop specifications and performance requirements. Includes activities to maintain databases within an application area, working individually or coordinating database development as part of a team. Provide consultative advice to development, overseeing the discussions, understanding and assimilation of external inputs to transform these into programmable actions.	Application consultant, Application developer, Application engineer, Backend developer, Computer Applications Engineer, Computer Systems Engineer, Devops engineer (partly), Integration developer, SCRUM master, Software engineer, System developer, Systems engineer
	Web Developer	Develop and implement websites, web applications, application databases, and interactive web interfaces. Evaluate code to ensure that it is properly structured, meets industry standards, and is compatible with browsers and devices. Present framework specs to optimise website performance, scalability, automation (including Artificial Intelligence capabilities) and server-side code and processes (either running on-premises and/or on cloud/serverless architecture). Includes activities to develop website infrastructure and integrate websites with other computer applications.	Intranet developer, Graphic web designer, Web content specialist, Web applications developer, Web architect, Full-Stack developer
	Software QA Engineer/Tester	Develop and execute software tests to identify software problems and their causes. Test system modifications to prepare for implementation. Document software and application defects using a bug tracking system and report defects to software or web developers. Create and maintain databases of known defects through documented test cases/scenarios. Understand and contribute to test automation to streamline checking processes. Includes participation in software design reviews to provide input on functional requirements, operational characteristics, product designs, schedules and sign-off.	Applications tester, Software quality assurance engineer/technician, Software quality control specialist, Software quality engineer, Software test engineer, Software test manager, Test Architect, QA Analyst
	UI/UX Designer/Developer	Design digital user interfaces or websites. Develop and test layouts, UI prototyping models, interfaces, functionality, and navigation menus to ensure compatibility and usability across browsers or devices. Includes using web framework applications as well as client-side code and processes. Develop User flows and carry out UX research to map out the steps end users take when accessing a new application. Includes evaluation of web design following web and accessibility standards and analysing web use metrics and optimise websites for marketability and search engine ranking. Includes activities to design and test interfaces that	Digital designer, Frontend designer/developer, User experience designer, UX researcher, Visual designer

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		facilitate the human-computer interaction and maximise the usability of digital devices, websites, and software with a focus on aesthetics and design.	
	Mobile Applications Developer	Research, design, and develop applications and systems specifically for mobile use/systems. Analyse user needs and develop software solutions, applying principles and techniques of computer science, engineering, and mathematical analysis. Apply database management principles, API and cybersecurity skills to increase security of mobile applications. Includes working with computer hardware engineers to integrate hardware and software systems and develop specifications and performance requirements. Develop and interlink mobile applications to wider systems and other devices using Internet of Things (IoT) capabilities.	Mobile applications designer, App Developer, Android/iOS Developer
	Machine Learning Designer / Developer / Engineer	Research, design, and develop data modelling, natural language processing, and solutions for machine learning and automation, including extraction and analysis of information from structured and unstructured datasets, and algorithms for deep learning. Apply programming skills with the purpose to train and retrain Machine Learning models for continuous improvement. Enriching automation frameworks and repositories for knowledge building purposes.	AI developer, AI architect, Automation engineer, Automation developer, Robotic Process Automation (RPA) specialist, ML Data Scientist
	Applications maintenance manager	Responsible for continuous operations of applications. Manage risk analysis, problem management, service levels, change management within the application, and overall responsibility for incidents and problems. Perform and prioritise improvements and changes in the applications, on the request from business or IT function. Liaison between business and IT roles to understand application running costs, profitability overall business goals. Translation of user-centric/business needs to a technical audience. (review)	Service manager, ITSM Service manager, Application manager, Customer success manager
	Systems analyst	Analyse engineering, business, and other data processing problems to develop and implement solutions to complex applications problems within IT applications. Perform integration functions, risk management, review application capabilities, workflow, and schedule limitations.	Digital analyst, IT specialist, Integration analyst, Service desk analyst, process analyst, Agile analyst
IT Infrastructure			
	Network Engineer/Architect	Design and implement computer and information networks, such as local area networks (LAN), wide area networks (WAN), intranets, extranets, and other data communications networks. Perform network modelling, analysis, and planning, including analysis of capacity needs for network infrastructures as well as required updates. Oversee the network implementation process and coordinate other members of the infrastructure team such as the Network Administrator. Includes the design of network and computer security measures. Provide technical support for hardware landscape (i.e., servers, routers, fiber optics) to installation and maintenance activities.	

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	Infrastructure & Cloud Architect/Analyst	Analyse engineering, business, and other data processing problems to develop and implement solutions to complex applications problems within IT infrastructure, system administrations issues, or network concerns. Develop cloud and hybrid (i.e., cloud and on-premises) infrastructure architecture and to improve data exchange and cross-communication between platforms. Perform systems management functions, improve existing computer systems, and review IT infrastructure capabilities, workflow, and schedule limitations.	Infrastructure analyst/architect, Infrastructure engineer, Operations analyst/architect, Cloud architect, Cloud analyst, Cloud specialist
	Infrastructure & Cloud Engineer	Install, configure, and maintain an organisation's operating systems, and physical and virtual servers. Provide decision support towards upgrading and budgeting for new hardware and assembly costs, software and related licenses. Perform system monitoring and verify the integrity and availability of hardware, network, and server resources and systems. Provide network support and troubleshooting to clients and colleagues in the IT team. Review system and application logs and verify completion of scheduled jobs, including system backups. Install, configure, and maintain local area network (LAN), wide area network (WAN), and data communications network, Analyse network and server resource consumption and control user access. Install and upgrade software and maintain software licenses.	Cloud engineer, Computer system engineer, Hardware engineer, Network operations engineer, Network tester
	Telecommunications Engineering Specialist	Design components for use in telecommunications, or instruments and controls. Design and install telecommunications equipment and facilities, such as electronic switching systems, optical fiber cabling, mobile network implementations and microwave transmission systems.	
	Operations Engineer/Technician	Create, modify, and test the code and scripts that allow computer applications to run and cross-communicate within a given IT infrastructure (including LAN and WAN) . Work from specifications drawn up by software and web developers or other individuals. Monitor and oversee cloud, on-premise server and network performance to troubleshoot. Includes developing / writing computer programs to store, locate, and retrieve specific documents, data, and information.	Devops engineer (partly), Applications operations manager/engineer, Service operations specialist, Network service support.
	Social Media Manager/Administrator	Plan, direct, and coordinate postings and interaction with social media, outside the web content creation. Use social media to expose new products, systems and recent developments made by the wider IT infrastructure team to build rapport with potential and existing clients. Apply Search engine optimisation.	Digital marketing manager, Digital marketing specialist, Community Manager, Digital media director, engagement manager/coordinator
	IoT Designer / Developer / Engineer	Operate, install, adjust, and maintain integrated computer/ communications systems, consoles, simulators, and other data acquisition, test, and measurement instruments and equipment, which are used in the "Internet of Things" (IoT). Strong knowledge of network security to minimise exposure risks within multiple hardware interactions.	Device engineer, IoT platform specialist
Cybersecurity			
	Chief Information Security officer (CISO)	Define, maintain and communicate the cybersecurity vision, strategy, policies and procedures. Manages the implementation of the cybersecurity	

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		policy across the organisation. Assure information exchange with external authorities and professional bodies	
	Cyber Incident Responder	Monitor and assess systems' cybersecurity state. Analyse, evaluate and mitigate the impact of cybersecurity incidents. Identify cyber incidents root causes and malicious actors. According to the organisation's Incident Response Plan, restore systems' and processes' functionalities to an operational state, collecting evidences and documenting actions taken.	
	Cyber, Legal, Policy and Compliance Officer	Oversee and assure compliance with cybersecurity- and data-related legal, regulatory frameworks and policies in line with the organisation's strategy and legal requirements. Contribute to the organisation's data protection related actions. Provide legal advice in the development of the organisation's cybersecurity governance processes and recommended remediation strategies/solutions to ensure compliance.	
	Cyber Threat Intelligence Specialist	Manage cyber threat intelligence life cycle including cyber threat information collection, analysis and production of actionable intelligence and dissemination to security stakeholders and the CTI community, at a tactical, operational and strategic level. Identify and monitor the Tactics, Techniques and Procedures (TTPs) used by cyber threat actors and their trends, track threat actors' activities and observe how non-cyber events can influence cyber-related actions.	
	Cybersecurity Architect	Design solutions based on security-by-design and privacy-by-design principles. Create and continuously improve architectural models and develop appropriate architectural documentation and specifications. Coordinate secure development, integration and maintenance of cybersecurity components in line with standards and other related requirements.	
	Cybersecurity Auditor	Conduct independent reviews to assess the effectiveness of processes and control and the overall compliance with the organisation's legal and regulatory frameworks policies. Evaluate, test and verify cybersecurity-related products (systems, hardware, software and services), functions and policies ensuring, compliance with guidelines, standards and regulations.	
	Cybersecurity Implementer	Provide cybersecurity-related technical development, integration, testing, implementation, operation, maintenance, monitoring and support of cybersecurity solutions. Ensure adherence to specifications and conformance requirements, assure sound performance and resolve technical issues required in the organisation's cybersecurity-related solutions (systems, assets, software, controls and services), infrastructures and products.	
	Cybersecurity Risk Manager	Continuously manage (identify, analyse, assess, estimate, mitigate) the cybersecurity-related risks of ICT infrastructures, systems and services by planning, applying, reporting and communicating risk analysis, assessment and treatment. Establish a risk management strategy for the	

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		organisation and ensure that risks remain at an acceptable level for the organisation by selecting mitigation actions and controls.	
	Cybersecurity Researcher	Conduct fundamental/basic and applied research and facilitate innovation in the cybersecurity domain through cooperation with other stakeholders. Analyse trends and scientific findings in cybersecurity.	
	Cybersecurity Educator	Design, develop and conduct awareness, training and educational programmes in cybersecurity and data protection-related topics. Use appropriate teaching and training methods, techniques and instruments to communicate and enhance the cybersecurity culture, capabilities, knowledge and skills of human resources. Promote the importance of cybersecurity and consolidates it into the organisation.	
	Digital Forensics Investigator	Connect artefacts to natural persons, capture, recover, identify and preserve data, including manifestations, inputs, outputs and processes of digital systems under investigation. Provide analysis, reconstruction and interpretation of the digital evidence based on a qualitative opinion. Present an unbiased qualitative view without interpreting the resultant findings.	
	Penetration Tester	Plan, design, implement and execute penetration testing activities and attack scenarios to evaluate the effectiveness of deployed or planned security measures. Identify vulnerabilities or failures on technical and organisational controls that affect the confidentiality, integrity and availability of ICT products (e.g. systems, hardware, software and services).	
Data Management/ Analytics			
	Business Intelligence Analyst	Apply data mining, data modelling, natural language processing, and machine learning to extract and analyse information from datasets. Visualise, interpret, and report data findings. Monitor data quality as first line of report for data governance.	Data analyst, Big Data analyst
	Business Intelligence Architect/Developer	Develop and implement techniques or applications to transform raw data into meaningful business information and insights using data-oriented programming languages and visualisation software. Apply automation, machine learning and new algorithms to increase the output of a data warehouse.	Big Data architect, Reporting developer
	Data Engineer	Responsible for designing, building and managing a business's operational and analytics databases, and for extracting data from the foundational systems of the business with techniques such as Extract, transform, load (ETL) so that can be used and leveraged to make insights and decisions.	
	Data Analyst	Analyse well-defined sets of data using different tools to answer business needs, by using raw or unstructured data to come up with analyses that produce results that can form basis for decision making. Responsible for applying data mining, data modelling, natural language processing, and machine learning. Visualise, interpret, and report data findings and creates	Business analyst, Market research analyst, Sales analyst, Financial analyst

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		user-oriented dynamic data reports. Implement frameworks and principles established by Business Intelligence architects, engineers and data scientists using relevant technologies including automation and AI.	
	Data Scientist	Develop and implement modelling techniques and/or analytics applications to transform raw data into meaningful information. Responsible for algorithms and statistical models for data analysis. Arrange undefined sets of data using multiple tools, applying and designing automation and frameworks.	Master data manager, Business intelligence specialist
	Data Warehousing Specialist	Create and optimise data models for warehouse infrastructure and workflow. Integrate new systems and databases with existing warehouse structure and refine system performance and functionality. Develop and maintain documentation on how the data warehouse is structured to map necessary upgrades and other developments of the system.	Data warehouse designer/ developer
	Database Administrator	Administer, test, and implement computer databases, applying knowledge of database management systems. Coordinate changes to computer databases. Identify, investigate, and resolve database performance issues, database capacity, and database scalability. Includes the planning, coordination, and implementation of security measures to safeguard computer databases.	Database engineer/operations specialist, Database security specialist
	Database Architect	Design strategies for enterprise databases, data warehouse systems, and multidimensional networks. Set standards for database operations, programming, query processes, and security. Model, design, and construct large relational databases or data warehouses.	Database designer/ developer/ specialist
Technical Support			
	IT Project Manager	Analyse and coordinate the schedule, timeline, procurement, staffing, resourcing and budget of an IT project, product or service. Lead and guide the work of technical staff. Serve as a point of contact for the client or customer	Technical project manager, Program manager, Project director, Project coordinator, Product manager
	Network/Systems Support Specialist	Analyse, test, troubleshoot, backup, maintain and evaluate existing network systems, such as local area networks (LAN), wide area networks (WAN), cloud networks, servers, and other data communications networks. Perform network maintenance to ensure networks operate correctly with minimal interruption.	Network incident manager, Network problem manager, Network Support technician
	Support specialist / developer	Create, modify, and test code and scripts to isolate or repair malfunctioning functions, systems, integrations and configurations. Manage internal technical support enquiries from other members of the team, such as engineers, project managers, and front-line support.	Incident manager, Problem manager, Root cause specialist
	Technology/Integration Consultant	Perform systems management and integration functions, improve existing computer systems, and review computer system capabilities, compatibility, workflow, and schedule limitations. Includes the analysis or recommendation of commercially available systems management and integration software.	Integration analyst/technician

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	User Support Specialist	Provide technical assistance to computer users. Answer questions or resolve computer problems for clients in person, via telephone, or electronically. Includes providing help concerning the use of computer hardware and software, including printing, installation, word processing, electronic mail, and operating systems.	Technical support manager
IT Leadership			
	Change Management	Creating and implementing change management strategies and plans that enable and maximise adoption in processes and organisation. Support in ensuring projects and change initiatives meet objectives on time and on budget by increasing adoption and usage. Change management focus on the people side of change, including changes to business processes, systems and technology, job roles and organisation structures.	Change manager, Business transformation manager, Change facilitator
	Chief Information Officer/VP/Director of IT	Senior executive responsible for the information technology and computer systems strategy to support enterprise goals.	Chief Digital Information Officer (CDIO), Information Technology (IT) Director
	Chief Technology Officer	Work alongside the CIO to translate the strategic IT planning into tangible technology systems, both on software and hardware sides. Plan, direct, and coordinate activities in such fields as data processing, information systems, systems analysis, and computer programming. Direct and monitor development, implementation and evaluation of an organisation's technological resources.	Head of technology, Head of development, Chief Technology Strategist, Chief Information Security Officer (CISO)
	Enterprise Architect	Broad functional responsibility to improve the IT department's functions and strategy to support future business goals. Will also create business architecture models that reflect business strategies and goals, evaluate engineering, talent and accounting models for risks and vulnerabilities.	Application enterprise architect
	IT sourcing procurement and governance	Support strategic sourcing, procurement, supplier diversity, and supplier relationships objectives. Manage governance and monitoring of supplier relationship. Interact with senior IT leaders to optimally source hardware, software and IT services.	IT Governance manager, IT Sourcing manager, Procurement specialist,
	Business Partner/Business Analyst	Analyse the organisation and design of technical systems, business models, processes and strategic business needs. A business analyst is also responsible for discovering the actual needs of stakeholders and express this in the form of requirements towards IT systems and enterprise architecture.	Transformation consultant, Business process analyst
	CISO	The CISO is responsible for an organisation's information and data security. The CISO develops security program guidance, directs and supervises the identification, development, implementation and maintenance of processes across the organisation to reduce business risks related to information and information technology (IT). Consolidates and analyses data to determine organisational security weaknesses and deficiencies. Responsible for the direct implementation of policies, compliance and procedures.	Chief Security Officer, Senior Information Security Officer (SISO), VP of security
Other IT/ Technology Roles/ Responsibilities			

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	Graphic Designer/Desktop Publisher	Design digital user interfaces or websites. Develop and test layouts, interfaces, functionality, and navigation menus to ensure compatibility and usability across browsers or devices. Includes using web framework applications as well as client-side code and processes. Includes the evaluation of web design following web and accessibility standards, and the analysis of web use metrics and optimisation of websites for marketability and search engine ranking. Design and test interfaces that facilitate the human-computer interaction and maximise the usability of digital devices, websites, and software with a focus on aesthetics and design.	Visual designer, User interface manager
	Multimedia Designer/Animator	Create special effects, animation, or other visual images using film, video, computers, or other electronic tools and media for use in products or creations, such as computer games and web animations.	Game designer/developer, User interface manager (multimedia)
	Web Designer	Design, create, and modify Web sites. Analyse user needs to implement Web site content, graphics, performance, and capacity. Produce publication-ready material. and align Search Engine Optimisation (SEO) principles with content so the information can be easily accessed by end users.	
	Webmaster/ Administrator	Responsible for maintaining company websites ensuring web servers, hardware and software are operating correctly, designing the website, generating and revising web pages. Research, analyse and implement Search Engine Optimisation (SEO), marketing tools and other resources (such as geo-targeting) to maximise exposure of web pages.	Web publisher, Web content manager

Table 1: Job roles definitions

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4.4.2 ICT job roles – reference layers

This section illustrates cross-reference between other job role frameworks and the base layer previously presented.

EUROPEAN SOFTWARE SKILLS ALLIANCE – ESSA

Figure 10: Roles in ESSA model (European SW Skills Alliance)

The ESSA initiative provides a framework to educate and train people into high demand software roles to skill, reskill, and upskill workers to cater for the future needs of our societies. Its ambition is quite aligned with that of LeADS, as it aims at closing the skills gaps and fulfilling the need for professional demand for software services. ESSA receives funding from the Erasmus+ programme and involves partners from industry and academia in order to define a European Software Skills Strategy and Curricula, learning programmes (EQF 4-7) & materials. Each of these assets is expected to be available in subsequent years, starting with the strategy in 2021, following with curricula in 2022 and Learning programmes and courses piloting and rollout in 2023. ESSA adopts European IT Professional Standards and frameworks, such as EN16234-1 e-CF together with EQF, to ensure a collective understanding of the new Software Skills Strategy between industry, education, and policy actors.

The focus of ESSA is on skills for software professionals, addressing a) skills required for the whole software lifecycle (software design, development, testing, troubleshooting, validation & verification, deployment, and maintenance), b) skills required to strengthen the software engineering discipline — for example, skills to ensure software quality and security and c) Transversal (soft) skills related to analytical thinking, problem-solving, communication, collaboration, business understanding etc.

LeADS presents higher granularity in the technical skills mentioned above and adds additional skills and technology areas not exclusively related to SW development. However, interoperability with this framework is of relevance for different reasons, including the link with curricula, programmes, and training that may already been using this framework.

A cross-reference to our proposed base layer will be provided in the final version of the LeADS framework.

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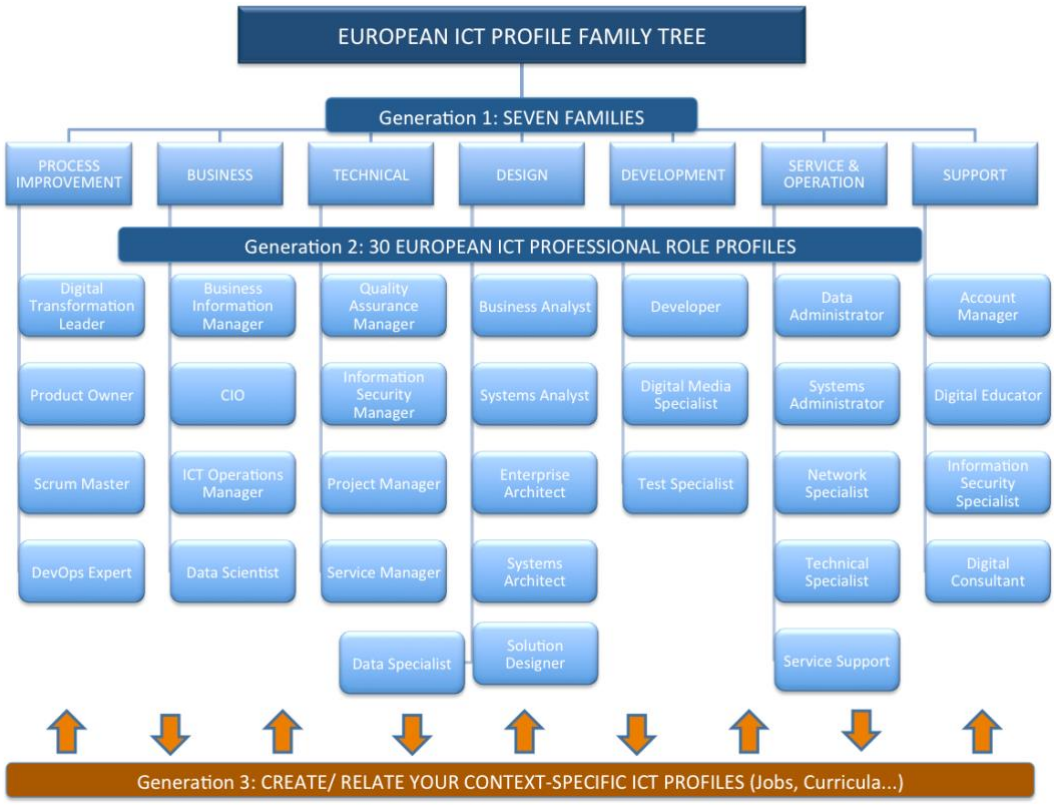
EUROPEAN COMPENTENCE FRAMEWORK – E-CF



As pointed out in the description of the ESSA framework, it is built on top of the European e-Competence Framework. The European Norm (EN) 16234-1 European e-Competence Framework (e-CF) provides a reference of 41 competences as applied at the ICT workplace, using a common language for competences, skills, knowledge and proficiency levels that can be understood across Europe. Its main advantage is that it can be used and understood by ICT user and supply companies, ICT practitioners, managers and HR departments, the public sector, educational and social partners across Europe. The framework has been developed by a large number of European ICT and HR experts in the context of the CEN Workshop on ICT Skills.

Some organizations facilitate navigation through the elements of the framework, such as IT Professionalism Europe through the e-CF explorer, an interactive tool to explore the competences and the 30 ICT Professional Role Profiles identified by CEN. The tool includes several dimensions as follows: 'Dimension 1' indicates the IT macro processes, 'Dimension 2' lists all the identified e-Competences and 'Dimension 3' shows the proficiency levels that apply to each competence. Definitions of roles as provided by e-CF are provided in the table below together with some references -still under work- to the base layer proposed by LeADS.

Figure 11: Roles in E-CF model (European Competence Framework)

e-CF Role	Description (Source: https://ecfexplorer.itprofessionalism.org/)	Reference to LeADS Base Layer (under revision)
Account Manager	Builds business relationships with clients to facilitate the sale of hardware, software, telecommunications or ICT services. Identifies opportunities and manages sourcing and delivery of products to customers. Has responsibility for achieving sales targets and maintaining profitability.	No reference – outside scope of base layer
Business Analyst	Analyses the information and the processes needed to support business plans. Formulates functional and non-functional requirements of the business organisation and	Business partner

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	advises on the lifecycle of the information solutions. Evaluates the impact in terms of change management.	
Business Information Manager	Proposes, plans and manages functional development of the Information System (IS) focusing upon the needs of users. Aligns the Information System to the business strategy within their area/domain. Ensures continuous enhancement whilst accounting for user requirements, service quality and budgetary constraints.	Business Intelligence analyst Business Intelligence architect / developer (partly)
Chief Information Officer	Develops and maintains Information Systems to generate value for the business and meet the organisation's needs. Ensures the alignment of the Information Systems strategy with the business strategy. Provides leadership for the implementation and development of the organisations architecture and applications.	Chief Information Officer
Database Administrator	Designs, implements or monitors and maintains data sets, structured (databases) and unstructured (big data). Administers and monitors data management systems and ensures design, consistency, quality and security.	Database administrator
Data Scientist	Leads the process of applying data analytics. Delivers insights from data by optimising the analytics process and presenting visual data representations. Finds, manages and merges multiple data sources and ensures consistency of datasets. Identifies the mathematical models, selects and optimises the algorithms to deliver business value through insights. Communicates patterns and recommends ways of applying data.	Data scientist
Data Specialist	Ensures the implementation of the organisations data management policy. Ensures asset protection through the provision of clean, consistent, quality assured data. Maintains the integrity of data, stores and searches data and supports presentation of data analysis.	Data analyst Data engineer Business Intelligence architect / developer (partly)
Developer	Designs and/ or codes components to meet solution specifications. Ensures building and implementing of ICT applications. Contributes to low-level design. Writes code to ensure optimum efficiency and functionality and user experience.	Software developer / engineer
DevOps Expert	Implements processes and tools to successfully deploy DevOps techniques across the entire solution development lifecycle. Applies a cross-functional, collaborative approach for the creation of customer-centric software solutions. Introduces automation throughout the software production system to deliver better software faster.	Software developer / engineer Operations engineer / technician
Digital Media Specialist	Integrates digital technology components for internal and external communication purposes. Designs and codes social media applications and websites. Makes recommendations on Application Programming Interface (API) and supports efficiency through appropriate content management systems.	Multimedia designer / developer
Digital Transformation Leader	Provides leadership for the implementation of the digital transformation strategy of the organisation. Drives cultural change and builds digital capability to deliver innovative business models and processes.	Change Management
Enterprise Architect	Designs and maintains the holistic architecture of business processes and information systems. Maintains a holistic perspective of the organisation strategy, processes, information, security and ICT assets. Links the mission, strategy and business processes to the IT strategy. Ensures project choices are integrated consistently, efficiently and in a sustainable manner according to the enterprise's digital standards.	Enterprise architect
ICT Operations Manager	Manages operations, people and overall ICT resources. Implements and maintains a designated part of an ICT operation ensuring that activities are conducted in accordance with organisational rules, processes and standards. Plans changes and implements them in	Applications maintenance manager

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	accordance with organisational strategy and budget. Risk manages and ensures the effectiveness of the ICT infrastructure.	
Information Security Manager	Leads and manages the organisation information security policy. Defines the information security strategy and manages implementation across the organisation. Embeds proactive information security protection by assessing, informing, alerting and educating the entire organisation.	Cybersecurity Risk Manager Cyber, Legal, Policy and Compliance Officer Chief Information Security Officer (CISO)
Information Security Specialist	Ensures the implementation of the organisation's information security policy by the secure and appropriate use of ICT resources. Defines, proposes and implements necessary information security techniques and practices in compliance with information security standards and procedures. Contributes to security practices, awareness and compliance by providing advice, support, information and training.	Cybersecurity Implementor Cybersecurity Researcher Cyber Threat Intelligence Specialist
Network Specialist	Ensures the alignment of the network, including telecommunication and/or computer infrastructure to meet the organisation's communication needs. Manages and operates a networked information system, solving problems and faults to ensure defined service levels. Monitors and improves network performances and security.	Network Engineer / Architect Network Systems administrator Network systems support specialist Telecom Engineering Specialist
Product Owner	Represents the needs of the stakeholder community, the voice of the customer, to the agile team. Understands customer requirements and validates that the developed software solution meets requirements. Links business and Agile teams.	Business partner
Project Manager	Manages projects to achieve optimal performance and results. Defines, implements and manages projects from conception to final delivery. Responsible for achieving optimal results, conforming to standards for quality, safety and sustainability and complying with defined scope, performance, costs, and schedule. Deploys agile practices where applicable.	IT Project manager
Quality Assurance Manager	Ensures that processes and organisations implementing Information Systems comply to quality policies. Establishes and operates an ICT quality approach aligned with the organisation's culture. Commits the organisation to the achievement of quality goals and an encourages an environment of continuous improvement.	Software QA Engineer / Tester
SCRUM Master	Leads and coaches an agile team. Creates a high performance self-managed dynamic team minimising impediments to development progress. Drives team by applying the agile process to achieve an optimised work-flow through continuous improvement. Supports team goals and coordinates activities with other teams.	Systems analyst
Service Manager	Plans, implements and manages solution provision. Manages the definition of Service Level Agreements (SLAs), Operational Level Agreements (OLAs) contracts and Key Performance Indicators (KPIs). Provides people management of staff monitoring, reporting and fulfilling service activities. Takes mitigation action in case of non-fulfilment of agreements.	Applications maintenance manager
Service Support	Provides remote or onsite diagnosis or guidance to internal or external clients with technical issues. Provides user support and troubleshoots ICT problems and issues. The primary objective is to enable users to maximise their productivity through efficient and secure use of ICT equipment or software applications.	Support specialist / developer
Solution Designer	Provides the translation of business requirements into end-to-end IT solutions. Proposes and designs solutions in line with technical architecture which fit business requirements and support change.	Computer system architect/analyst UI/UX designer/developer Web designer

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Systems Administrator	Administers ICT System components to meet service requirements. Installs software, configures and upgrades ICT systems. Administers day-to-day operations to satisfy continuity of service, recovery, security and performance needs.	Webmaster/administrator User support specialist Network systems administrator
Systems Analyst	Analyses organisation requirements and specifies software and system requirements for new IT solutions. Ensures the technical design and contributes to the implementation of new and/or enhanced software provision. Provides solutions for the improvement of organisational efficiency and productivity.	Systems analyst Data analyst
Systems Architect	Plans, designs and integrates ICT system components including hardware, software and services. Designs, integrates and implements complex technical ICT solutions ensuring procedures and models for development are current and comply with common standards. Monitors new technology developments and applies if appropriate. Provides technological design leadership.	Enterprise architect Cybersecurity architect Systems analyst
Technical Specialist	Maintains and repairs hardware, software and service applications. Effectively maintains customer hardware/software. Responsible for delivering timely and effective repairs to ensure optimal system performance and superior customer satisfaction.	Support specialist/developer Network systems support specialist Technology integration consultant User support specialist Telecom engineering specialist
Test Specialist	Designs and performs testing plans. Ensures delivered or existing products, applications or services comply with technical and user needs and specifications. For existing systems, applications, innovations and changes; diagnoses failure of products or services to meet specification.	Software QA engineer/tester

Table 2: Job roles definitions as per E-CF (European Competence Framework)

Again here, the granularity showcased by the LeADS model and the specific coverage of skills associated to high-impact technologies such as AI or Quantum demonstrate the added value of LeADS and the progress made with respect to the current state of play. Nevertheless, interoperability with relevant frameworks being used by stakeholders is key to ensure acceptance, validation and ultimately wide usage of the LeADS ADS framework and the sustainability of the actions taken.

4.4.3 Relevant ICT job roles – additional layer

Figure 12: ICT Job Roles: additional layer

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JOB ROLE CATEGORY	JOB ROLE	DEFINITION
Additional Individual		
	FinOps	FinOps is an evolving cloud financial management discipline and cultural practice that enables organisations to get maximum business value by helping engineering, finance, technology and business teams to collaborate on data-driven spending decisions
	DevOps	DevOps constitutes a grouping of roles across IT and management that combine Software Development (Dev) and IT Operations (Ops) capabilities to optimise the delivery of lifecycle of software, enabling organisations to promote a continuous stream of work, innovation and enhancements. DevOps teams are usually formed of developers, product owners, security engineers and quality assurance professionals usually following a workstream methodology (such as Agile) aiming to streamline work progress. Although the multi-faceted roles and capabilities of DevOps and other Ops have to be mentioned, it cannot be counted as a single occupation and therefore is not included in the base layers of the LeADS framework.
	AIOps	Combines operational data with machine learning, AI, and other analytic models to automate IT operations processes, including event correlation, anomaly detection and causality determination.
	NetOps	Much like automation and DevOps, or software-defined networking, NetOps involves the skills, people, and tools deployed by an organisation to deliver a network of services for its employees or end users.
	DataOps	DataOps is a collaborative data management practice focused on improving the communication, integration and automation of data flows between data managers and data consumers across an organisation.
	SecOps	SecOps, formed from a combination of security and IT operations staff, is a highly skilled team focused on monitoring and assessing risk and protecting corporate assets, often operating from a security operations centre, or SOC.
	GitOps	GitOps is an operational framework that takes DevOps best practices used for application development such as version control, collaboration, compliance, and CI/CD tooling, and applies them to infrastructure automation.
	SCRUM Master	Responsible for creating a high performance self-managed dynamic team minimising impediments to development progress. Drives team by applying the agile process to achieve an optimised work-flow through continuous improvement. Supports team goals and coordinates activities with other teams.
	NoOps	NoOps (no operations) is the concept that an IT environment can become so automated and abstracted from the underlying infrastructure that there is no need for a dedicated team to manage software in-house. NoOps role includes development, implementation and maintenance of NoOps concepts.
	CloudOps	CloudOps Engineer role requires maintaining reliable, fault tolerant infrastructure and application availability to meet the demands of our growing customer base. The SE will be responsible for production operations and releases of SaaS applications deployed in the public cloud

Table 3: Other ICT job roles definitions (additional layer)

4.5 Evolution of the framework

D1.1 presents an advanced version of the framework proposed by LeADS, specifically referring to the first two layers corresponding to the technologies/technology areas and the skills. The third layer, focused on job roles is less mature and requires farther comparison and analysis of additional reference skills frameworks for a complete understanding and relationship to widely accepted models that are currently being used by stakeholders on both the supply and demand sides.

The LeADS consortium envisages additional work on that layer in parallel to the analysis of feedback obtained from external experts that have been contacted for community engagement and validation. In particular, LeADS has pursued the following feedback activities:

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- Meeting with members of the Steering Board, representing different profiles and stakeholders, as a body entitled to guide LeADS from an strategic point of view. The framework was presented to them, and partners were available for questions and doubts. At the time of submitting this deliverable, formal feedback has not been provided yet.
- Workshop organised with a set of experts in some of the technology areas included in the framework, attended by 43 technology experts and with whom the framework was also shared. Elements of the framework, especially the layer of skills with all the definitions were provided in advance for prior analysis. At the time of submitting this deliverable, partners are in the process of analysing the feedback, since the amount of information captured during the session was huge and the workshop took place on the 15th of December, just shortly before the release of this report. See appendix I for a short description of the workshop and its format.
- Finally, tools used to gather feedback from the constituency attending the aforementioned workshop are being left open for additional inputs until the end of the year. Many of the organizations participating in the session expressed their high interest about the topic and we thought that some of their colleagues may want to add more details (or themselves) on the murals set up by LeADS to facilitate the discussion. Since BDVA (BI/ data science), AIOTI (IoT) and some partners like Martel (cloud) and BluSpecs (Quantum) took an active role in reaching out external communities associated to specific technology areas, we decided to focus the discussions particularly on some of those areas. Setting up additional murals will help us to get input on technologies that were not covered or not to the extent we wanted.

Additional feedback sessions may be carried out by LeADS for completeness and especially if some clarifications are needed or conflicts are to be sorted out due to different visions. As it can be perceived, some of the feedback collection is still under work and that is the reason why we decided to augment and refine the current version of the LeADS framework by end of January 2023, taking also advantage for further development of the job roles layer, as it has been depicted. At that time the framework will be deemed stable for the next phases of the project.

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5. CONCLUSIONS

D1.1 presents the current version of the ADS Framework proposed by the LeADS project. The Framework is a key element, since it provides the reference for the future work of the project and especially for the assessment of the demand and supply of ADS in Europe.

The LeADS framework is composed by three building blocks or layers: a) Technologies or Technology areas, b) Skills and c) (Job) roles.

Technologies

From a methodological point of view, two steps have been developed regarding (a): identification of technologies (long list) and scoping of our work by selecting a more limited number of technologies for the framework. The identification of technologies is based on a high number of data sources, including external data sources and especially a wide range of works and taxonomies previously developed by partners. The use of such an extensive umbrella of IDC taxonomies is based on the fact that IDC taxonomies are structured to meet the demand from the market on detailed market and forecast information and represent best estimates of the market spending by sector, industry, use case, and technology. One the initial list of technologies was identified, selection of technologies in our scope was done following these criteria: i) Relevance to the LeADS project, ii) Relevance to Europe as a digitally advanced region, iii) Qualify as Advanced (in reference to the ADS concept) and iv) Important in short to mid-term (since the timeframe of this study is 5-7 years). The result of this work includes the following technologies: **Cloud technologies, Business Intelligence / Data Science, Security technologies, Quantum technologies, Artificial Intelligence (AI), Internet of Things (IoT).** Definitions for all the technologies are provided as part of the framework.

Skills

For (b) the first step has been the identification of skills and skills grouping. Guiding principles of the methodology include: the need for consensus, usability, ability for further depth and variety, and technology driven approach (i.e., while we acknowledge the demand for soft skills, they are not part of the LeADS scope). Some of the sources used for such identification include but are not limited to ESCO framework, O*Net, the Occupational Information Network, Publications and open databases by Lightcast / Burning Glass Technologies, Role definitions and related descriptions provided by Bureau of Labor Statistics and ISCO-08 and other frameworks addressed in layer (c). The approach for selecting and prioritizing among different levels of detail and definitions is demand-driven: i) Technology and technology sub-market (if a certain technology or technology sub-market is in high demand and in high growth, the skills related to that technology (market) are deemed relevant for additional detail); ii) Use case (skills definitions are linked to use cases where demand and demand growth can be quantified or estimated), iii) Industry (certain skills are related to a specific industry, or a sector of industries. Where the demand for the respective industries could be quantified or estimated, the related industry related skills are deemed relevant for additional detail). As a result of this work, the framework provides identification and definition of relevant skills within each of the technologies selected in layer a).

Job roles

This layer of the framework is still *work in progress* and requires refinement. It defines job roles enabling us to link the advanced digital skills to a number of job roles widely used and that are reasonably common in the labour market. The job roles framework is also defined in layers: i) a base layer with unique definitions of non-overlapping roles. This base layer needs to be consistent and stable over time; ii) a reference layer linking the unique definitions to other existing frameworks and iii) additional layers with relevant job roles and descriptions overlapping the base layer, but commonly used. These additional job roles are typically shorter in lifespan, but nevertheless widely accepted. For i) we provide a tree of job roles with their

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formal definitions, For ii) two major frameworks widely used and accepted are depicted: the one of ESSA (European SW Alliance) and the E-CF (European Competence Framework). They are briefly described and referenced in the document, but further analysis is needed to establish the corresponding relationships with the LeADS framework looking at interoperability for wide understanding and acceptance. While these frameworks are important for our work, they are not enough for the objectives of LeADS. The granularity demonstrated by the LeADS framework and the specific coverage of skills associated to high-impact technologies such as AI or Quantum illustrates the added value of LeADS and the progress made with respect to the current state of play.

The work undertaken by this consortium on the framework has been confronted with the views of external experts. Several activities have been carried out to involve external constituencies, such as an interactive workshop (see Appendix I). Feedback is still being collected through different channels and will be analysed and considered for an evolved version of the framework where we do not expect radical changes, but we will rethink naming and groping of skills and maybe adaptation of the names of technology areas for the sake of consistency. For example, we may include more skills on edge computing and reflect that part more explicitly in the model (currently addressed as part of IoT). In addition, some comments have been received about the approach of sector-based skills with respect to cross-sector or horizontal ones. Some additional ones like energy, or applications that build upon some of the identified technologies, such as metaverse, may be considered. Section 4.5 describes the process for the evolution of the framework, which will be frozen for final released in January 2023, becoming a stable asset for the activities of demand and supply assessment.

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ANNEX 1: LIST OF TECHNOLOGY TAXONOMIES

- IDC Worldwide Black Book 3rd Platform Edition Taxonomy
- IDC Worldwide Black Book Live Edition Taxonomy
- IDC Worldwide ICT Spending Guide Enterprise and SMB by Industry Taxonomy
- IDC Worldwide IT Spending Guideline of Business Taxonomy
- IDC 3rd Platform (Cross Industry) Spending Guides Taxonomy
- IDC Worldwide Artificial Intelligence Spending Guide Taxonomy
- IDC Worldwide Augmented and Virtual Reality Spending Guide Taxonomy
- IDC Worldwide Big Data and Analytics Spending Guide Taxonomy
- IDC Worldwide Internet of Things Spending Guide Taxonomy
- IDC Worldwide Public Cloud Services Spending Guide Taxonomy
- IDC Worldwide Robotics and Drones Spending Guide Taxonomy
- IDC Worldwide Security Spending Guide Taxonomy
- IDC Worldwide Digital Transformation Spending Guide Taxonomy
- IDC Worldwide Edge Spending Guide Taxonomy
- IDC Worldwide Future of Work Spending Guide Taxonomy
- IDC Worldwide Future of Workstyle Spending Guide Taxonomy
- IDC Worldwide Technology Employment Impact Guide Taxonomy
- IDC Worldwide Quantum Computing Taxonomy
- IDC Worldwide Security Services Taxonomy
- IDC Quarterly Computing Platforms and Storage ODM Direct Tracker Taxonomy
- IDC Quarterly Enterprise Infrastructure Tracker Taxonomy
- IDC Quarterly Ethernet Switch Tracker Taxonomy
- IDC Quarterly Mobile Device Tracker Taxonomy
- IDC Quarterly Network Infrastructure Tracker Taxonomy
- IDC Quarterly Personal Computing Device Tracker Taxonomy
- IDC Quarterly Router Tracker Taxonomy
- IDC Quarterly Storage Software and Cloud Services Tracker Taxonomy
- IDC Quarterly Unified Communications and Collaboration Tracker Taxonomy
- IDC Quarterly Wearable Device Tracker Taxonomy
- IDC Quarterly Wireless LAN Tracker Taxonomy
- IDC Quarterly Workstation Tracker Taxonomy

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ANNEX 2 : WORKSHOP WITH EXPERTS

LeADS partners have contacted several experts along the initial phase of the project, ending up in the organization of a workshop on December 15 aiming at gathering feedback from experts on the current version of the framework.

The workshop attracted 40+ experts in different technologies (50+ registrations), and especially in BI/Data science, cloud, IoT and AI, thanks to wide dissemination performed by partners and with the active support of associations like AIOTI and BDVA, each of them with several hundreds of members. Instructions were provided prior to the workshop (preparatory phase), during the workshop (thanks to facilitators) and after (post-workshop feedback).

Preparation before the workshop:

We encouraged attendees to check the presentation used as basis to explain the framework, methodology, etc. as well as the Skills definitions. A summarized and targeted version of materials were provided in advance.

During the workshop: logistics & workshop format:

The workshop was run virtually through zoom for 2h with the following format:

- Plenary (informative) session where LeADS and the current version of the Framework were presented (30-40 min approx.)
- Then, we distributed attendees into 3 sessions based on their profiles, each of them devoted to more detailed discussions on skills in specific technology areas. The interactive sessions were led and facilitated by members of the consortium using the Miro tool. Murals were specifically prepared to guide discussions in:
    - **Business Intelligence & Data Science (partially including cloud computing)**
    - **Artificial Intelligence**
    - **Internet of Things**
- Brief reporting on major discussions in each of the parallel sessions

After the workshop

The relationship with participants has been followed-up by providing them with the ability to include further input in the murals set up for those technologies, and adding new murals in Miro for those with knowledge and willingness to contribute to other technology areas (e.g. Quantum, cybersecurity…).

At the time of submitting this deliverable, partners are analysing the feedback in detail and discussing on the impact on the framework so that some refinements can be made in the final version.

Some details about the Miro murals and input received by experts are included below as a matter of example.

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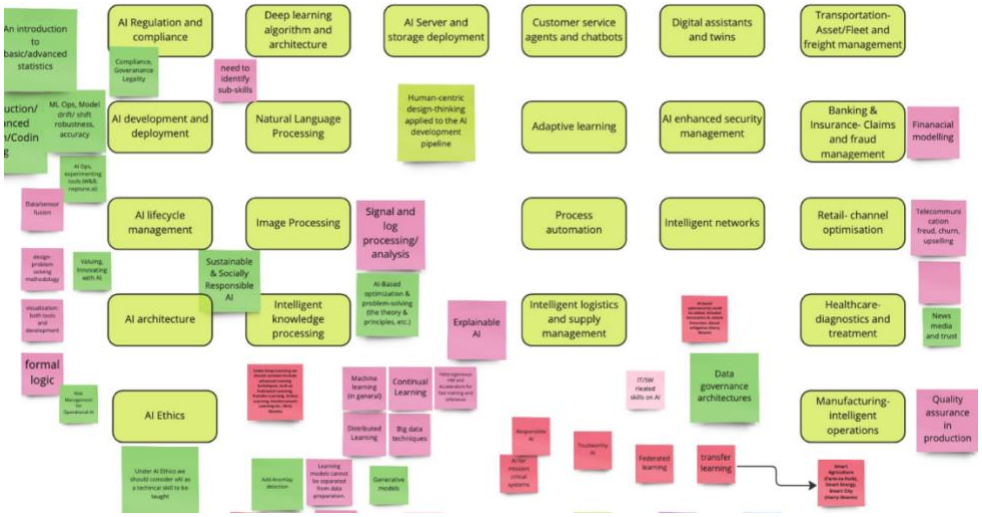
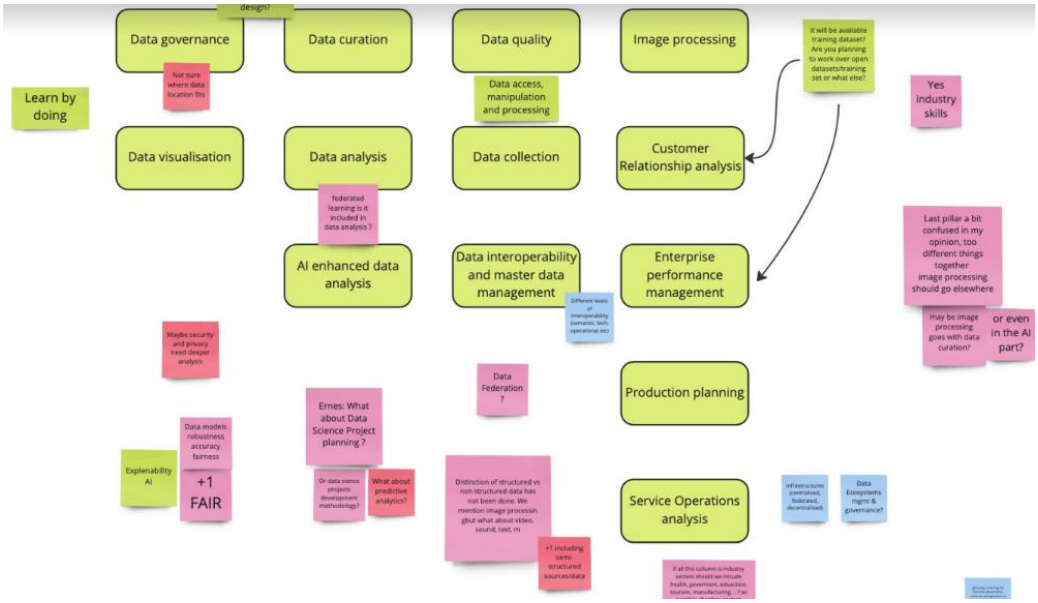
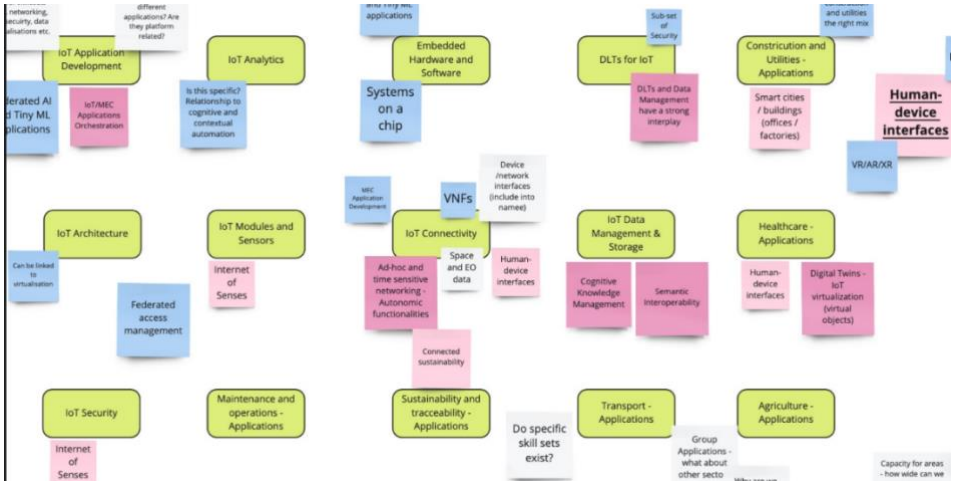


Details of the Miro mural on AI



Details of the Miro mural on BI/Data Science



Details of the Miro mural on IoT

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