Learning Arrangement Laboratory Report

WP3 - Deliverable 10/2023

DInO – Digital Innovation Ostbayern ist ein gemeinsames Projekt von:

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Introduction

This Learning Arrangement Laboratory Report – our first Deliverable in WP3 “Test before Invest” – gives an overview of our six services, which project partners are managing them and lists subject-specific didactic concepts as well as example workflows explaining how we plan to deliver our services. Our six services include: Dependability (Functional Safety & IT-Security), Eye-Tracking as a Digital Tool, AI and Machine Learning, IoT & UAV Test Lab, High Performance Computing Capacities and 5G Testbed.

Test before Invest encourages a focus on proof of concept, pilot programs, and prototype development to validate the project's objectives, ensuring that it aligns with the strategic goals and needs of our customers, fostering a more informed and calculated investment decision. With this work package we give companies the opportunity to try out new digital services and applications. Resulting proof of concepts and demonstrative implementations can serve as collateral for potential investors and financial institutions, demonstrating the effectiveness of anticipated changes and their capacity to assist clients in generating sufficient revenue to justify the investment. Adding to that, we want to create a close interlinking of science and business by combining the knowledge existing in our university laboratories.

The following document gives an overview of our service portfolio and explains our plan to deliver our services to our customers. First, we list the individual target groups consisting of SME’s and PSE’S. To ensure that we cover a wide range of customers each service developed individual subject-specific didactic concepts, ranging from seminars to customer centered problem-based-learning approaches. Afterwards an example workflow states the necessary steps. This workflow can be adjusted to customers’ needs and ensures that we develop and prepare content based on digital internal processes. This ensures not only that we pick up on individual problems, but adaptability also ensures that we maintain a low-threshold introduction to offers of DInO.

The Learning Arrangement Laboratory Report lists all covered technologies, infrastructure, and standards/norms. As customer needs differ, firstly an overview is given. A deeper explanation is given in the Appendix. This Report aims to show that all our laboratories are ready to provide their services and have established the according processes to support SME’s and PSO’S in Eastern Bavaria.

Task 3.1 – Dependability (Functional Safety & IT-Security)

Project Partner	**Project Team / Contact Person**
OTH Regensburg, Software Engineering Laboratory for Safe and Secure Systems (short LaS^3)	Meret Kristen Prof. Dr. Jürgen Mottok

Target Customers	**Number of targeted Customers** (as written in the proposal)
SME'S and PSE's	40 SME's and 10 PSE's

Equipment
• LaS^3 (optional eye tracking laboratory) • Bulletin board, flipchart, moderation cards

Selectable Learning Arrangements (depending on customer needs)
Getting an overview in … • Secure Software Development (SAMM) • Safe and Secure Coding in C/C++ • Secure Software Process Models (ISO/IEC 270xx, BSI Grundschutz, CISIS 12) • Safe Software Process Models (IEC 61508) • Security Awareness (optional with Eye-Tracking) • Product Security (e.g. pen-testing, fuzzing)

Available subject-specific didactic concepts
• Constructivism-based didactics • Seminar style in a workshop format • Problem-based learning (PBL), - problems proposed by the customer

Example WP Workflow
1. Needs analysis for the SME or PSE using a specific questionnaire (also identifying current problems) 2. Content selection involving choosing specific topics from a set of learning arrangements 3. Hands-on workshop in LaS^3 (or on site at the customers location) 4. Evaluation of hands-on workshop

Covered Technologies, Infrastructure and Standards
Secure Software Development • Software Assurance Maturity Model (SAMM) **Safe and Secure Coding** • MISRA-C, MISRA-C++ • CERT-C, CERT-C++ • more depending on customer needs

Functional Safety

- IEC 61508

Management of IT-Security

- ISE/IEC 27000 family
- BSI Grundschutz
- CISIS 12

Product Security

- Penetration tests
- Fuzzing

Security Awareness

- Phishing and Social Engineering
- Data Protection
- Password Security
- Incident Reporting
- …

Appendix: Description of covered Technologies, Infrastructure and Standards

Software Assurance Maturity Model (SAMM)

The Software Assurance Maturity Model (SAMM) is designed to help organizations assess and improve their software security practices. SAMM provides a structured approach for organizations to evaluate and enhance their software security posture. It does this through a three-tiered model that encompasses various aspects of software security. Organizations can use SAMM to assess their current security maturity level in each business function, identify gaps, and create a roadmap for improvement.

The SAMM model covers:

1. **Maturity levels** in terms of software security practices
2. **Business functions** that are crucial for the effective management of software security
3. **Security practices** that organizations can adopt to enhance their software security

Safe and Secure Coding

Safe and secure coding refers to the practice of writing computer programs or developing software applications with a strong focus on minimizing vulnerabilities and potential security risks. It involves adopting coding techniques, best practices, and security measures to ensure that software is not only functional but also resistant to attacks, exploits, and other security threats. By integrating security into the development process and following established coding standards, organizations can reduce the risk of security breaches and ensure the confidentiality, integrity, and availability of their software and data.

Safe and Secure coding covers the following key aspects:
Secure Coding Standards, Secure Development Lifecycle (SDLC), Code Reviews and Testing, Patch Management, Input Validation, Error Handling, Secure Communication,

Secure APIs, Data Encryption, Monitoring and Logging, Authentication and Authorization. Used standards include MISRA-C, MISRA-C++, CERT-C, CERT-C++ and others depending on the customer's needs.

IEC 61508

IEC 61508 is an international standard for functional safety of electrical, electronic, and programmable electronic systems. It provides a framework and guidelines for ensuring the safety of systems that are used in various industries, including manufacturing, chemical processing, transportation, and more. IEC 61508 is recognized globally and is used to assess and manage the safety of complex systems. It helps organizations ensure the safety of their systems and processes by providing a systematic and risk-based approach to functional safety management.

The IEC 61508 standard covers the following key aspects:
Risk-based Approaches, Safety Lifecycle, Safety Integrity Levels (SIL's), Functional Safety Requirements, Verification and Validation, Documentation and Records, Certification and Assessment, Use of Proven Techniques

CISIS 12

CISIS12 contains clear recommendations for action, structured in twelve steps that are continuously reviewed in a PDCA cycle. This structures the introduction and operation of the ISMS into clear and comparatively easy-to-handle packages. CISIS12 comprises a standard, an implementation manual, a building block and a catalog of measures. It was developed specifically for use in municipalities and SMEs. CISIS12 distinguishes between concrete measures for systematically and continuously increasing information security in the modalities "can", "should", "must". CISIS12 covers the following twelve steps:

1. Creating a guideline
2. Sensitizing employees
3. Establishing an information security team
4. Establishing an IT documentation structure
5. Creating IT service management processes
6. Compliance, processes and applications
7. Analyzing IT structure
8. Risk management
9. Target/actual comparison
10. Planning and implementation
11. Internal audit
12. Revision

ISE/IEC 27000 family

The ISO/IEC 27000 family, often referred to as ISO 270xx or ISO 27000 series, is a set of international standards and guidelines for information security management. These standards are published by the International Organization for Standardization (ISO) and the International Electrotechnical Commission (IEC) and provide a framework for organizations to manage information security effectively, address risks, and protect

their sensitive information assets. Depending on their specific needs and industry, organizations may choose to adopt and certify against the relevant standards in this family to enhance their information security practices. The ISO/IEC 27000 family includes several standards, with ISO/IEC 27001 being the core standard:

- ISO/IEC 27001: Information Security Management Systems (ISMS)
- ISO/IEC 27002: Code of Practice for Information Security Controls
- ISO/IEC 27003: Information Security Management System Implementation Guidance
- ISO/IEC 27004: Information Security Management Measurement
- ISO/IEC 27005: Information Security Risk Management
- ISO/IEC 27006: Requirements for Bodies Providing Audit and Certification of Information Security Management Systems
- ISO/IEC 27007: Guidelines for Information Security Management Systems Auditing
- ISO/IEC 27011: Information Security Management Guidelines for Telecommunications Organizations

- ISO/IEC 27017: Code of Practice for Information Security Controls for Cloud Services
- ISO/IEC 27018: Code of Practice for Protecting Personal Data in the Cloud

BSI Grundschutz

The BSI Grundschutz is a set of guidelines and recommendations for information security management developed by the German Federal Office for Information Security (Bundesamt für Sicherheit in der Informationstechnik, short BSI). Its primary purpose is to help organizations in Germany and beyond establish and maintain effective information security practices. It provides guidelines, security controls, and recommendations to help organizations protect their information assets and mitigate risks effectively. The set of guidelines include:

- BSI Standard 200-1: Information Security Management
- BSI Standard 200-2: IT Baseline Protection
- BSI Standard 200-3: Risk Analysis and Management

The BSI Grundschutz covers the following key aspects:
Threat and Risk Analysis, Standardized Security Controls, Compliance and Certification, Continuous Improvement, Compatibility with International Standards

Product Security

Product security refers to the measures and practices taken to design, develop, manufacture, and maintain products (such as software applications, hardware devices, or consumer goods) with a primary focus on ensuring their safety, reliability, and resistance to security threats and vulnerabilities. The goal of product security is to minimize risks and potential harm to users, organizations, and the integrity of the product itself due to security flaws, breaches, or vulnerabilities.

An introduction to penetration testing and fuzzing will be given.

Security Awareness
Security awareness refers to the knowledge, attitudes, and behaviors of individuals within an organization regarding information security. It is a critical aspect of an organization's overall cybersecurity strategy because it focuses on educating and training employees, users, and stakeholders about the importance of cybersecurity and how to protect sensitive information and assets from various threats and risks. Security awareness is a shared responsibility that extends beyond IT departments. It involves every member of an organization, from executives and managers to employees at all levels. By raising awareness and promoting a culture of security, organizations can significantly reduce the risk of security incidents and better protect their information assets.

Security awareness covers the following key aspects:
Phishing, Social Engineering, Data Protection, Password Security, Incident Reporting, Compliance and Policies, Training and Education as well as Attitudes and Mindsets

Empirical eye tracking studies are possible to measure the efficiency of the awareness measures

Task 3.2 – Eye-Tracking as a Digital Tool

Project Partner	**Project Team / Contact Person**
OTH Regensburg, Software Engineering Laboratory for Safe and Secure Systems (short LaS^3)	Fabian Engl Prof. Dr. Jürgen Mottok

Target Customers	**Number of targeted Customers** (as written in the proposal)
SME's	40 SME's

Equipment

- 16 Tobii Pro Spectrum Eye-Tracker
- 9 Tobii Pro Fusion Eye-Tracker
- Empirical study designs

Selectable Learning Arrangements (depending on customer needs)

- Usability Analysis for GUI-based applications
- Evidence-based Review-Support (Requirements, Design, Code)
- Supporting Trainings using EMME-Videos (Eye Movement Modelling Examples)

Available subject-specific didactic concepts

- Problem-based learning (PPL)
- Empirical Research Process
- Research-based learning

Example WP Workflow

1. Formulating of research hypothesis
2. Definition of the usability test plan and test script
3. Recruitment of test participants
4. Pre-Session interview with users
5. Conduct eye tracking survey on customer product
6. Post-Session interviews users
7. Evaluation and communication of the survey results

Covered Technologies, Infrastructure and Standards

Eye-Tracking Usability Evaluations

- GUI applications
- Review Process
- Modelling

Eye Movement Modelling Examples (EMME)

Usability Standards

- DIN EN ISO 9241 - 110 and - 112
- CPUX-UT

Appendix: Description of covered Technologies, Infrastructure and Standards

GUI Evaluations

Eye tracking can be used to evaluate applications using a graphical user interface (GUI) by monitoring and analyzing a user's eye movements while they interact with the software. This method provides valuable insights into how users visually engage with the interface, helping designers and developers identify usability issues, improve user experience, and optimize the GUI design. GUI's evaluations include:

- Fixations and Saccades
- Attention Distributions and Heat Maps
- Dwell Time and Areas of Interest
- and more depending on the use case

Evaluations of the Review Process

Eye tracking can also be used to analyze review processes such as code, requirement or design reviews. Here eye tracking provides additional insights into how reviewers interact with the code and where their attention is focused. Evaluations include:

- Focus of Attention
- Novice vs. Expert Comparisons
- Code Consistency and Style
- Bug and Issue Detection
- Understanding of complex Code

Evaluation of Modelling Processes

Eye tracking can support modeling processes and languages, especially in the context of software engineering and design. Among them are:

- Model comprehension
- Identification of Modell Elements
- Model Navigation

Eye Movement Modelling Examples (EMME)

Eye Movement Modelling Examples can visualize a user's eye movement by showing the eye movement on screen. This movement can support other users to follow instructions from experts by highlighting specific areas of interest and showing transitions on the screen. EMME can serve as a support tool for video trainings supplying attentional guidance. This guidance can help attendees to better follow complex explanations, models, code or many more.

DIN EN ISO 9241 - 110 and - 112

DIN EN ISO 9241-110 is an international standard that provides guidelines and recommendations for the design and evaluation of interactive systems with a focus on usability. It is part of the ISO 9241 series of standards, which cover various aspects of human-computer interaction (HCI) and ergonomics.

DIN EN ISO 9241-110 specifically addresses the usability of dialogue systems, including software applications, websites, and other interactive technologies. It serves as a valuable resource for designers, developers, and organizations aiming to create interactive systems that are both functional and user-friendly.

It promotes best practices in usability and human-computer interactions including:

- User-Centered Design
- Usability Goals and Requirements
- Usability Evaluation
- Consistency and Predictability
- User Satisfaction

The DIN EN ISO 9241-112 is an international standard that provides guidance on the design and evaluation of dialogues in human-computer interaction (HCI) with a specific focus on accessibility. It primarily focuses on ensuring the accessibility of information and communication technology systems. It provides principles and guidelines for designing user interfaces and dialogues that are inclusive and accessible to a wide range of users, including those with disabilities. Key aspects include:

- Detectability
- Interpretability
- Consistency
- Distinctiveness
- Compactness of Content
- Avoidance of Distraction

CPUX-UT

The Certified Professional for Usability and User Experience - Usability Testing (short CPUX-UT) is a certification program for individuals who specialize in usability testing and user experience (UX) research. It is part of the CPUX certification series, which is administered by the International Usability and UX Qualification Board (UXQB).

The CPUX-UT certification is designed to validate the knowledge and skills of professionals involved in planning, conducting, and analyzing usability tests to improve the usability and user experience of products and services. It covers:

- Usability test planning and preparation
- Selection and recruitment of test participants
- Usability test facilitation and moderation
- Data collection and analysis techniques
- Reporting and communication of usability findings
- Ethical considerations in usability testing

Task 3.3 – AI and Machine Learning

Project Partner	**Project Team / Contact Person**
OTH Regensburg, Regensburg Center of Artificial Intelligence (short RCAI)	Benno Bielmeier Prof. Dr. Wolfgang Mauerer

Target Customers	**Number of targeted Customers** (as written in the proposal)
SME'S and PSE's	40 SME's and 10 PSE's

Equipment

- Advanced High-Performance Computing (HPC) setup featuring two Supermicro Nvidia A100 GPU servers along with an IBM Power 9009-22G system
- Comprehensive open-source toolbox equipped with standard Machine Learning tools, including Docker and Jupyter Notebook/Lab to facilitate research and experimentation
- Fully virtualized environment hosted on our local cloud infrastructure, fortified with state-of-the-art security mechanisms to ensure data integrity and confidentiality
- Seminar room equipped with visual aids and collaborative tools, enhancing the quality of presentations and fostering collaborative learning experience

Selectable Learning Arrangements (depending on customer needs)

- Modular online courses and tutorials covering basics about AI and its adoption in SMEs
- On-site training and consultations tailored to the specific needs of individual SMEs
- Interactive webinars and virtual workshops, allowing participants to engage in discussions during the session
- Mentorship programs
- Peer Learning Groups
- Series of guest speakers from successful AI adoption projects
- Expert panels and roundtable discussions
- Simulation and sandbox environments, allowing SMEs experimenting with AI tools and models

Available subject-specific didactic concepts

Methods

- Feasibility assessment to determine whether AI technologies align with goals and needs
- Readiness check to adopt AI considering infrastructure, data quality and personnel skills
- Use case identification
- Proof of Concept (PoC) to test the feasibility and potential impact of machine learning solutions on specific problems or processes

- Ethical considerations of effects and impact on people and society
- Making realistic adjustments to over-optimistic expectations in AI capabilities and subproject management tasks
- Development of Minimum Viable Product (MVP)

Principles

- learning-by-doing
- fail fast, learn faster
- sustainability
- collaborative development and sharing of best practices

Example WP Workflow

1. Initial interview to analyze the SME's or PSE's needs
2. Optional: Introductory workshop on AI technologies (at RCAI or on the customer's site)
3. Optional: AI Use Case workshop to identify and prioritize valuable AI applications (at RCAI or on the customer's site)
4. Optional: Iterative engineering consulting on data collection and pre-processing, ML algorithm selection, optimization, evaluation and deployment; Monitoring of the project's progress
5. Optional: Hands-On exploration with case studies using RCAI's HPC infrastructure
6. Feedback and evaluation interview with future perspectives

Covered Technologies, Infrastructure and Standards

AI Capabilities

- Natural Language Processing
- Computer Vision
- Time series analysis
- Simulation
- Reinforcement Learning: Optimization and Control
- Pattern recognition
- Forecasting
- Generation

AI Application

- Machine Learning Algorithms & Machine Learning Frameworks
- Data Science Toolkits
- Cloud Computing

Best Practices and Standards

- Data Storage and Management
- Open-Source Libraries and Open Data
- (Model Deployment)
- Security and Privacy
- Regulatory Compliance

Appendix: Description of covered Technologies, Infrastructure and Standards

AI Capabilities

Artificial intelligence (AI) encompasses a wide range of techniques that empower machines to perform tasks that typically require human intelligence. Within AI, there are several subfields, each focusing on specific aspects of intelligent behaviour. These subfields include the following.

Natural Language Processing (NLP) involves the development of algorithms and models that enable computers to understand and generate human language. It is used in applications such as sentiment analysis, machine translation, and speech recognition, with applications in customer service and language translation.

The subfield of computer vision focuses on teaching computers to interpret and understand visual information from images and videos. It includes tasks like object recognition, image segmentation, and facial recognition, with applications in self-driving cars and medical imaging.

Time series analysis is a statistical technique used to analyse and predict data that changes over time. It uses mathematical models and machine learning algorithms to identify patterns and trends in time-stamped data, making it valuable in fields like finance, economics, and healthcare.

Simulation involves using algorithms and statistical models to replicate real-world situations and predict their behaviour. This technology finds applications in weather forecasting, traffic management, and supply chain optimization.

Reinforcement learning focuses on training agents to make decisions in complex and uncertain environments. It enables agents to learn from feedback and optimize their behaviour to achieve specific goals. Reinforcement learning is used in robotics, game playing, and recommendation systems.

Pattern recognition involves the use of algorithms and statistical models to classify data into predefined categories based on their features and characteristics. It is widely used in image recognition, speech recognition, and natural language processing.

Forecasting is a statistical technique that predicts future values based on past data. Machine learning algorithms and statistical models are used to identify patterns and trends in historical data, making it essential in fields like finance, economics, and healthcare.

Data generation uses AI models like Generative Adversarial Networks (GANs) and Variational Autoencoders (VAEs) to create new data or content. It is applied in entertainment, advertising, and design to generate realistic images, videos, music, and text.

AI Applications

In the realm of AI applications, we place significant importance on the following aspects, each briefly explained, that enable organizations to build and deploy sophisticated machine learning models that can analyse large datasets, make predictions, optimize decisions, and improve business outcomes.

Machine learning algorithms use statistical models and computational techniques to identify patterns, make predictions, and optimize decisions based on large datasets, each with individual strengths and drawbacks. Usually, they are provided bundled in machine learning frameworks, software libraries that provide the tools and infrastructure for building and deploying such models. These frameworks simplify the

process of developing and training machine learning algorithms by providing pre-built components, datasets, and visualization tools. Examples of popular machine learning frameworks include TensorFlow, PyTorch, Keras, and Scikit-Learn.
Before the actual training phase of machine learning, the available data is analysed and pre-processed leveraging data science toolkits, software suites providing a range of tools and techniques for data analysis and visualization and enabling efficiently working with large datasets. Examples of popular data science toolkits include Anaconda, Jupyter Notebook, and R Studio. By combining the advantages of both text-based explanations and interactive code execution, Python and R notebooks may lower the learning curve for practitioners.
As working with big amounts of data is computationally intensive, delivering computing resources over the internet in the form of cloud computing is generally used, where users can access and use computational resources such as servers, graphics processing units (GPUs), storage, databases, software, and analytics on-demand. Cloud computing enables organizations to build and deploy machine learning models at scale without investing in expensive hardware or infrastructure. Popular cloud computing platforms include Amazon Web Services (AWS), Microsoft Azure, Google Cloud Platform (GCP), and IBM Cloud. Typically, applications on cloud platforms are hosted in Docker containers to ensure proper isolation of application-specific dependencies and workloads.

Best Practices and Standards

Organizing and storing vast amounts of data efficiently becomes a crucial need for the fast development of various AI models. Various data storage systems, such as relational databases, NoSQL databases, and data warehousing solutions, play a pivotal role in this endeavour. By leveraging the insights gained from previous projects, organizations can optimize their data storage strategies, allowing for rapid exploration of diverse AI approaches and faster development cycles.

Not only for newcomers to the realm of AI but also for experienced players, *open-source libraries and open data* are valuable resources due to their being freely available to use and modify. Open-source libraries such as NumPy, SciPy, Matplotlib, and pandas provide pre-built functions and algorithms that can be used to build machine learning models. Open data portals such as Kaggle, UCI Machine Learning Repository, and the Open Data Network offer access to large datasets that can be used for training and testing machine learning models.

To apply governance regularities, especially those related to preserving privacy, data anonymization techniques like aggregation, pseudomization, and differential privacy are applied.

The high-performance computing infrastructure of RCAI supports all the described technologies and standards in virtualized, ready-to-use building blocks, thus providing an easily accessible playground for exploration.

Task 3.4 – IoT & UAV Test Lab

Project Partner	**Project Team / Contact Person**
THD Deggendorf	Sebastian Kohler

Target Customers	**Number of targeted Customers** (as written in the proposal)
SME`s & PSE's	40 SME`s, 10 PSE`s

Equipment

- Drone DJI Matrice 600 Pro
- Drone Parrot Bluegrass Fields
- Drone DJI Mavic 2 Pro
- Drone Parrot Anafi Thermal
- Hexacopter Raptor (2x)
- Drone DJI Phantom 4
- VTOL drone Delta Quad Pro
- Quadrocopter Tarot Sport 650
- Sensors of IoT
- Different 3D printers
- HoloLens
- Cameras

Selectable Learning Arrangements (depending on customer needs)

- Gain / build up know how
- Knowledge transfer to the customers

Available subject-specific didactic concepts

- Problem-based-learning (PBL)
- Empirical Research Process
- Research-based learning
- Comparative Studies
- Use cases/best practices
- Seminar style in a workshop format

Example WP Workflow

1. Initial interview to analyze the needs of the customer
2. Optional: introductory workshop
3. Optional: drone flight presentations
4. Optional: 3D printers
5. Optional: presentation of use cases of current and past projects
6. Optional: presentations at the campus in Freyung
7. Feedback and evaluation interview with future perspectives

Covered Technologies, Infrastructure and Standards

Lora Wan

Different sensors of IoT

- Temperature
- Humidity
- Pressure
- Movement
- Light
- Gas
- Ground humidity
- Air quality

HoloLens technology

3D printing

All types of state-of-the-art drone technologies

Different detecting systems

- Radarcamera
- Multispectercamera
- Hyperspectercamera
- Lasercan
- Infrared
- Thermal infrared

Appendix: Description of covered Technologies, Infrastructure and Standards

The Technology Campus in Freyung has an experience of more than 10 years in constructing and using all types of state-of-the-art UAVs/drones, such as Hexacopter, VTOL, Quadrocopter.
The maximal MTOW is 25 kg.
Drones can be implemented with different detecting systems. They can also be used with 5G cores to construct a temporary 5G campus network. Measuring regarding network strength is possible as well.

The HoloLens technology and the 3D printing has been applied in several use cases and projects. The employees at the campus are experts in these technologies.

Lora Wan and IoT sensor technology is in daily use and implementation at the campus.

All above illustrated technologies are available for the customers.

Task 3.5 – High Performance Computing Capacities

Project Partner	**Project Team / Contact Person**
DIT (Deggendorf Institute of Technology) with the Institute of Future Technologies	Prof. Dr. Helena Liebelt Siegfried Hildebrand Antje Fischer N.N

Target Customers	**Number of targeted Customers** (as written in the proposal)
SME'S and PSE's	40 SME's and 10 PSE's

Equipment

- High Performance Data Center Laboratory at the DEGG's, Deggendorf, available from end 2024
- Laboratory at Leibniz-Rechenzentrum in Garching/Munich – after arrangement
- Laboratory at VIRZ (Verband Innovatives Rechenzentrum e.V.) – after arrangement
- Bulletin board, flipchart, moderation cards

Selectable Learning Arrangements (depending on customer needs)

Getting an overview in …

- HPC basics and potential use cases
- HPC physical infrastructure and hosting simulation software
- Simulation of models
- Solving highly complex or data-intensive problems
- Optimization of models and algorithms

Available subject-specific didactic concepts

- Constructivism-based didactics
- Seminar style in a workshop format
- Problem-based learning (PBL) - problems proposed by the customer
- Case studies

Example WP Workflow

1. Needs analysis for the SME or PSE using a specific questionnaire (also identifying current problems)
2. Content selection involving choosing specific topics from a set of learning arrangements.
3. Hands-on workshop in laboratory
4. Evaluation of hands-on workshop

Covered Technologies, Infrastructure and Standards

HPC Infrastructure

- General Architecture
- Cluster Computing Architecture
- Scaling Nodes and Clusters

HPC Applications and Software

- OpenHPC
- Virtualization and Containers

Simulation, Optimization, Solving and Calculation

- Fortran
- Python
- Java
- C, C++
- Intel Parallel Studio XE
- ssh - Secure Shell
- Git
- OpenMP, IntelMPI

Appendix: Description of covered Technologies, Infrastructure and Standards

The THD-IT lab for Quantum Computing and High-Performance Capacities is financed by an industry collaboration with the leading technology companies Thomas Krenn & Rittal. It provides highest technology standards and will be operational by end 2024.

This living lab provides the European-wide single training center for Quantum Computing & High-Performance Capacities. Customers learn about the physical infrastructure and hosting simulation software. Through hands-on trainings, access to a rare and special knowledge base is given. Customers obtain first experiences with quantum computing simulators & hardware. The HPC-Capacities supports customers to use the capacities for large calculation rendering works, needed to be executed on HPC–infrastructure without having to buy respective technologies.

HPC basics and potential use cases:
Presentation of HPC possibilities and potentials for medium-sized companies and PSOs. With a series of use cases, HPC is demonstrated in a practical way, broken down to the basics.

HPC physical infrastructure:
HPC also differs from classical data centers in terms of architecture. In the areas of storage, network and compute, we show the differences between HPC and classic data centers. The HPC Lab, which will be available at the end of 2024, will enable a true hands-on experience. Using HPC is a little different from running programs on traditional computers. Ideally, an HPC consists of many different nodes grouped together in a logical manner to perform high-intensity tasks and solve highly complex or data-intensive problems. To get the most out of HPC, special challenges and requirements, e.g., scaling, must be met.

Simulation, Optimization, Solving and Calculation:
High Performance Computing generally refers to aggregating computing resources together in order to perform more computing operations at once. A number of

programming languages can be used to optimize existing algorithms, simulate models, or solve complex computational problems.
Example: HPC and AI can help accumulate natural and weather data. The named technologies can be used to improve the overall situation in this area and are therefore part of the Test before Invest laboratories of DInO.

Task 3.6 – 5G Testbed

Project Partner	**Project Team / Contact Person**
THD Deggendorf	Sebastian Kohler

Target Customers	**Number of targeted Customers** (as written in the proposal)
SME's	50 SME's

Equipment
• Keysight N9030B Spectrum analyzer/Signal analyzer • Keysight VXG Signal generator M9384B • Different Software Defined Radio Systems • Mobile Measurement Backpack system • EMV-Cage • 5G Open Radio Station: ORStation-2X1-SDK600 • Indoor 5G Campus network, 3.7-3.8 GHz with open RAN Technology

Selectable Learning Arrangements (depending on customer needs)
• Recognize the advantages of fast data transfer • Knowledge transfer to the customers • Understand the benefits and possibilities of 5G

Available subject-specific didactic concepts
• Problem-based-learning (PBL) • Empirical Research Process / Research-based learning • Comparative Studies • Use cases/best practices • Seminar style in a workshop format

Example WP Workflow
1. Initial interview to analyze the needs of the customer 2. Optional: introductory workshop 3. Optional: measurement (network coverage, signal strength) 4. Optional: test installation of a campus net 5. Optional: state of the art overview on the topic 5G 6. Optional: presentation of use cases of current and past projects 7. Optional: presentations at the campus in Freyung 8. Feedback and evaluation interview with future perspectives

Covered Technologies, Infrastructure and Standards
• Fifth-generation of mobile network communication technology • 5G Standalone Network (Core, RAN, UE) as testbed • Measurement Systems (signal generator and analyzer) • ETSI TR 121 915

Appendix: Description of covered Technologies, Infrastructure and Standards

Technology

5G, or fifth-generation wireless technology, represents a significant leap in communication technology compared to its predecessors. Here are some key aspects of 5G network communication:

- Speed and Data Rates: Aim for 20 Gbps peak data rates with mmWave.
- Low Latency: Aim for 1 millisecond or less latency.
- Increased Capacity: Support for a large number of devices and connections.
- Network Slicing: Virtualized network segments for different applications.
- Frequency Bands: Utilizes low, mid, and high-frequency spectrums, including mmWave.
- Massive MIMO: Multiple-Input, Multiple-Output technology for better efficiency.
- Beamforming: Focuses and directs signals for improved quality.
- Security: Enhanced encryption and authentication.
- Energy Efficiency: More energy-efficient design.
- Supports IoT, AR, VR, and more.

In summary, 5G network communication represents a significant advancement in wireless technology, offering faster speeds, lower latency, increased capacity, and enhanced capabilities to support a wide range of applications and services, including IoT, augmented reality, virtual reality, and more.

Standards

ETSI TR 121 915, description of the 3GPP release 15 specification of 5G

Infrastructure

A 5G network comprises several key components, including the Core Network (CN), Radio Access Network (RAN), and User Equipment (UE). Let's describe each component and their interactions:

1. User Equipment (UE):
   - The UE refers to the end-user devices, such as smartphones, tablets, laptops, IoT devices, and other gadgets that connect to the 5G network.
   - UEs are equipped with 5G-compatible radios and modems to communicate with the 5G RAN.

2. Radio Access Network (RAN):
   - The RAN is responsible for the radio communication between the UE and the core network. It is composed of various components:
   - gNB (gNodeB): The gNB is the 5G New Radio (NR) base station, which connects to the UE over the air interface. It is responsible for managing wireless connections, radio resource allocation, and signal transmission.
   - Radio Units (RU): 5G RANs use advanced antenna technology and beamforming to focus and direct signals for improved quality, capacity, and efficiency.

3. Core Network (CN):

- The 5G Core Network is responsible for managing network resources, routing data, and providing various services. It includes among other parts the following components:
- AMF (Access and Mobility Management Function): Manages UE mobility and session establishment.
- SMF (Session Management Function): Controls the data session establishment and management.
- UPF (User Plane Function): Routes and forwards user data, ensuring efficient data transfer.

In summary, a 5G network with Core RAN (Radio Access Network) and UE (User Equipment) is a complex and highly efficient system. The UE devices communicate with the gNBs in the RAN, which in turn interact with the 5G Core Network to provide high-speed, low-latency, and secure wireless communication services to users and IoT devices, while also supporting network slicing for different use cases.