Grant Agreement No: 101096307

Full Title: THz Industrial Mesh Networks in Smart Sensing and Propagation Environments

Start date: 01/01/2023

End date: 31/12/2025

Duration: 36 Months

Deliverable D1.3

TIMES Mid-Project Report

Document Type	Deliverable
Title	D1.3 - TIMES Mid-Project Report
Contractual due date	30/06/2024 (M18)
Actual submission date	28/06/2024
Nature	Report
Dissemination Level	PUB
Lead Beneficiary	CNIT
Responsible Author	Danila Ferretti (CNIT)
Contributions from	All Partners

Revision history

Version	Issue Date	Changes	Contributor(s)
v0.1	24/06/2024	Initial version	Danila Ferretti (CNIT)
v0.2	27/06/2024	Partners Input, corrections of deliverable descriptions in WP3, WP4, WP7	Tommaso Zugno (HWDU), Mate Boban (HWDU)
V1.0	28/06/2024	Approved version	Danila Ferretti (CNIT), Luca Sanguinetti (CNIT)

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Executive Summary

The TIMES project, focusing on advancing THz communication technologies for industrial applications, has reached its midpoint with significant achievements across its eight work packages (WPs). This report provides a comprehensive overview of our progress, highlighting key milestones, challenges addressed, and adjustments made to ensure alignment with project objectives and stakeholder expectations.

1. Introduction

1.1 Scope

The scope of this mid-project report is to evaluate the progress of the TIMES project as of M18, providing a detailed assessment of accomplishments, challenges encountered, and strategic adaptations undertaken across all work packages. It aims to inform stakeholders, including consortium members, funding bodies, and industry partners, about the current status and future directions of TIMES.

1.2 Audience

This report is intended for public use.

1.3 Structure

The rest of the document is structured as follows:

- Section 2 presents an overview of achievements across all eight WPs, highlighting transformative outcomes and milestones achieved.
- Section 3 provides detailed reports on each WP's activities, including key deliverables, internal reports, and advancements made.
- Section 4 discusses the scientific, economic, and societal impact of TIMES, emphasizing dissemination and exploitation activities, as well as strategic engagements.
- Section 5 lists completed and pending deliverables.
- Section 6 highlights critical milestones achieved and planned.
- Section 7 details deviations encountered during project execution, their implications, and proposed corrective actions.

2 TIMES Overall Progress

The TIMES project represents a holistic approach to advancing THz communication technologies within industrial environments through its comprehensive framework spanning eight work packages (WPs). Each WP is dedicated to distinct research and development, collectively aiming to achieve significant milestones and transformative outcomes.

WP1 laid the groundwork by establishing robust management structures and a strategic dissemination framework, ensuring effective project oversight and stakeholder engagement. Building on this foundation, WP2 defined critical scenarios and conducted foundational simulations essential for deploying THz-based smart radio ecosystems in industrial settings, bridging theoretical exploration with practical implementation. In WP3, TIMES focused on developing precise channel models crucial for sub-THz communication reliability, setting the stage for enhanced system performance. This foundational work was extended in WP4, which employed multi-goal optimization strategies utilizing Reflective Intelligent Surfaces (RIS) and advanced MAC protocols to enhance THz-based mesh networks' efficiency and scalability. WP5 navigated challenges in THz front-end circuit development, antennas, and Intelligent Reflective Surfaces (IRS), overcoming hurdles in prototype fabrication to advance toward key performance metrics. Simultaneously, WP6 initiated PoC planning and component integration critical for validating technology readiness and system efficacy. WP7 played a pivotal role in disseminating project achievements and fostering stakeholder engagement through diverse communication channels, laying the groundwork for commercial exploitation of TIMES innovations. Lastly, WP8 focused on integrating ethical considerations and GDPR compliance, conducting a comprehensive Data Protection Impact Assessment (DPIA) to ensure responsible data management and regulatory adherence.

Together, these efforts underscore TIMES' commitment to advancing THz communication technologies while ensuring ethical integrity, regulatory compliance, and strategic dissemination of project outcomes. By addressing key challenges, TIMES aims to contribute significantly to the evolution of industrial communications and future wireless technology advancements.

3 Explanation of the work carried out per Work Package

3.1 Work Package 1

WP1 of the TIMES project, focusing on establishing a robust infrastructure for project management and dissemination, has successfully completed several key deliverables and internal reports:

- **D1.1 Project Website:**
    - **Overview:** The temporary project webpage launched on WiLb's website provides an initial glimpse into the TIMES project, featuring mission statements, partner details, and early updates. Transition to the official domain (times6g.eu) and security certifications were delayed initially but resolved with new project officer engagement.
    - **Objective:** To establish a comprehensive online presence for TIMES, disseminating project information effectively and ensuring accessibility to stakeholders and the public.
    - **Key Results:** Successful acquisition of the official project domain and implementation of necessary security measures to support ongoing dissemination and communication efforts.
- **IR1.1 Management Handbook:**
    - **Overview**: This document serves as a comprehensive reference manual outlining management structures, procedures, and responsibilities within the TIMES project.
    - **Objective**: To provide clear guidance and support for effective project management among TIMES consortium partners.
    - **Key Results**: Establishment of structured management processes, guidelines for deliverable production, and protocols for internal communication and decision-making.
- **D1.2 Initial Data Management Plan:**
    - **Overview**: The Data Management Plan (DMP) ensures compliance with FAIR principles, focusing on data accessibility, interoperability, and reusability. It outlines secure storage and transfer protocols for project data.
    - **Objective**: To manage project data ethically and legally, ensuring alignment with EU regulations and facilitating open access to experimental and simulation data.
    - **Key Results**: Implementation of data security measures, including encrypted storage and adherence to ethical guidelines, to support transparent data management throughout the project.
- **D1.3 TIMES Mid-Project Report:**
    - **Overview**: This report provides a comprehensive update on TIMES project progress, achievements, and future directions at the midpoint of the project.
    - **Objective**: To assess and communicate the project's current status, highlighting milestones achieved and adjustments made to project goals and timelines.
    - **Key Results**: Detailed documentation of project advancements, challenges addressed, and strategic adaptations made based on mid-project evaluations and stakeholder feedback.

WP1 has laid a solid foundation for the TIMES project through effective website development, comprehensive management guidelines, and a robust data management plan, ensuring smooth project execution and dissemination of results.

3.2 Work Package 2

WP2 of the TIMES project focuses on defining and refining scenarios essential for understanding, simulating, and implementing THz-based smart radio ecosystems within industrial environments. This work package serves as a pivotal bridge between theoretical exploration and practical implementation, laying the groundwork for subsequent activities across the project. WP2 has successfully completed several key deliverables and internal reports, including:

- **IR2.1 Initial Report on Scenarios of Use Cases and Channel Measurement Testing:**
    - **Overview**: This report initiates Work Package 2, outlining scenarios for channel measurement testing in industrial environments to understand THz signal propagation.
    - **Objective**: To define essential use cases and scenarios critical for validating THz communication models and technologies.
    - **Key Results**: Identification of specific industrial scenarios and preliminary results from initial channel measurement tests, informing further development of THz communication strategies.
- **IR2.2 Initial Report on Scenarios for Software and Hardware Simulation:**
    - **Overview**: Complementing IR2.1, this report defines scenarios for software and hardware simulations within the TIMES project, essential for modelling THz-based smart radio ecosystems.
    - **Objective**: To establish simulation frameworks and parameters necessary for evaluating THz communication performance in diverse industrial settings.
    - **Key Results**: Definition of simulation methodologies, including ray tracing and system-level simulations, providing foundational data for optimizing THz network designs.
- **D2.1 Definition of Use Cases, KPIs, and Scenarios for Channel Measurements:**
    - **Overview**: Expanding on IR2.1, this deliverable provides a detailed definition of use cases, key performance indicators (KPIs), and scenarios tailored for channel measurements in industrial environments.
    - **Objective**: To guide the execution of channel measurement activities, ensuring consistency and relevance in assessing THz signal propagation characteristics.
    - **Key Results**: Clear guidelines and methodologies established for conducting and evaluating THz channel measurements across various industrial scenarios.
- **D2.2 Definition of Scenarios for Software Simulations:**
    - **Overview**: Building on IR2.2, this deliverable defines detailed scenarios for software simulations within the TIMES project, focusing on modelling THz communication behaviours.

- **Objective**: To provide simulation frameworks and parameters essential for developing and testing THz communication protocols and algorithms.
- **Key Results:** Specification of simulation models and parameters, facilitating accurate emulation of THz network behaviours and supporting iterative refinement of communication strategies.

- **D2.3 Definition of the Scenarios and KPIs for Hardware Demonstration and PoC:**
  - **Overview**: This deliverable outlines scenarios and key performance indicators (KPIs) critical for hardware demonstrations and Proof of Concept (PoC) realization within the TIMES project.
  - **Objective**: To define requirements and benchmarks for validating THz hardware implementations in industrial applications.
  - **Key Results**: Specification of hardware components and integration plans for conducting successful PoCs, laying the groundwork for practical deployment of THz technologies.

WP2 has made significant progress in defining and refining scenarios crucial for the TIMES project, laying the foundation for subsequent activities related to channel measurements, software simulations, and hardware demonstrations. These accomplishments ensure the project's trajectory towards successful implementation of THz-based smart radio ecosystems in industrial settings.

3.3 Work Package 3

WP3 of the TIMES project focuses on developing and refining channel models for sub-THz communication in industrial environments. This work package addresses the creation, validation, and improvement of channel models based on measurements and state-of-the-art research. WP3 has successfully completed several key deliverables and internal reports, including:

- **IR3.1 State-of-art Channel Models in Industrial Environments at sub-THz Frequencies:**
  - **Overview**: This report reviews existing channel models applicable to sub-THz frequencies in industrial environments, highlighting strengths and limitations.
  - **Objective**: To establish a baseline understanding of current channel modelling approaches and identify gaps for developing improved models within TIMES.
  - **Key Results**: Assessment of state-of-the-art channel models, providing insights into areas for enhancing THz communication reliability and performance in industrial settings.
- **D3.1 Initial Channel Measurements in Industrial Environments at sub-THz Frequencies:**
  - **Overview**: This deliverable presents initial channel measurements conducted in various industrial environments at sub-THz frequencies.
  - **Objective**: To validate theoretical models and assess real-world THz signal propagation characteristics across different industrial scenarios.
  - **Key Results**: Data from initial measurements, informing refinement of THz channel models and strategies for optimizing communication systems in industrial environments.
- **IR3.2 Initial Channel Models for Industrial Environments at sub-THz Frequencies:**

- **Overview**: Building on D3.1, this report introduces initial channel models tailored for industrial environments at sub-THz frequencies.
- **Objective**: To develop and validate channel models that accurately reflect THz signal propagation dynamics in industrial settings.
- **Key Results**: Specification of model parameters and validation outcomes, contributing to the enhancement of THz communication reliability and performance.

WP3 has made significant progress in developing and refining channel models for sub-THz communication in industrial environments. These accomplishments provide a strong foundation for accurate channel characterization, which is essential for designing and optimizing THz communication systems in industrial applications.

3.4 Work Package 4

WP4 of the TIMES project focuses on the multi-goal optimization and exploitation of smart propagation environments to enhance the performance of THz-based mesh networks. This work package addresses the challenges of THz communications by designing a THz air interface capable of ISAC and leveraging technologies such as Reflective Intelligent Surfaces (RIS) and advanced MAC protocols. WP4 has successfully completed several key deliverables and internal reports, including:

- **D4.1 Intermediate report on PHY layer enhancements for THz links supporting sensing and communication functionalities**
  - **Overview**: This deliverable presents intermediate findings on physical layer procedures for enabling highly efficient and reliable THz links supporting sensing and communication functionalities and discusses estimation mechanisms to predict the evolution of THz channels.
  - **Objective**: To design a THz-based air interface supporting sensing and communication functionalities.
  - **Key Results**: performance analysis of THz LOS MIMO communications, waveform design for THz ISAC, analysis THz RF impairments, mitigation scheme for time-frequency synchronization errors.
- **D4.2 Intermediate report on multi-goal mesh network optimization and exploitation of smart propagation environments**
  - **Overview**: This deliverable explores strategies for optimizing mesh networks using RIS and THz communications in smart propagation environments.
  - **Objective**: To develop the concept of smart sensing and propagation environment at THz frequencies leveraging RISs and advanced MAC protocols.
  - **Key Results**: Investigation of the theoretic potential of RISs, analysis of RF impairments in RIS-aided channels, novel sensing approaches employing RISs and metaprisms, initial MAC protocol design for THz multi-goal mesh network demonstrating improvements in network efficiency and coverage for industrial IoT applications.

WP4 has made significant progress in optimizing and exploiting smart propagation environments for THz-based mesh networks. By leveraging a novel THz air interface, RIS technology, and innovative MAC protocols, the work package has laid a strong foundation for enhancing network performance in complex industrial environments. These accomplishments ensure the project's trajectory towards successful implementation of THz-based smart radio ecosystems.

3.5 Work Package 5

WP5 focuses on the development and characterization of THz front-end circuits, antennas, and intelligent reflective surfaces (IRS). Despite significant progress in various aspects of design and initial prototype fabrication, WP5 has faced delays that have impacted the timeline for Deliverable D5.1, initially scheduled for June 2024. The unforeseen delay in the fabrication process at Fraunhofer IAF, due to equipment malfunctions, necessitated a two-month extension request for the submission of D5.1. However, substantial work has been carried out, including the design of front-end modules, signal-generation modules, and various antenna types. Additionally, the development of IRS prototypes and their characterization is progressing, with the expectation that critical milestones will be met in the coming months. This progress is documented in:

- **IR5.1 Initial prototypes of antennas and IRS**
    - **Overview**: Initial exploration of antenna and IRS prototypes developed. This report outlines the foundational concepts, design methodologies, and preliminary outcomes essential for advancing THz communication technologies.
    - **Objective**: Describe the antenna and IRS concepts investigated in the initial phase of the TIMES project, emphasizing design approaches and technical specifications aimed at enhancing wireless connectivity and performance in industrial environments.
    - **Key Results**: Initial fabrication and characterization of high-gain lens horn antennas, demonstrating enhanced beam shaping capabilities and development of passive metasurfaces for beam deflection and exploration of active metasurfaces using liquid crystal technologies.

3.6 Work Package 6

In WP6 of the TIMES project, initial discussions have commenced among consortium partners, encompassing expertise in hardware and network aspects. Drawing from the PoC outlined in D2.3 within WP2, early deliberations have centred on planning and implementing various foundational components crucial for the PoCs. Specifically, early discussions have been directed towards designing and realizing key building blocks such as antennas, intelligent reflective surfaces (IRS), and MMICs tailored for PoCs. Concurrently, ongoing brainstorming aim to integrate these components effectively and refine the PoC scenario. The ultimate success of these efforts hinges upon achieving optimal performance metrics across critical parameters like antenna gain, IRS bandwidth, reflection losses, and system margins related to transmitter power and receiver sensitivity.

3.7 Work Package 7

WP7 of the TIMES project focuses on disseminating and communicating project objectives and results, coordinating technical discussions, and defining exploitation and standardization plans. WP7 has successfully completed several key deliverables and internal reports, including:

- **IR7.1 Communication Handbook**
    - **Overview**: Established official social media presence on LinkedIn, Twitter, Facebook, and YouTube for TIMES. Guidelines include submission criteria for images, videos, and descriptions to the shared repository.
    - **Objective**: To maintain a consistent brand image and effectively disseminate project updates and achievements through social media platforms and other communication channels.
    - **Key Results**: Defined guidelines for using the TIMES and SNS JU logos, ensuring brand integrity across all communication materials and platforms.
- **D7.1 Dissemination and Communication Plan**
    - **Overview:** The plan outlines a comprehensive strategy for disseminating project outcomes and engaging with stakeholders. It includes tools such as social media, newsletters, brochures, videos, and events to reach target audiences.
    - **Objective:** To ensure widespread awareness of TIMES achievements, facilitate knowledge transfer, and support early exploitation of project results through strategic communication and dissemination activities.
    - **Key Results:** Establishment of key performance indicators (KPIs) to monitor dissemination effectiveness and initial steps towards commercial exploitation through IPR management and engagement with standardization bodies.
- **IR7.2 Initial exploitation plan**
    - **Overview**: IR7.2 details the initial strategy for exploiting TIMES project results, emphasizing IPR management and knowledge protection within the consortium.
    - **Objective**: To define ownership, access rights, and dissemination strategies for project-generated results, focusing on maximizing the societal and commercial impact of TIMES innovations.
    - **Key Results**: Development of THz communication technologies, mesh network architectures, and integrated sensing solutions, laying the groundwork for commercial exploitation and societal benefit realization.
- **D7.2 Intermediate Report on Standardization, Dissemination and Exploitation Activities**
    - **Overview**: This report consolidates the progress made in standardization, dissemination, and exploitation activities within the TIMES project.
    - **Objective**: To provide a comprehensive overview of the project's contributions to standardization bodies, dissemination efforts, and initial steps in commercial exploitation of project results.
    - **Key Results**: Highlights achievements in disseminating project findings through publications, conferences, workshops, webinars, and exhibitions, alongside strategies for managing intellectual property rights and contributing to THz standardization efforts.

The dissemination plan aims to create a recognizable project image, inform stakeholders, and stimulate new opportunities in THz communications development. The two-way communication channel ensures stakeholder involvement and continuous improvement of project outcomes.

3.8 Work Package 8

Work Package 8 (WP8) focuses on integrating ethical considerations and ensuring GDPR compliance within the TIMES project. It encompasses the appointment of an external ethical advisor and the completion of a Data Protection Impact Assessment (DPIA). WP8 has successfully completed several key deliverables, including:

- **D8.2 Collaboration Ethical Advisor**
    - **Overview**: The appointment of an external ethical advisor, Esq. Simone Sparti, facilitated engagement with the management team to align with the TIMES project's objectives and anticipated outcomes.
    - **Objective**: To integrate ethical considerations into the TIMES project, ensuring compliance with data protection regulations and enhancing the ethical framework surrounding advanced localization and tracking technologies.
    - **Key Results**: Esq. Simone Sparti collaborated with the management team to gain a comprehensive understanding of the TIMES project's aims and outcomes, review essential project documents such as the Grant Agreement, Ethics Summary Report, and Evaluation Summary Report and initiate and oversee the completion of the Data Protection Impact Assessment (DPIA).
- **D8.1 Data Protection Impact Assessment**
    - **Overview**: The Data Protection Impact Assessment (DPIA) assesses risks associated with personal data processing in the TIMES project, ensuring compliance with GDPR regulations during the development of advanced localization and tracking technologies.
    - **Objective**: The DPIA aims to identify and assess risks related to personal data processing, determine the necessity and appropriateness of data processing activities, and recommend measures to mitigate risks and uphold GDPR compliance.
    - **Key Results**: Key outcomes include a detailed assessment of identified risks and their potential impacts, recommendations for mitigating risks and ensuring GDPR compliance, and documentation supporting data processing decisions and compliance efforts.

WP8 aims to assess future risks associated with the development of localization and tracking technologies and propose solutions to ensure compliance with data protection regulations, notably the General Data Protection Regulation (GDPR), in future applications.

4 Impact

The TIMES project has made significant strides towards achieving its scientific and societal impact objectives through comprehensive dissemination and exploitation activities. These efforts have targeted various stakeholders including research communities, investors, EU institutions, and the general public, focusing on advancing THz communication technologies for industrial applications.

Scientific Impact:

- **Conference Presentations and Workshops:** Participation in prestigious events such as IEEE ICC and EuCNC & 6G Summit facilitated the dissemination of cutting-edge research on THz communication networks, fostering collaborations and shaping future standards in wireless communication technologies.
- **Technical Publications:** Contributions to IEEE conferences and specialized workshops (e.g., EuCAP2024) have advanced the understanding of THz channel models and their applicability in industrial environments, contributing to the scientific literature on wireless communication.

Economic Impact:

- **Industry Engagement:** Collaborative activities at events like Hannover Messe and European Microwave Week have strengthened ties with industry leaders, showcasing TIMES innovations and exploring potential applications in Industry 4.0 solutions.
- **Media Coverage:** Non-scientific media articles and press releases in Italian media have raised awareness among citizens about TIMES' role in advancing wireless technologies, potentially influencing investment and future industrial applications.

Societal Impact:

- **Educational Outreach:** Participation in STEM Day and presentations at University of Bologna aimed to inspire the next generation of innovators and engineers, demonstrating the transformative potential of 6G technologies in enhancing industrial processes and connectivity.

Update on Exploitation and Dissemination Plan:

- The initial dissemination plan outlined in the DoA has been executed effectively, with a high number of planned activities either delivered or ongoing. Notable achievements include a robust presence at key industry and research conferences, successful media engagements, and strategic collaborations with EU-funded projects such as 6G-SHINE and TERRAMETA.
- Ongoing activities, including participation in IEEE ICC 2024 and European Microwave Week 2024 workshops, continue to strengthen TIMES' visibility and impact, ensuring sustained dissemination of research outcomes and fostering new collaborations.

Monitoring and Evaluation Strategy:

- Monitoring of dissemination activities has been conducted through regular feedback collection from participants and stakeholders, tracking metrics such as audience engagement, media reach, and collaboration outcomes.
- Evaluation involves comparing achieved outcomes with baseline expectations, ensuring alignment with project objectives and adapting strategies as needed to maximize impact.

By leveraging these efforts, TIMES remains committed to advancing THz communication technologies while actively engaging stakeholders across scientific, economic, and societal domains, thereby solidifying its position as a key contributor to the future of wireless technology innovation in Europe and beyond.

5 Deliverables

Deliverable	Title	WP	Lead Partner	Type	Dissemination level
D1.1	Project Website	1	CNIT	DEC	PU
IR1.1	Management Handbook	1	CNIT	R	SEN
IR2.1	Initial report on scenarios of use cases and channel measurement testing	2	AETNA	R	SEN
IR7.1	Communication handbook	7	BIREX	R	SEN
D7.1	Dissemination and communication plan	7	BIREX	R	SEN
IR2.2	Initial report on scenarios for software and hardware simulation	2	AETNA	R	SEN
D1.2	Initial Data Management Plan	1	CNIT	DMP	SEN
D2.1	Definition of use cases, KPIs, and Scenarios for Channel Measurements	2	TNOR	R	PU
IR3.1	State-of-art Channel Models in industrial environments at sub-THz frequencies	3	CNIT	R	SEN
D2.2	Definition of Scenarios for Software Simulations	2	HWDU	R	PU
D2.3	Definition of the scenarios and KPI for hardware demonstration and PoC	2	CNRS	R	PU
D3.1	Initial channel measurements in industrial environments at sub-THz frequencies	3	TUBS	R	PU
D4.1	Intermediate report on PHY layer enhancements for THz links supporting sensing and communication functionalities	4	HWDU	R	PU
IR7.2	Initial exploitation plan	7	AETNA	R	SEN
IR3.2	Initial Channel Models for Industrial Environments at sub-THz Frequencies	3	HWDU	R	PU
D1.3	TIMES Mid-Project Report	1	CNIT	R	PU
D4.2	Intermediate report on multi-goal mesh network optimization and exploitation of smart propagation environments	4	CNIT	R	PU
D5.1	Design and characterization report of the THz circuits	5	FRAUNHOFER	R	PU
D7.2	Intermediate Report on Standardization, Dissemination and Exploitation Activiti	7	HWDU	R	PU
IR5.1	Initial prototypes of antennas and IRS	5	CNRS	R	SEN
D5.2	THz front end validation	5	FRAUNHOFER	R	PU

D3.2	Channel Measurements in industrial setting with IRS at sub-THz frequencies	3	TUBS	R	PU
D4.3	Final report on PHY layer enhancements for THz links supporting sensing and communication functionalities	4	HWDU	R	PU
D5.3	Design, fabrication and verification of high directivity and beam steering antennas at THz frequencies.	5	ANT	R	PU
D3.3	Characterisation of IRS, high directivity antennas and beam steering antennas at sub-THz frequencies	3	CNRS	R	PU
D5.4	Development and validation of IRS-based THz links	5	CNRS	R	PU
D3.4	Final Report on Channel Models for industrial environments at sub-THz frequencies	3	HWDU	R	PU
D4.4	Final report on multi-goal mesh network optimization and exploitation of smart propagation environments	4	CNIT	R	PU
D6.1	Validation of MODEMS and Integration of joint PHY/MAC	6	USTUTT	R	PU
D1.4	Data Management Plan	1	CNIT	DMP	SEN
D6.2	Integration and validation of MODEM+RF Front ends	6	USTUTT	R	PU
D2.4	Updated report on scenario and KPI coherence	2	AETNA	R	PU
D6.3	Full integration of the 300 GHz PoC	6	CNRS	R	PU
D6.4	PoC Validation	6	BIREX	R	PU
D7.3	Final Report on Standardization, Dissemination and Exploitation Activities	7	BIREX	R	PU

6 Milestones

Milestone	Title	Lead Partner
M01	Project website	*CNIT*
M02	Management Processes Defined	*CNIT*
M03	Dissemination and communication activities planned	*BIREX*
M04	Description of use cases, requirements, and scenarios for channel measurements	*AETNA*
M06	Extraction of parameters from preliminary channel measurements	*TUBS*
M07	Release of SiMoNe Simulator, made available to all the consortium	*TUBS*
M08	Initial PHY-layer algorithms for integrated and sensing THz communications developed and tested	*CNIT*
M09	First TIMES workshop and first white paper on TIMES vision	*CNIT*
M10	Exploitation activities planned	*BIREX*
M11	Initial multi-goal network optimization schemes and MAC procedures developed for THz-based mesh networks with IRS	*CNIT*
M12	THz front-end circuits developed and tested	*FRAUNHOFER*
M13	Initial prototypes of antennas and IRS developed	*AETNA*
M14	THz front-end modules developed and tested	*FRAUNHOFER*
M15	Final channel measurements in industrial setting with IRS prototypes	*TUBS*
M16	Final PHY-layer algorithms for integrated and sensing THz communications developed and tested	*HWDU*
M17	Final high directivity and beam steering antennas fabricated and tested	*AETNA*
M18	Second TIMES workshop	*BIREX*
M19	Final IRS fabricated and tested	*AETNA*
M20	Channel models for industrial environments with IRS at sub-THz established	
M21	Final multi-goal network optimization schemes and MAC procedures developed for THz-based mesh networks with IRS	*CNIT*
M22	Modems and joint PHY/MAC schemes integrated	*USTUTT*
M23	TIMES exploitation Workshop III	*BIREX*
M24	Full integration of MODEMS and THz front-end modules completed	*USTUTT*
M25	TIMES exploitation Workshop IV	*BIREX*
M26	Third TIMES workshop	*HWDU*
M27	Final report on standardization, dissemination and exploitation activities	*TUBS*
M28	Full integration and validation of the PoC completed	

7 Deviations from Annex 1 and Annex 2

The TIMES project has encountered deviations from the original DoA primarily due to unforeseen circumstances impacting the timely completion of specific deliverables. Below is an explanation of these deviations, their consequences, and proposed corrective actions:

7.1 Tasks/Objectives

Cancellation of Deliverable D1.5:

- **Reasons for Deviation:** Deliverable D1.5, scheduled near the end of the reporting period, posed challenges due to overlapping reporting requirements with final financial and technical reports. This overlap would result in redundant efforts and incomplete reporting.
- **Impact:** Cancelling D1.5 ensures resources are allocated efficiently towards comprehensive final reports without compromising project documentation integrity.
- **Corrective Action:** If the cancellation poses issues, adjustments will be made to ensure all essential aspects are covered in other deliverables.

Delay in Submission of Deliverable D5.1:

- **Reasons for Deviation:** Significant delays in the fabrication process of THz front-end circuits at Fraunhofer IAF, exacerbated by equipment unavailability and subsequent adjustments, resulted in an 8-week delay.
- **Impact:** Postponing D5.1 affects subsequent tasks dependent on circuit performance data, potentially altering resource allocation and planning within Work Package 5.
- **Corrective Action:** Requesting a two-month extension until Month 20 to incorporate accurate measurement data and uphold deliverable quality standards.

Delay in Submission of Deliverable D5.2:

- **Reasons for Deviation:** Dependency of module development (Task 5.2) on circuit performance data from Task 5.1. Export regulations and holiday periods further contribute to a requested delay until February 2025 (Month 26).
- **Impact:** Adjusting timelines to avoid logistical delays and ensure compliance with export regulations, potentially affecting integration tasks in subsequent work packages.
- **Corrective Action:** Despite the delay, initial modules are expected by Month 22, minimizing the impact on subsequent integration tasks.

Delay in Submission of Deliverable D8.2:

- **Reasons for Deviation:** Challenges in obtaining suitable quotations for appointing an external ethics expert delayed D8.2. High costs necessitated negotiations among partners, affecting the timeline.
- **Impact:** The delay in appointing the ethics expert impacts the ethical oversight timeline outlined in Work Package 8, requiring adjustments in financial reporting and compliance.
- **Corrective Action:** Requesting an extension until Month 16 (April 2024) to finalize negotiations and ensure proper appointment of the ethics advisor, adhering to project requirements.

These deviations reflect our commitment to adapting to unforeseen challenges while maintaining project integrity and compliance. We continue to monitor and adjust our strategies to ensure timely completion and successful execution of TIMES project objectives.