

16-03-2023

Deliverable D4.4

Dissemination and Exploitation Activities

Deliverable D4.4

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The research leading to these results has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 951886 (CLONETS-DS).

Abstract

This deliverable describes the dissemination and exploitation activities carried out during the project, such as creating and maintaining the project website, issuing periodic newsletters, delivering presentations at stakeholder conferences, developing communication material, participating in dissemination events such as public and specialised conferences, organising a stakeholder workshop and school for physicists, and others.

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Executive Summary

The dissemination and exploitation activities are an important part of any project. Participants of the CLONETS-DS project prepared a website within the framework of these activities, which was constantly updated with information relating to the project. In addition, they prepared a stakeholder workshop and delivered presentations about the project at various scientific conferences. The project partners also participated in internal project meetings of GN4-3 and GN5-1, promoting the idea of time and frequency (T&F) in the National Research and Education Networks (NRENs) environment.

Regular newsletters were also prepared for stakeholders, summarising the work of the project. The last one will be presented in March 2023.

These dissemination and exploitation activities help to develop the potential user community by informing them of the potential of the T&F reference system, exchanging best practices, and encouraging them, as well as the formal stakeholder bodies, to support the development of these services.

1 Introduction

This document describes the dissemination and exploitation activities carried out during the CLONETS-DS project to communicate project results to stakeholders and beyond the immediate scientific community concerned.

Section 2 presents the logo and templates developed for the project. Section 3 outlines dissemination and exploitation activities including the website, stakeholder materials, conferences and school initiative. Section 4 summarises key points and makes an overall assessment.

2 Logo and Templates

2.1 Logo

The project partners designed a logo for the project, which refers to the idea of transferring time from atomic clocks via fibre optic links, and creating a network of connections. The logo was prepared in both colour (Figure 1) and black-and-white versions (Figure 2) for optimal effect on both colour and black-and-white materials. In addition, logos have been prepared in various resolutions to suit printed materials and websites.



Figure 1. Colour CLONETS-DS project logo



Figure 2. Black-and-white CLONETS-DS project logo

Based on the logo, a colour-consistent presentation template was prepared for use during work meetings and official presentations at conferences, as well as leaflet and document templates. Each of these is described below.

2.2 Presentation Template

The title page of the CLONETS-DS presentation template (Figure 3) includes the logo of the project, space for the main title of the presentation and also the presenter's name and organisation. Below there is a place for Topic, Date, and Location. There is also a copyright notice, acknowledgement of EU funding and the flag of the European Union in the bottom right corner.

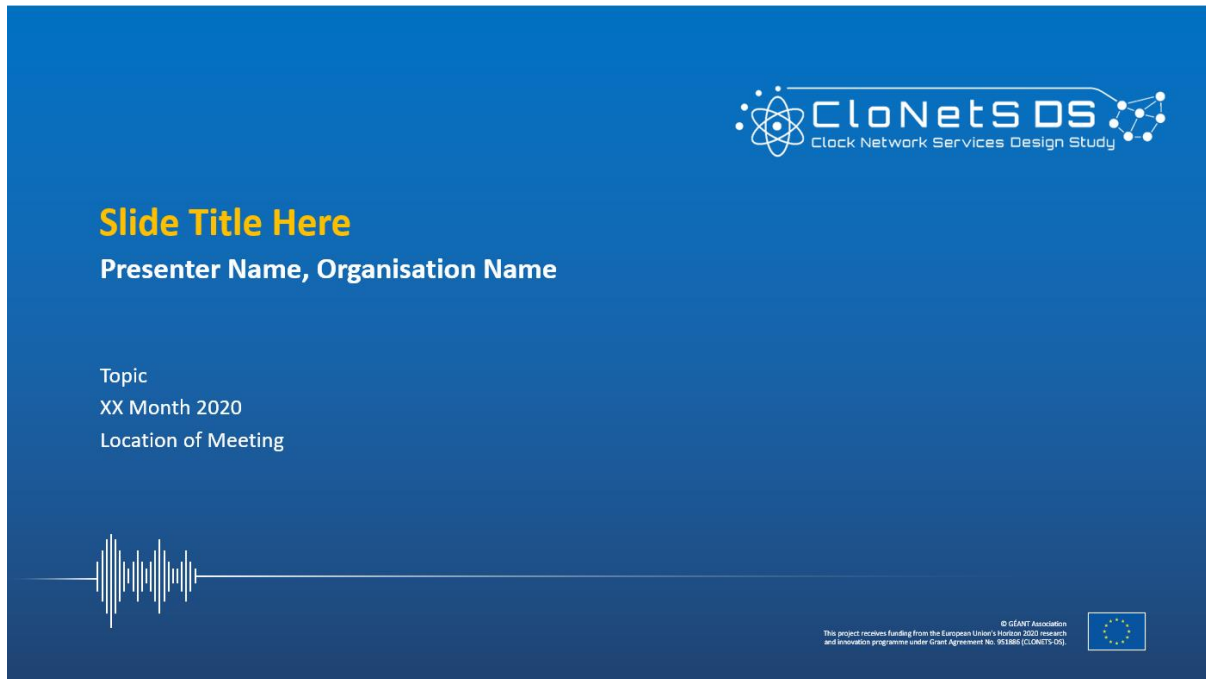


Figure 3. Title page of the CLONETS-DS presentation template

The main contents page of the CLONETS-DS presentation template (Figure 4) shows the main title of the slide in yellow and the subtitle in white, and also the white CLONETS-DS logo.

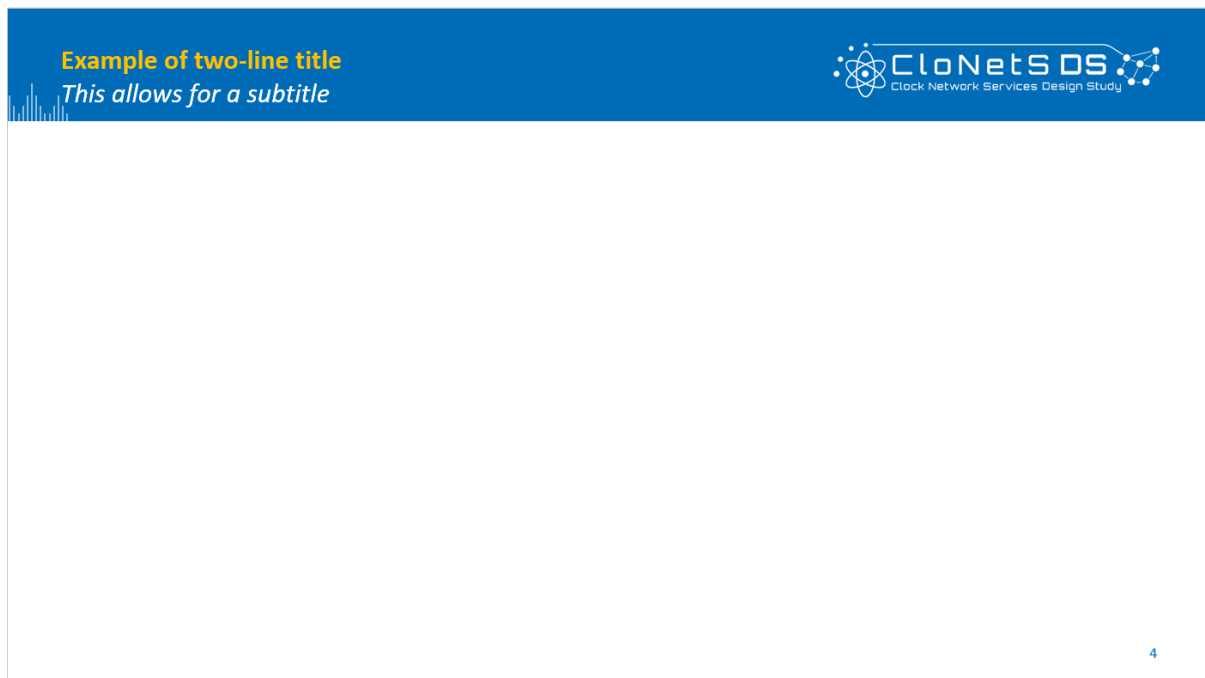


Figure 4. Main page of the CLONETS-DS presentation template

The final page is similar to the first page, with the CLONETS-DS logo and acknowledgement information.

2.3 Leaflet Template

Project partners have also prepared a leaflet template, which was the basis for publishing newsletters describing the work of the project and aimed at stakeholders.

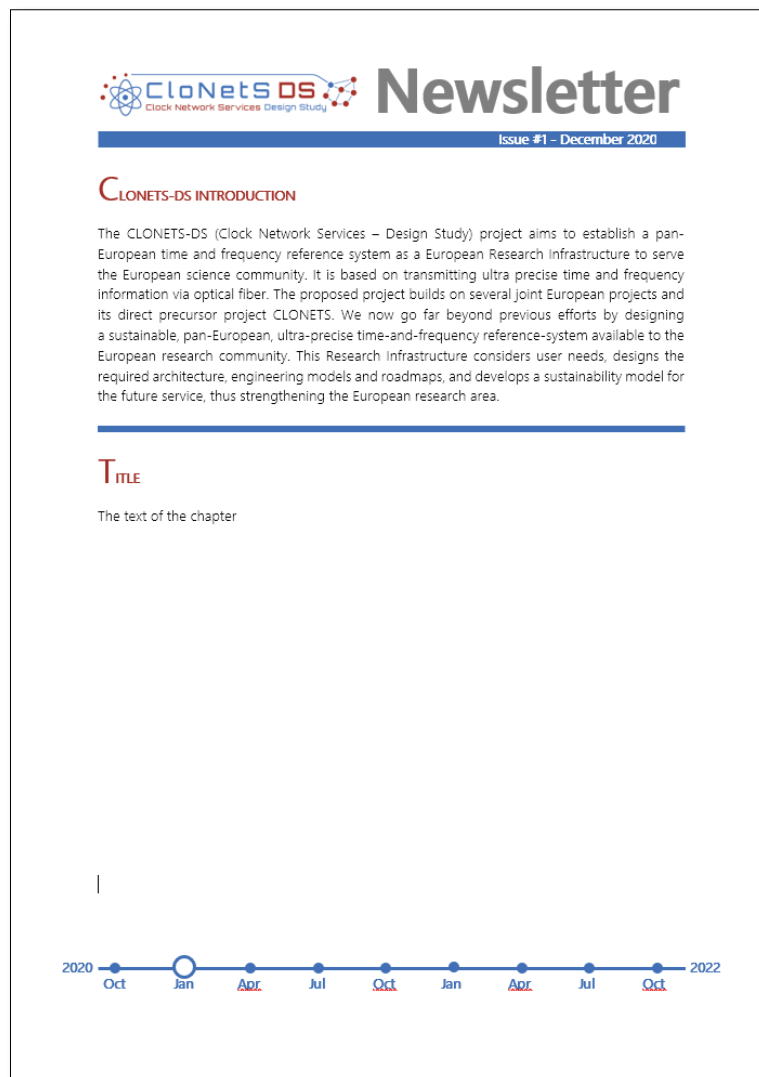


Figure 5. Leaflet template first page

The leaflet is in the form of a four-page document. On the first page (Figure 5), at the top is the project logo and the title “Newsletter”. Then there is the issue number and date of publication. Below is a description of the project, followed by current information relating to the project work. At the bottom is a timeline indicating the duration of the project, with the publication date marked again. The last page contains contact and funding information (Figure 6).

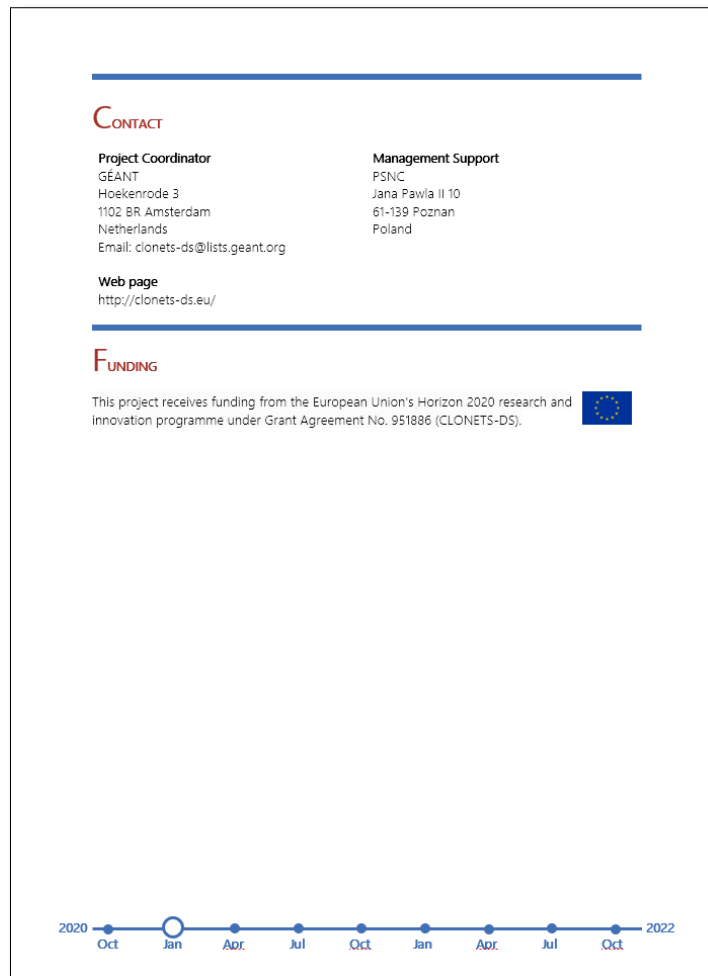


Figure 6. Leaflet template last page

2.4 Document Template

Project partners have also prepared a document template for deliverables. The template includes the project logo on the first page, and in the headers of each of the following pages. The first page also contains key information: the date of issue of the document, the title, as well as additional information:

- Contractual Date.
- Grant Agreement No.
- Work Package.
- Task Item.
- Nature of Deliverable.
- Dissemination Level.
- Lead Partner.
- Document ID.
- Authors.

In addition, the first page provides information about the funding of the project and an abstract:

“© GÉANT Association on behalf of the CLONETS-DS project.

The research leading to these results has received funding from the European Union’s Horizon 2020 research and innovation programme under Grant Agreement No. 951886 (CLONETS-DS).”

2.5 Other Resources

A map with a list introducing all project partners was also prepared (Figure 7). The list was updated when the project partners changed during the project.

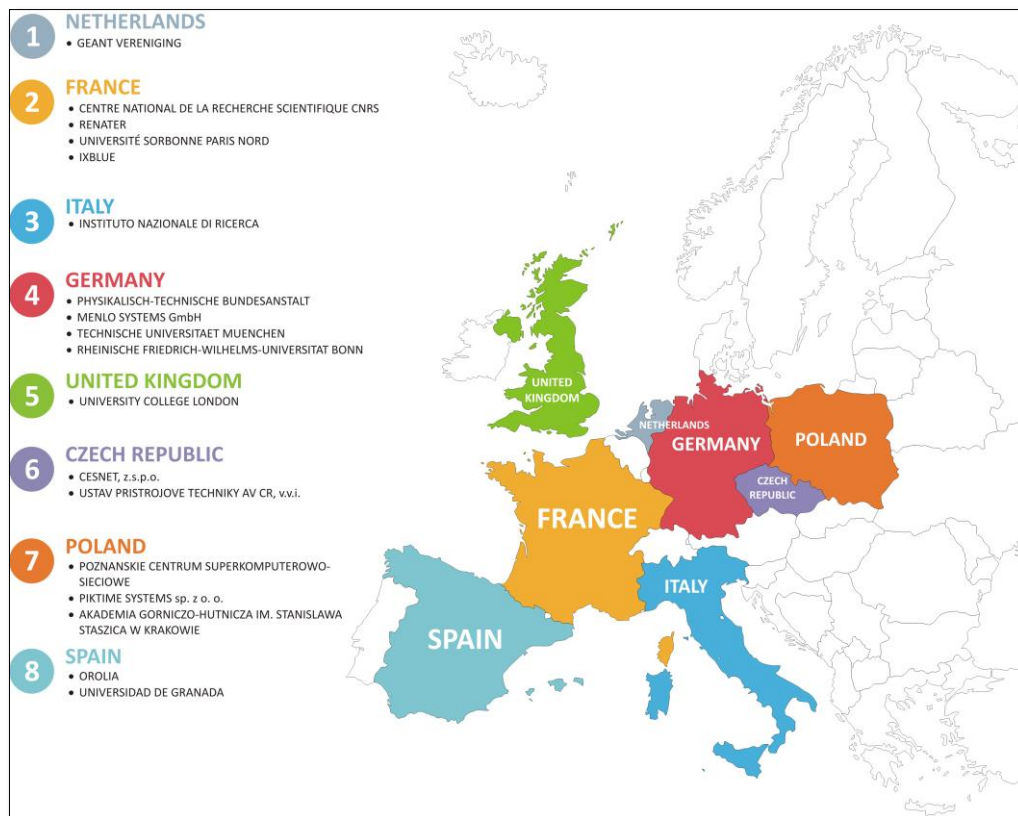


Figure 7. Participants’ map

3 Dissemination and Exploitation Activities

3.1 Website

Project partners know how important a website is to dissemination and exploitation of project results and prepared the project website accordingly [CLONETS-DS]. It was ensured that the website was clear, easily readable and contained the most important information about the project, as well as described the current project work. Technologies were used to prepare the website to enable optimal viewing of the site both on desktop computers (Figure 8) and mobile devices (Figure 9).

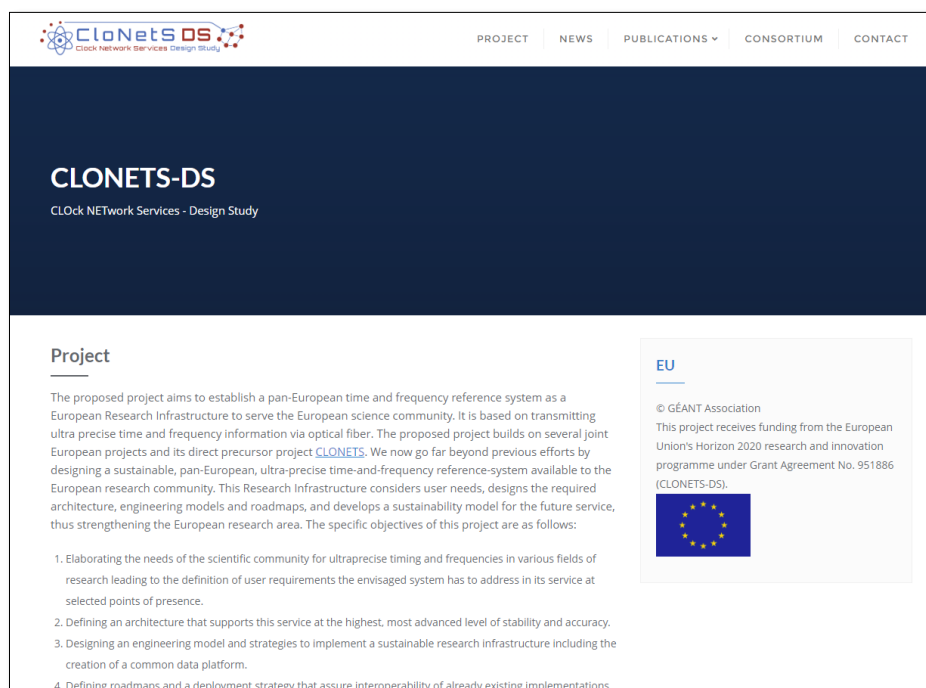


Figure 8. Home page of CLONETS-DS project website

The website consists of five main pages:

- Project home page – contains the main information about the project and its objectives.
- News – contains current information about publications, meetings and conferences at which the project was presented.
- Publications – consists of four subsections containing information about public deliverables, newsletters, posters, and miscellaneous.

- Consortium – introduces the partners of the project.
- Contact – contains contact information.

The CLONETS-DS logo, as well as funding information, appears on each site.



Figure 9. Mobile version of CLONETS-DS website

3.2 Stakeholders' Materials

The project partners prepared three newsletters, which were published in the 3rd, 15th and 24th months of the project. In addition, in the last month of the project, the last newsletter will be published, summarising the work of the project.

3.2.1 First Newsletter

The first newsletter was published in December 2020. The newsletter focused on presenting the project's goals and the project partners, and described the project's kick-off meeting.

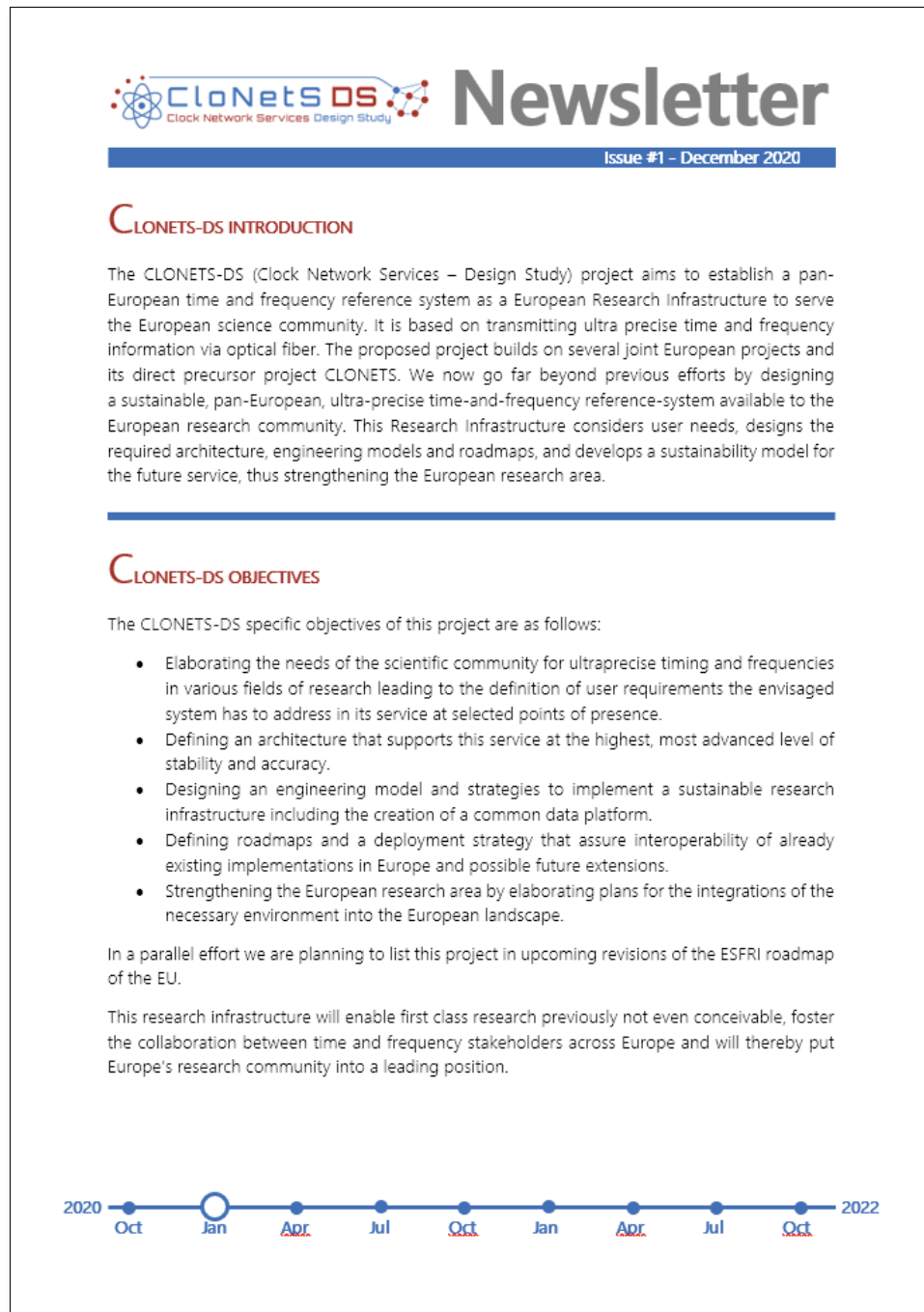


Figure 10. First page of first newsletter

3.2.2 Second Newsletter

The second newsletter was published in December 2021. The newsletter focused on presenting the workshop prepared as part of Work Package 1 in Bad Honnef. More information about the workshop

can be found in *Deliverable D1.1 Stakeholder Workshop* [D1.1]. The newsletter also reported on the change in project partners and the publications created within the project.



Figure 11. First page of second newsletter

3.2.3 Third Newsletter

The third newsletter was published in September 2022. This newsletter focused on the proposed European T&F network topology. It also described promotional activity by project partners at four conferences: EFTF 2022, CLEO 2022, TNC22, and the NORDUnet conference. It also mentioned the EC review of the project.

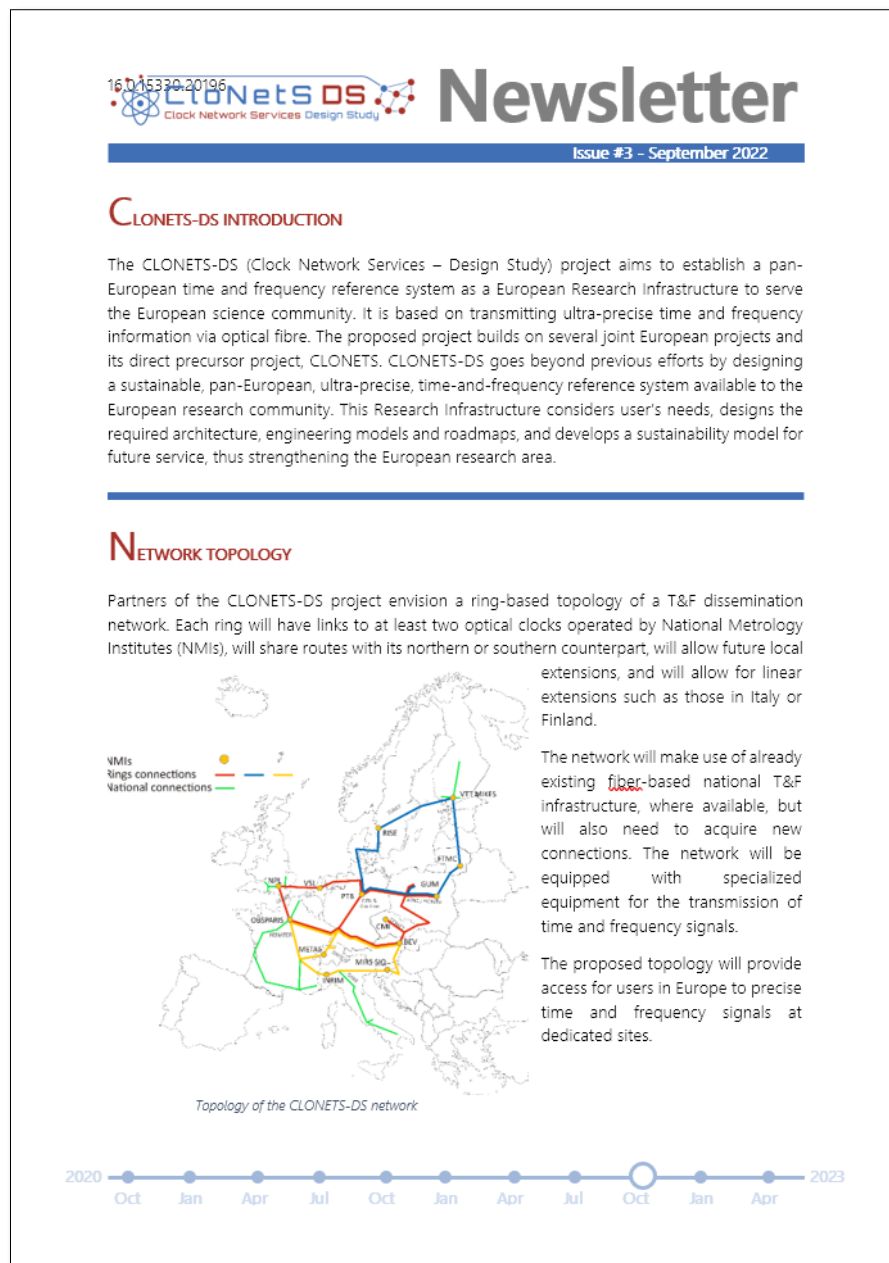


Figure 12. First page of third newsletter

3.2.4 Fourth Newsletter

The fourth and final newsletter was published at the end of the project in March 2023. This newsletter celebrated the collaborative approach of the partners and pledged future meetings and cooperation to maintain best practice and keep partners informed of other European and national initiatives.

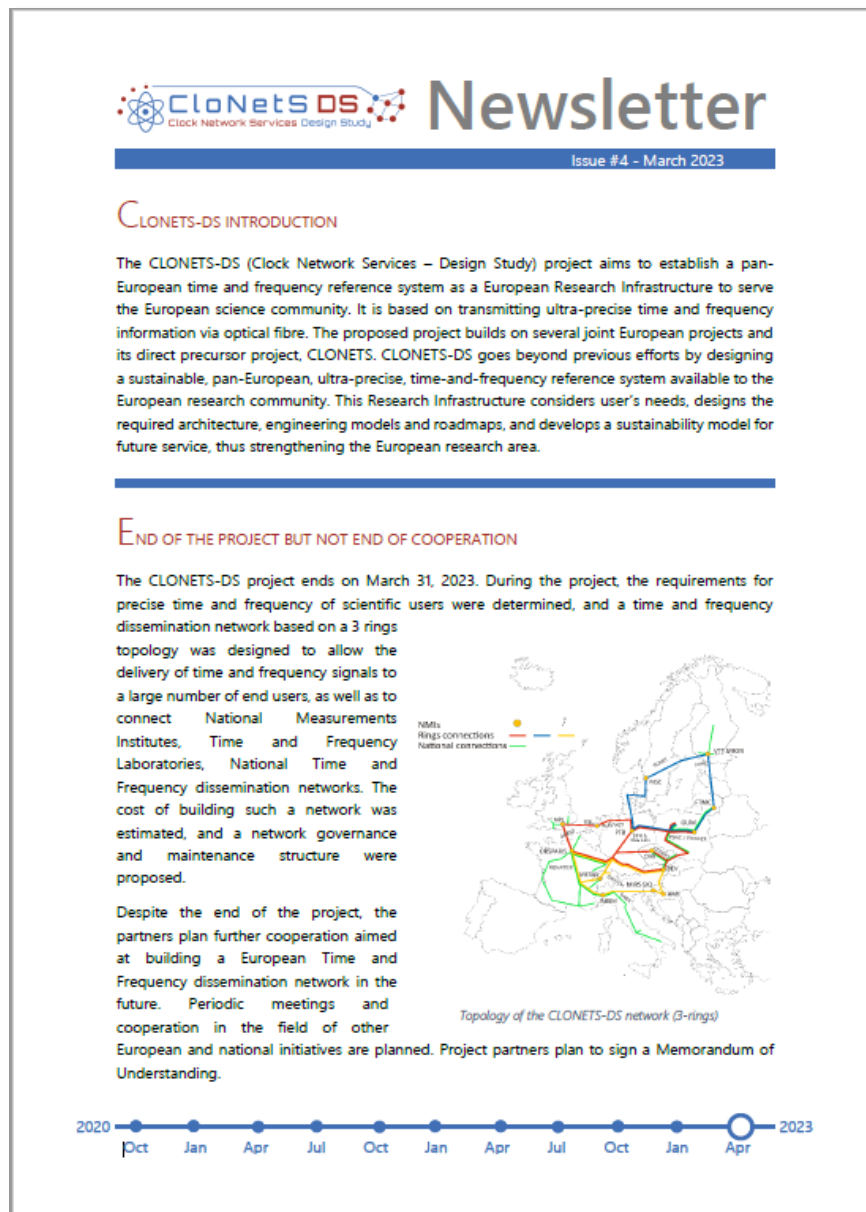


Figure 13. First page of fourth newsletter

3.3 Conferences

CLONETS-DS project partners presented the project at a range of scientific conferences.

3.3.1 Conferences in 2021

The CLONETS-DS project was presented by Josef Vojtěch from CESNET at the Conference on Lasers and Electro-Optics (CLEO) 2021 [CLEO 2021]. The presentation focused on introducing the CLONETS-DS project, its objectives and main goals.

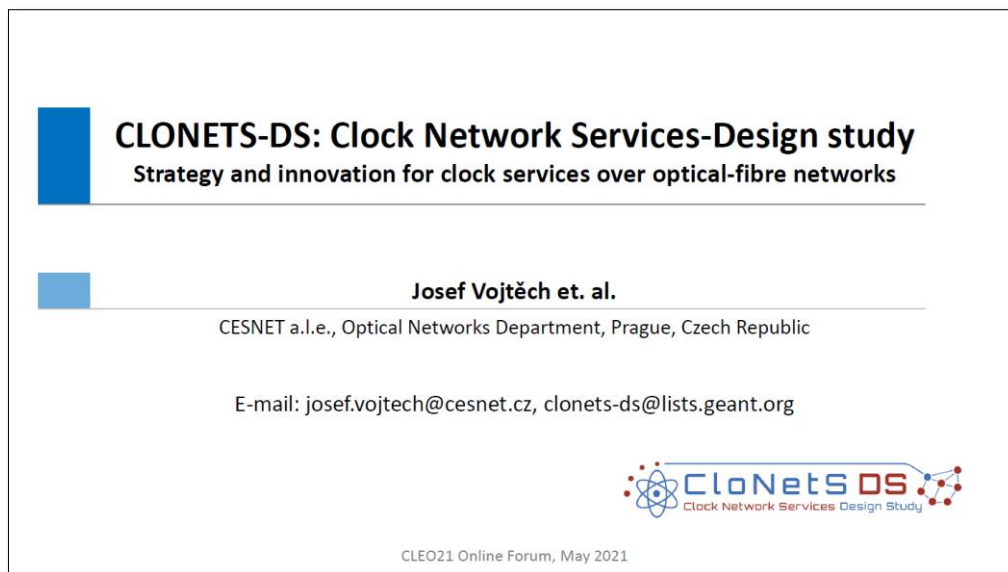


Figure 14. CLONETS-DS presentation at CLEO 2021 conference

CLONETS-DS was also presented by Radek Velc from CESNET at the Asia Communications and Photonics (ACP) 2021 conference [ACP]. This presentation introduced the field of optical frequency and time distribution, described the current need regarding access to precise time and frequency signals, showed CLONETS-DS project participants and also outlined objectives, work plan, and our ambition and impact.

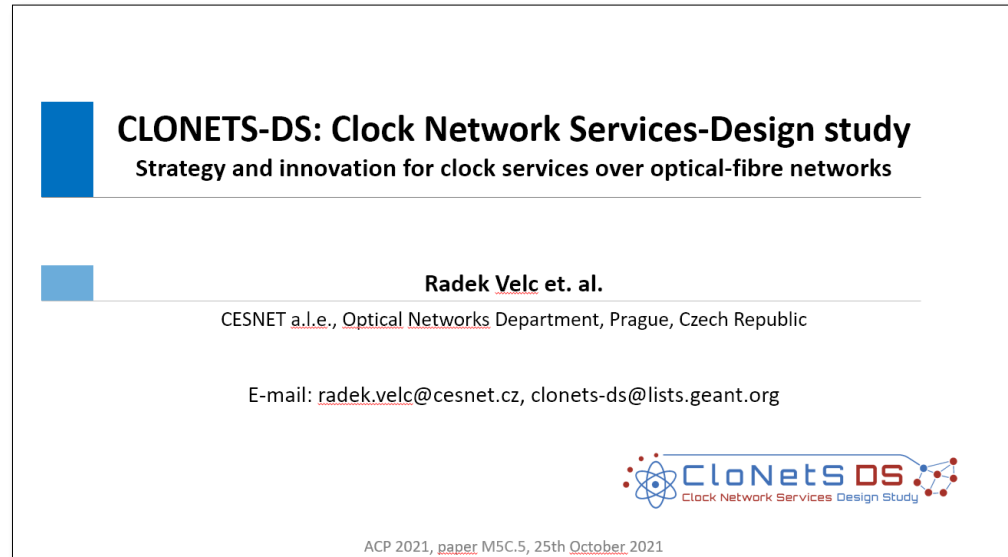


Figure 15. CLONETS-DS presentation at ACP 2021 conference

3.3.2 Conferences in 2022

The CLONETS-DS project was presented by Wojbor Bogacki from PSNC at TNC22 in June 2022 [TNC22]. The title of the presentation was "Strategy and innovation for clock services over optical-fibre networks". The presentation explained the motivation to create a European T&F dissemination network and described the CLONETS-DS project.



Figure 16. CLONETS-DS presentation at TNC22

The CLONETS-DS partners also prepared a side event at the International Conference on Research Infrastructures (ICRI) 2022 [ICRI 2022]. This conference was organised by one of the CLONETS-DS partners.



Figure 17. CLONETS-DS side event at ICRI 2022

In addition, PTB gave a talk at the Robust Optical Clocks for International Timescales (ROCIT) International Workshop on Optical Clocks for International Timekeeping, titled “Time and frequency services via optical fibre networks for European science” [ROCIT].

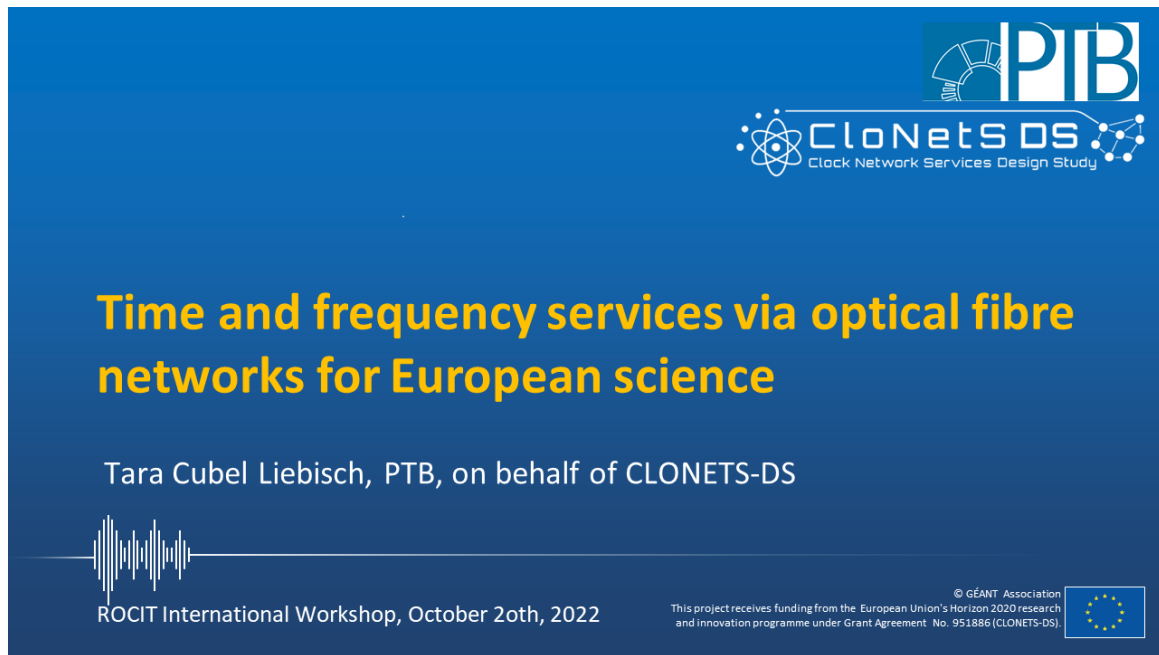


Figure 18. CLONETS-DS presentation at ROCIT Workshop

The CLONETS-DS project was also presented in a short talk by Harald Schnatz from PTB at the 2022 NORDUnet conference. The presentation introduced time and frequency issues, showed user needs, and described CLONETS-DS regarding user needs.

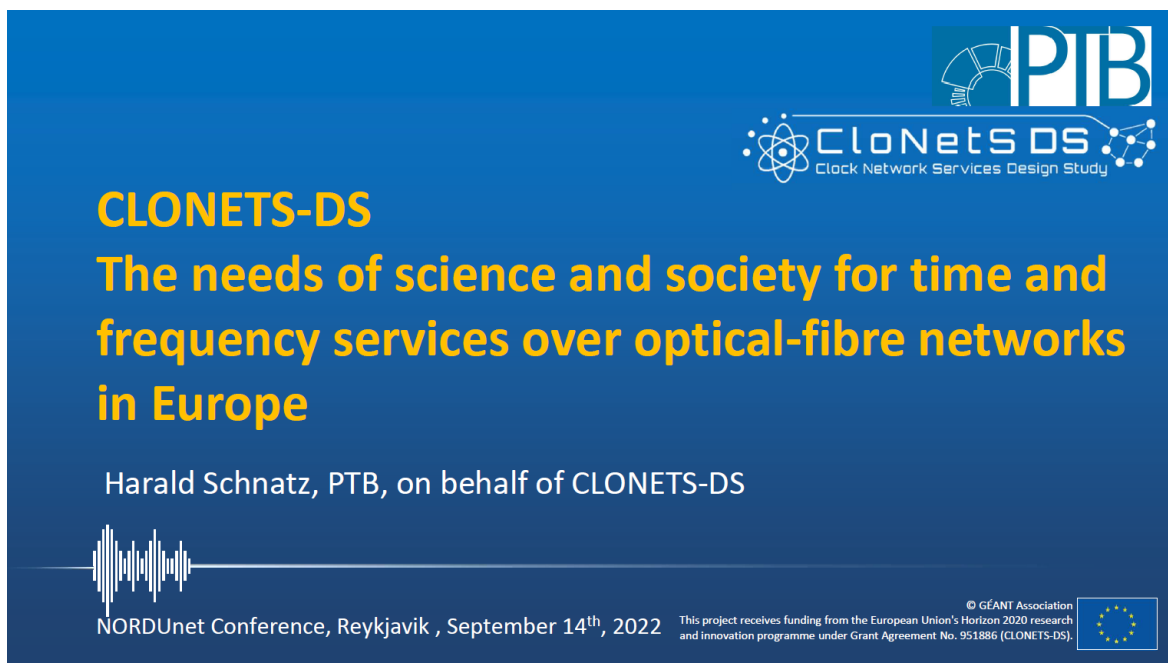


Figure 19. CLONETS-DS presentation at NORDUnet conference

The CLONETS-DS project was presented at the Internet2 conference by Krzysztof Turza from PSNC in December 2022 [[Internet2 conference](#)]. The project results and benefits were shown.

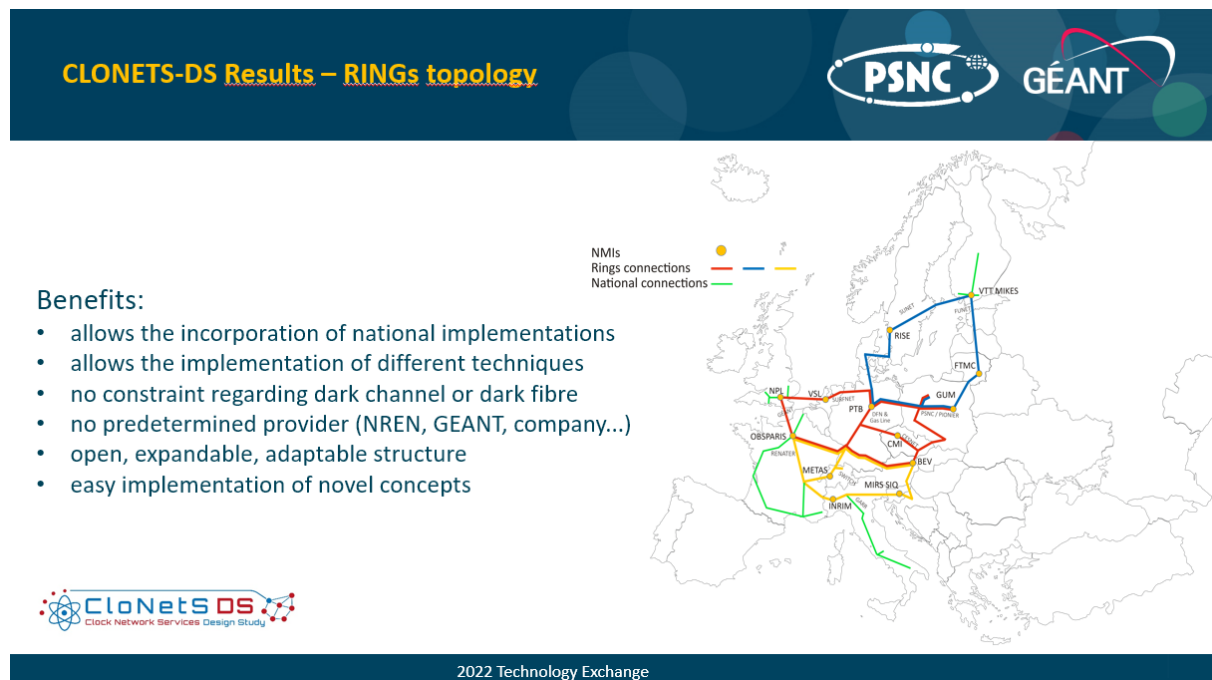


Figure 20. CLONETS-DS presentation at Internet2 conference

3.3.3 Conferences in 2023

The CLONETS-DS project was presented at the Precise Time and Time Interval Systems and Applications (PTTI) 2023 conference by Wojbor Bogacki from PSNC. The title of the presentation was: “CLONETS-DS – Clock Network Services-Design Study - Strategy and innovation for clock services over optical-fibre networks”. The presentation showed CLONETS-DS results, paying special attention to the topology of European T&F network dissemination.

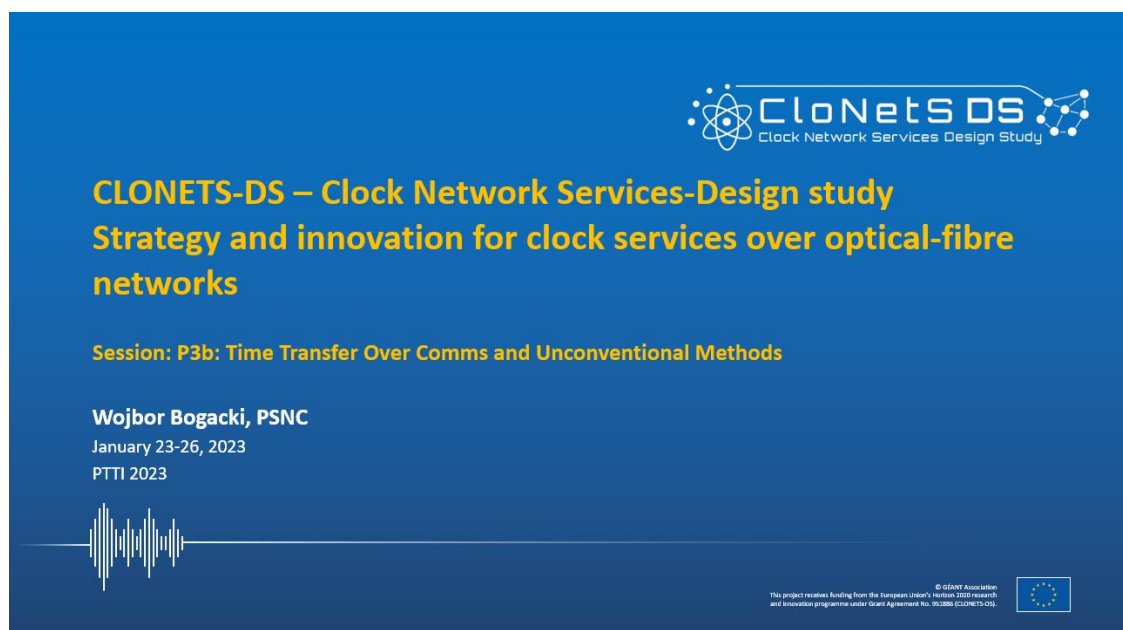


Figure 21. CLONETS-DS presentation at PTTI 2023

3.4 School for Physicists Initiative

The CLONETS-DS project partners also participated in the organisation of a school for physicists which took place 18–22 April 2022 [[School](#)]. The lectures were held under the title “From Basics to Applications of Optical Fibre Links and Frequency Combs”. The objective was to disseminate the possibilities of high-precision measurements made possible by the transfer by optical fibre of a time and frequency reference coupled to a frequency comb. The applications concerned high-resolution atomic or molecular spectroscopy, fundamental physics, and recent developments in geophysical sensing or astrophysical measurements involving long-distance synchronisation.

3.5 Other Activities

Project partners also cooperated with other European projects. As part of these activities, the CLONETS-DS project was presented at a GÉANT infoshare meeting.



Figure 22. CLONETS-DS presentation at GÉANT infoshare event

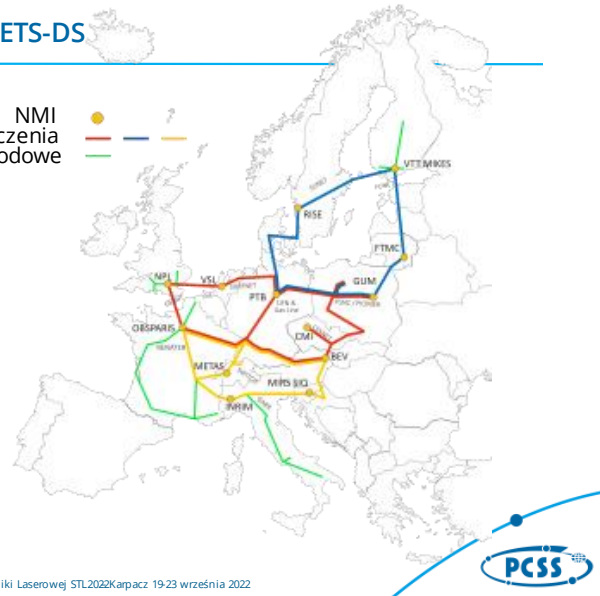
The CLONETS-DS project was also presented and discussed at internal meetings of WP6 and WP7 in the GN4-3 and GN5-1 projects.

CLONETS-DS was presented at the national Polish Sympozjum Techniki Laserowej (STL) 2022 conference [[STL 2022](#)].

Infrastruktura europejska – CLONETS-DS

Planowana topologia sieci

NMI
 Proponowane połączenia
 Połączenia narodowe



10

XIII Sympozjum Techniki Laserowej STL2022Karpacz 19-23 września 2022


Figure 23. CLONETS-DS presentation at STL 2022 conference

Project partners also prepared posters for the EETF 2022 conference and Time and Frequency over Optical Networks (TiFOON) project conference.

CLONETS-DS

Clock NETWORK Services - Design Study

Web page: <http://clonets-ds.eu>



CLONETS-DS INTRODUCTION

The CLONETS-DS (Clock Network Services Design Study) project aims to establish a pan-European time and frequency reference system as a European Research Infrastructure to serve the European science community. It is based on transmitting ultra precise time and frequency information via optical fiber. The proposed project builds on several joint European projects and its direct precursor project CLONETS. We now go far beyond previous efforts by designing a sustainable, pan-European, ultra-precise time-and-frequency reference-system available to the European research community. This Research Infrastructure considers user needs, designs the required architecture, engineering models and roadmaps, and develops a sustainability model for the future service, thus strengthening the European research area.

CLONETS-DS OBJECTIVES

The CLONETS-DS specific objectives of this project are as follows:


- Elaborating the needs of the scientific community for ultraprecise timing and frequencies in various fields of research leading to the definition of user requirements the envisaged system has to address in its service at selected points of presence.
- Defining an architecture that supports this service at the highest, most advanced level of stability and accuracy.
- Designing an engineering model and strategies to implement a sustainable research infrastructure including the creation of a common data platform.
- Defining roadmaps and a deployment strategy that assure interoperability of already existing implementations in Europe and possible future extensions.
- Strengthening the European research area by elaborating plans for the integrations of the necessary environment into the European landscape.

In a parallel effort we are planning to list this project in upcoming revisions of the ESFRI roadmap of the EU. This research infrastructure will enable first class research previously not even conceivable, foster the collaboration between time and frequency stakeholders across Europe and will thereby put Europe's research community into a leading position.


THE CONSORTIUM

18 partners from 8 countries have joined the CLONETS-DS project. The leader of the consortium is GÉANT VERENIGING. There are 3 National Measurement Institutes (NMIs), 4 National Research and Education Networks (NRENs), 7 academic laboratories and 4 industrial partners. The consortium partners complement each other with knowledge and experience and form a unique group capable of building a time and frequency distribution network in Europe.









- 1 **NETHERLANDS**
• SURF
- 2 **FRANCE**
• CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE CNRS
• RENATER
• UNIVERSITÉ SORBONNE PARIS NORD
• UCL
- 3 **ITALY**
• ISTITUTO NAZIONALE DI RICERCA METROLOGICA
- 4 **GERMANY**
• PHYSIKALISCH-TECHNISCHES BUNDESANWALT
• RENATER
• TECHNISCHE UNIVERSITÄT MÜNCHEN
• RHEINISCH-FRIEDRICH-WILHELM-UNIVERSITÄT BOEN
- 5 **UNITED KINGDOM**
• UNIVERSITY COLLEGE LONDON
- 6 **CZECH REPUBLIC**
• CEITEP
• ÚSTAV PRŮVĚROVÉ TECHNIKY AV ČR, a.s.
- 7 **POLAND**
• POLSKIE CENTRUM SUPERWYPOKONOWOŚCI
• PIETRZYCE SYSTEMS sp. z o.o.
• KATEDRA KONSTRUKCYJNEJ FIZYKI IM. STANISŁAWA STĄDZIŁKI W BIAŁYMOSTCE
- 8 **SPAIN**
• CSIC
• UNIVERSIDAD DE GRANADA












Coordinator



Participants

EFTF IFCS 2022 - 24 -28 April Paris

This project receives funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 951886 (CLONETS-DS).




Figure 24. CLONETS-DS poster for EET 2022

Lastly, PTB presented a poster at the Quantum Sensors and Tests of New Physics (QSNP) Conference in Hannover [QSNP].

The benefits, needs and impact of time and frequency services via optical fibre networks for European science

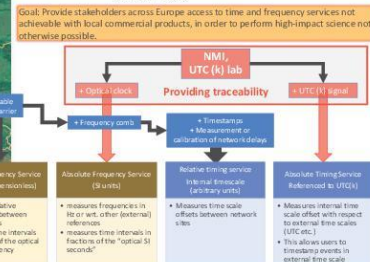
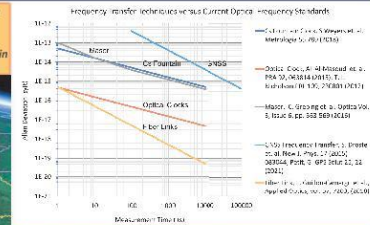
Tara Cubel Liebisch and Harald Schnatz in collaboration with the CLONETS-DS Consortium
Physikalisch-Technische Bundesanstalt, Bundesallee 100 38116 Braunschweig, Germany



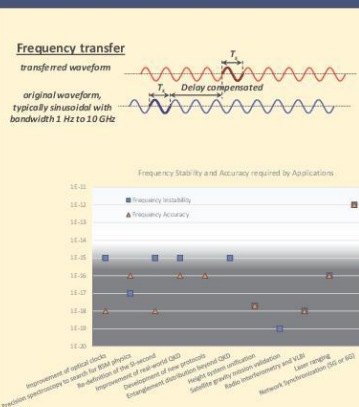
Benefits

- Science Case 1: Fundamental Science**
- Improvement of optical clocks
 - Precision spectroscopy to search for beyond standard model (BSM) physics
 - Re-definition of the SI unit second
- Science Case 2: Quantum Technologies**
- Improvement of real-world QKD
 - Development of new protocols
 - Entanglement distribution beyond QKD
- Science Case 3: Earth Observation / Geodesy**
- Height system unification
 - Satellite gravity mission validation
 - Geodetic network consistency
- Science Case 4: Astronomy**
- Radio interferometry and VLBI in astronomy
 - Laser ranging
 - Pulsar timing
- Science Case 5: Telecommunication and Networks / Position, Navigation, Synchronization, and Timing**
- Optical timescales
 - Position, navigation & timing, PNT
 - Resilience for GNSS
 - Supervision of telecommunication networks and synchronization (5G or 6G)

"I am sure in some respects, either in atomic physics or nuclear physics or astronomy, and maybe even geology -- although one doesn't think of precision measurements of time with respect to geology, I think it will come in -- that you are opening a new field for greater and greater understanding of time." L. I. Rabi, Panel Discussion at PTI in 1982 discussing the advancements in measuring time, "particularly time intervals"

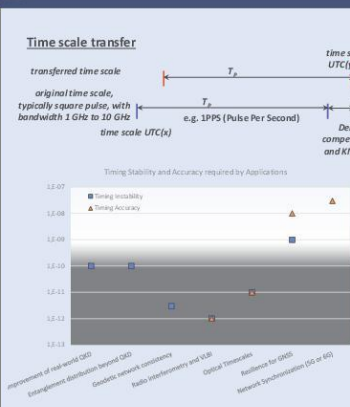


Needs



Challenges of frequency transfer via fiber:

- Determine and compensate for propagation delay fluctuations
- Cancellation schemes for phase fluctuations due to vibrations, temperature, polarization
- Good passive shielding
- Heterodyne detection at a different frequency
- Inline amplification

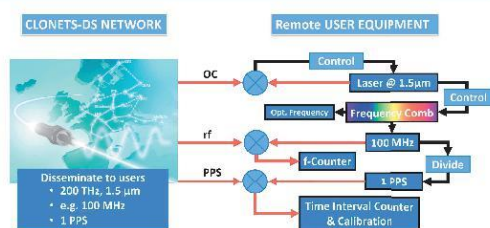


Challenges of time transfer via fiber:

- Absolute value of the "Delay = Phase = Path Length" is required, Stabilization and Calibration
- Improved timing instability requires larger signal bandwidth
- Infrastructure for optical frequency transfer can not necessarily be used for time transfer

Impact

Existing advanced techniques		Performances Frequency (instability) Time (precision, Time Deviation TDEV)	TRL	Distance
Frequency	Optical Carrier (Carrier Wavelength)	Active cancellation 10^{-15} @ $1s$; 10^{-20} @ $1d$ (bi-directional) Various demonstrations France, Germany, Italy, Japan, USA	8	>1000 km
	RF Carrier (Modulated Wavelength)	Active cancellation with optical delays 10^{-14} @ $1s$; 10^{-19} @ $1d$ (bi-directional); O. Lopez et. al. App. Phys. B 98 (2010)	4	0-100 km
		Active cancellation with electronic delays (ELSTAB) 10^{-13} @ $1s$; 10^{-17} @ $1d$ (bi-directional); P. Krehlik et. al. IEEE (2016)	8	500-1000 km
		White Rabbit PTP 10^{-16} @ $1d$ (unidirectional); L. Slawczynski et. al. IEEE (2015)	8	>1000 km
Time	Two-way comparison	TDEV = 2ps (bi-directional); J. Kodet et. al. Metrologia 53 (2016)	5-6	ca. 500 km
		TDEV = 30ps calibration through GPS (unidirectional) V. Smotlacha and A. Kunz IEEE 2012	6	ca. 500 km
	Optical frequency comb	Calibration uncertainty <40ps TDEV 500 fs @ $1s$ (bi-directional); M. Lessing et. al. App. Phys. Lett. 110 (2017)	4-5	>100 km
	Active cancellation with electronic delays (ELSTAB)	TDEV < 1ps calibration uncertainty <40 ps (bi-directional); L. Slawczynski et. al. Metrologia 50 (2013)	8	>1000 km
	Protocol based (White Rabbit PTP)	Verified with GPS disagreement <2ns (uni-directional); E. Dierikx et. al. IEEE 63 (2016)	8-9	>1000km
		Calibration uncertainty <10ns (bi-directional); J. Serrano et. al. ICAL EPCS 2009	8-9	0-100 km



This project receives funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 951886 (CLONETS-DS).



Figure 25. CLONETS-DS poster at Quantum Sensors and Tests of New Physics Conference

4 Conclusions

The project partners actively promoted the project and its results at many conferences and internal GÉANT meetings and at the invitation of other projects. Mostly these were given as presentations, but posters were also prepared.

In addition, project partners prepared stakeholders materials, namely newsletters, which are available on the project website [\[CLONETS-DS\]](#). Public deliverables and some of the presentations given at conferences are also available on the project website.

These dissemination and exploitation activities help to develop the potential user community by informing them of the potential of the T&F reference system, exchanging best practices, and encouraging them, as well as the formal stakeholder bodies, to support the development of these services.

References

[ACP]	http://www.acpconf.com/
[CLEO_2021]	https://opg.optica.org/conference.cfm?congress=CLEO#2021
[CLONETS-DS]	https://clonets-ds.eu/
[D1.1]	https://clonets-ds.eu/wp-content/uploads/2022/07/Deliverable-1.1-Stakeholder-Workshop.pdf
[ICRI_2022]	https://www.icri2022.cz/
[Internet2_conference]	https://internet2.edu/2022-technology-exchange/
[NORDUnet_conference]	https://nordu.net/welcome-to-the-31st-nordunet-conference/
[QSNP]	https://www.conference-qsnp.uni-hannover.de/en/
[PTTI_2023]	https://www.ion.org/ptti/
[ROCIT]	http://empir.npl.co.uk/rocit/2022/09/20/international-workshop-optical-clocks-for-international-timekeeping/
[School]	https://linkandcomb.sciencesconf.org/
[STL_2022]	https://photonics.pl/node/86
[TNC22]	https://tnc22.geant.org/

Glossary

ACP	Asia Communications and Photonics
CLEO	Conference on Lasers and Electro-Optics
EETF	European Frequency and Time Forum
ICRI	International Conference on Research Infrastructures
NREN	National Research and Education Network
PTTI	Precise Time and Time Interval Systems and Applications
QSNP	Quantum Sensors and Tests of New Physics
ROCIT	Robust Optical Clocks for International Timescales
STL	Symposium Techniki Laserowej
T&F	Time and Frequency
TiFOON	Time and Frequency over Optical Networks
TNC	The Networking Conference
WP	Work Package