Fostering the Innovation Potential of Research Infrastructures

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CLONETS – CLock NETwork Services

**Strategy and innovation for clock services
over optical-fibre networks**

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Deliverable D3.1

Preliminary list of TF service categories and needs survey questions

Final

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D3.1   Preliminary list of TF service categories and needs survey questions

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References and Applicable Documents

[1]   http://www.clonets.eu

List of Acronyms and Abbreviations

CLONETS	CLock NETwork Services: Strategy and innovation for clock services over optical-fibre networks Project
DWDM	Dense wavelength division multiplexing
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
IoT	Internet of Things
MTIE	Maximum Time Interval Error
NMI	National Metrology Institute
NTP	Network Time Protocol
RI	Research Infrastructure
RMS	Root Mean Square
TDEV	Time deviation
TF	Time and Frequency
T/F	Time or Frequency
UTC	Universal Time Coordinated
WP	Work Package

List of Project Partner Acronyms

AGH/AGH-UST	Akademia Górniczo-Hutnicza im. Stanisława Staszica w Krakowie
CESNET	CESNET, zájmové sdružení právnických osob
CNRS	Centre National de la Recherche Scientifique, France (3 rd Party to ObsParis)
INRIM	Istituto Nazionale di Ricerca Metrologica
GARR	Gruppo per l'Armonizzazione delle Reti della Ricerca
Menlo	Menlo Systems GmbH
MUQUANS	MUQUANS
NPL	National Physical Laboratory
ObsParis	Observatoire de Paris
OPTOKON	OPTOKON a.s.
Piktime Systems	Piktime Systems sp z o.o.
PSNC	Instytut Chemii Bioorganicznej Polskiej Akademii Nauk – Poznańskie Centrum Superkomputerowo-Sieciowe
PTB	Physikalsch-Technische Bundesanstalt
RENATER	Groupement d'interêt Public pour le Reseau National de Telecommunications pour la Technologie, l'Enseignement et la Recherche
Seven Solutions	Seven Solutions S.L.
TOP-IX	Consorzio TOrino Piemonte Internet eXchange
UCL	University College London
UP13	Université Paris 13
UPT AV CR (ISI)	Ustav Pristrojove Techniky AV, v.v.i.

Executive Summary

This deliverable D3.1 summarizes the work done in the frame of Task 3.1 of Work Package 3 (WP3) of the CLONETS project. The general goal of WP3 is the identification of additional users and applications of Time and Frequency (TF) services beyond Research Infrastructures (RIs). The main goal of this Deliverable is to provide relevant information necessary for the preparation and implementation of the survey to be carried out in Task 3.2; concerning the needs of public, research, government and commercial subjects, aimed at the identification of users and stakeholders of TF services and their possible evolutions in the future.

Two main topics are covered by D3.1:

- A preliminary proposal of categories of TF services – A list of TF service categories based on multiple criteria which helps to better design the survey structure; the survey will attempt to cover all kinds of anticipated responses. This list, which is based on knowledge and experience of project partners, is brief and generic.

- A proposal of questions to include in the survey – This is organised into four groups covering: the identification of the user; the relevance of the TF service; the required quantitative parameters of the TF service; and the signal source, available optical connectivity and transport path.

The presentation given in this document should not be considered final. The set of questions covers all, or almost all, relevant aspects, but their presentation and organisation may be modified in the construction of the Task 3.2 survey questionnaire itself. The TF service categories will be revisited on the basis of the survey results, to adapt them as well as possible to the reality of the user community. The final results of this work will be given in D3.3.

1 Introduction

The objectives of this document are to provide a categorisation of Time and Frequency (TF) services in terms of the types and the features of Time or Frequency (T/F) signals to be provided to the user; and a set of survey questions to help the consortium to recognise the TF user profile, evaluate the importance of TF dissemination for the user activity, give a quantitative description of the TF needs in terms of parameters such as accuracy, stability, traceability, resilience, accessibility, and redundancy, and provide an overview of the reference signals and network topology used to disseminate TF. Note that this constitutes an intermediate stage in the CLONETS project rather than a final output; this information will form the basis for the survey of TF service users beyond Research Infrastructures (RIs), which is to be carried out in Task 3.2.

Section 2 describes the preliminary list of service categories. In order to accommodate several viewpoints, these categories are identified according to performance (e.g. accuracy) in Subsection 2.1 and also according to the required type of optical infrastructure in Subsection 2.2. Several other criteria are reflected in Subsection 2.3. Section 3 describes basic questions that will be part of the survey. Questions are grouped into 4 parts: Subsection 3.1 identifies the user of a service; the relevance of a TF service for a particular purpose is evaluated in Subsection 3.2; and most importantly Subsection 3.3 asks the survey participant about the required parameters of the TF service. The last Subsection 3.4 deals with requirements on signal source, available optical connectivity and transport path.

Final comments and conclusions are given in Section 4.

2 Service categories

TF optical service categories identified to be suitable for users beyond RIs can be specified and distinguished according to several criteria:

- required accuracy/uncertainty and stability
- level of traceability
- availability/resilience
- security
- available type of optical delivery path between service provider and consumer

Combining these criteria in different ways, we propose several measures to define service categories:

2.1   Service categories according to performance level of provided TF signal

Parameters of services in this list are intentionally described by assumed type of usage rather than explicit accuracy or stability because questions in the survey will also ask "*for what purpose*" rather than "*what accuracy*", to be familiar for broader range of respondents:

- Frequency transfer for distribution/comparison of optical clocks, best possible stability.
- Distribution of T/F from NMIs, with performance not degrading parameters of a Cesium clock or Hydrogen maser.
- Time transfer between NMIs for comparison of time scales.
- T/F service with performance not worse than GNSS (*i.e.* GNSS alternative/ replacement).

- T/F service in a large optical network (with possible deployment of special network components).
- Time transfer with uncertainty better than NTP.

2.2 Service categories depending on optical connectivity

Type of available optical connectivity might be limiting factor for users of TF optical services. We can distinguish following optical infrastructures:

- Dark fibre between service provider and user.
- Network with reserved optical channels (e.g. DWDM technology).
- TF service in optical network under own control with possible deployment of special network components (*e.g.* time distribution in own network).
- Data service above optical layer (*e.g.* Ethernet as a Layer 2 service).

2.3 Other criteria of service categories

Services might require different levels of time source status:

- Legal requirements.
- Traceability (to UTC or other time scales).
- Redundancy.
- Safe communication channel (protection against forgery, etc.).
- Accessibility.

3 Survey questions

Survey questions are grouped into four main parts:

- User identification

Objective: characterize who is taking the questionnaire. This will help linking the proper services to the proper user categories later on.

- Perceived value of TF in the user activity, the sector of the user

Objective: assess the level of criticality of getting a frequency reference or a time reference, and what drives this need.

- Main parameters of required/considered TF services (accuracy, stability, etc.)

Objective: map the trends of user needs in terms of the features of TF reference signals.

- Local production or importation of TF signals

Objective: discriminate between local production and/or transfer from an external reference in order to assess the possible role of future optical TF infrastructure.

3.1 User identification

Questions of Part 1:

- Your company/organisation?
- Your country/countries of operation?
- Your position held in the company?

- Approximate size of company (number of employees):
  - up to 9 employees
  - 10 to 49 people
  - 50 to 249 people
  - more than 250 people

- In what industry (in which field) does your company/organization operate?

3.2   Importance of TF service

Questions in Part 2 allow user to specify relevance and importance of considered TF services.

There are two questions, both in form of table:

- How would you describe the relevance of the use of TF reference signal within your company/organization/department today? *Please put 'X' in the corresponding boxes, only one per row.*

	Very Relevant (core of your activity)	Medium Relevance (not the core of your activity but your activity relies on or highly benefits from such a signal)	Relevant (you use this signal sometimes or for periphery activities)	Not Relevant
Use of a signal as a reference of time				
Use of a signal as a reference of frequency				

- What is the perceived value of TF for your organization? *Please put 'X' in the corresponding boxes, several responses per row are allowed.*

	Help improve the quality of your activity (product or service that you deliver)	Improve the performance of your production process	Improve the safety of your activity (product or service)	Help earn a competitive advantage or market-shares	Comply with existing or future regulations	Other (please specify)
Use of a signal as a reference of time						
Use of a signal as a reference of frequency						

3.3   Parameters of TF service

In this part, the user is asked about their requirements for TF and/or T/F services:

3.3.1 *Frequency signal*

This section contains the following questions:

- Describe how you use the frequency reference signal

- Please rank the following characteristics of a useful frequency signal for your activity. *Assess according to the ranking a scale between 1 "completely irrelevant" and 5 – "critical".*

	1	2	3	4	5	It is hard to say
Stability						
Accuracy						
Reliability/resilience						
Traceability						
Secondary source for a backup or two independent sources						

- What reference frequency is used and shall be required in the future? *Please put 'X' in choice(s) (If you know the exact value, please specify in the field)*

	Today	In 5/10 years
< 1 MHz		
1 MHz – 100 MHz		
1 GHz – 10 GHz		
Optical		
If other, what value?		

- What level of accuracy of this frequency is important for you?

- Does the application require certified frequency (*e.g.* frequency certified by national NMI or other institution authorized by relevant law)?

- How you can specify the required stability:
    o explicit short / long term stability *(go to the next question)*
    o normalized term (*e.g.* Stratum *x*, PRC, ...) *please specify*: ___

- What level of stability of this frequency matters to you?
    o Required long term frequency stability:
        ▪ Not better than 1×10^{-7}
        ▪ $1\times10^{-7} - 1\times10^{-9}$
        ▪ $1\times10^{-9} - 1\times10^{-11}$
        ▪ Better than 1×10^{-11} – please, specify the value: ___
        ▪ Long-term stability is not important to me
        ▪ It is hard to say

    o Required short term frequency stability:
        ▪ Not better than 1×10^{-7}
        ▪ $1\times10^{-7} - 1\times10^{-9}$
        ▪ $1\times10^{-9} - 1\times10^{-11}$
        ▪ Better than 1×10^{-11} – please, specify the value: ___
        ▪ Short-term stability is not important to me
        ▪ It is hard to say

3.3.2 *Time signal*

This section contains the following questions:

- Please rank the following characteristics of a useful time signal for your activity. *Assess according to the ranking a scale between - 1 "completely irrelevant" and 5 – "critical".*

	1	2	3	4	5	It is hard to say
Stability						
Accuracy						
Reliability/resilience						
Traceability						
Legal time						
Secondary source for a backup or two independent sources						

- For which application precise time and / or legal time are used (or considered to be used)? *Please, mention all these applications and provide separate answer to following questions for all of them.*

- How you can specify required accuracy and jitter/stability
  - explicit value *(go to the next question)*
  - by a formal standard or a well-known example (*e.g.* similar to GPS, ...), *please specify: ___*

- What are the explicit values required by you?
  - What is the required absolute accuracy of the time?
    - \> 0.5 s
    - 1 ms – 500 ms
    - 1 µs – 1 ms
    - 1 ns – 1µs
    - < 1 ns
    - It is hard to say

  - What is the required jitter/stability of the provided time? *Specify also the term, please (RMS, MTIE, TDEV, ...)*
    - \> 1ms
    - 1 µs – 1ms
    - 1 ns – 1 µs
    - < 1 ns
    - It is hard to say

- Does the application require legal time?

- Does the application require UTC traceability?

3.4   Signal source requirements

The goal of this section is to assess the importance of the reference signal, its metrological or legal specification.

- At your organization/department/institution, where does the reference signal that you are using come from? *Please put 'X' in the corresponding boxes.*

	Internal production (a clock is owned and operated by your organization)	Import (the external reference signal is delivered to you from someone else, for e.g. by GPS transfer)	You do not know
Use of a signal as a reference of time			
Use of a signal as a reference of frequency			

- What is the available (or assumed) optical connectivity or infrastructures used for considered TF services?
  - o Dark fibre between service provider and user.
  - o Network with reserved optical channels (e.g. DWDM technology).
  - o Optical network under own control with possible deployment of special network components (*e.g.* time distribution in own network).
  - o Data service above optical layer (e.g. Ethernet as Layer 2 service).
  - o Other, please specify: ___

- Please specify the category of points (separate locations), at which it is required to provide precise time
  - o Laboratory, technology room, …
  - o Device, appliance, instrument, vehicle, node, …
  - o IoT sensor
  - o Other, please specify: ___

- Please specify the approximate number of points (separate locations), at which it is required to provide precise time: ____

- If it is possible, specify for the number of points, the maximum distance between any two consecutive points?
  - o Below 1 km
  - o 1 km to 10 km
  - o 10 km to 100 km
  - o 100 km to 1000 km
  - o >1000 km

- Could you specify, for the number of points, the typical distance between two consecutive points?
  - o Below 1 km
  - o 1 km to 10 km
  - o 10 km to 100 km
  - o > 100 km

- Did any failures related to the reception of time signal occur at your company / organization in the past?

- Please specify how often during the year these types of situations occur?

- How long does the break usually last?

- How long interruption in access to precise/official time source is accepted at your company / organization?

- Has your company/ organization applied redundancy procedures for failures related to reception of time signal?

- Has your company/ organization tested redundancy procedures for failures related to reception of time signal?

4 Conclusions

In this document, we have proposed a preliminary set of TF service categories involving multiple criteria, and a list of questions, in four groups, to identify and quantify the needs of TF service users and their possible evolutions in the future. This information will form the basis for the survey of TF service users beyond RIs which is to be carried out in Task 3.2.

The presentation given in this Deliverable should not be considered final. The set of questions covers all, or almost all, relevant aspects, but their presentation and organisation may be modified in the construction of the Task 3.2 survey questionnaire itself. The TF service categories will be revisited on the basis of the survey results, to adapt them as well as possible to the reality of the user community. The final results of this work will be given in D3.3.