

- timing in encryption
- time stamping (documents, paper free,...)
- potential new application (autonomous cars, synchroniz

A critical technical issue is the security. One of the driving forces behind the development of fiber-based time transfer is the acknowledged vulnerability of GNSS, any and all fiber-based solution will have to be, by far, more secure (incident resistant,) than GNSS-based solutions. IP world is a different world, IP security along with specific PTP/WR security issues will be a major "MUST" within all these deployments. As any IP based solution is sensitive to classical IP attack , such as Packet Injection, "fake or generated" delay in the time of flight between nodes, transmitting time signals must be protected from any such attack.

ment of fiber-based time transfer that mean that it is more resistant, natural "secure" and the generic **security** is the next major challenge and WR are also sensitive to any attack on all boxes carrying or

We will conclude by a review of new applications and new industrial and commercial accurate time distribution activities on top of the classical area of time transfer.

market deployment towards new applications, introduce new potential activities described above, such as :

- introducing time stamping of ray
- introducing the concept of "Time as a Service", traceable to a given referer (synchronized) Data Center, Data Center need to be synchronized, Data Center might be the best solution

aiming to disseminate time signals, and addressing time provision from local Data Center, time stamp, telecom, fintech, ...). Data Center operation, and such synchronized Data Center allow us to have locally traceable and accurate time.

EXTRACT

Chapter A provides some basic information on fiber-based time transfer as an alternative to GNSS,

introduce fiber-based time transfer as a main alternative to GNSS,

Chapter B provides some background on proposed technologies (A comparison of SDH migrating SDH towards fiber-based independent timing technologies)

WR technologies, compared to other fiber based technologies, introduce some hints of telecom network evolution, work done in Europe pointing out the need for GNSS

In chapter C we describe the requirements to require, timing, **availability, traceability**, dealing with time stamp (time stamp of ray, the trend towards Data center, ...), time transfer

applications , domains and market, requiring, or expected requirements of each individual sectors, in **terms of accuracy, availability, traceability**, fintech Data Center, Energy, usually mentioned when talking about time, but also approaching new market evolutions such as legal documents - patents, ...-, time in encryption and security, time stamp, telecom, fintech, ...), work and introducing the concept of "Time as a Service", following the trend towards "service" tools and technologies, similar to colocation Data center, ...), ways to allow us the size of these various potential markets (and their

In chapter D

figures of our estimation and simulation of the size of potential activity in various individual markets.

It will emphasize the fact that fiber-based timing technology is "everywhere", and many of the applications discussed here may rely on IP based protocols, NTP (and secure NTS) , IEEE 1588 PTP, over traffic network or over dedicated channels, and we observe also that, due to the integration of the White Rabbit technology in the IEEE standard (as HA High Accuracy profile) our recommendation on technology targets PTP, under all standardized profile, telecom, energy, security, High accuracy,....

In parallel we are introducing GNSS receiver improvement options, hybridation by the
“improved security GNSS” PLUS alternative timing option as countermeasure of
“trustability” reference.... There still a huge GNSS receiver market, but that
alternative and backup technologies, to help to provide, not only the system accuracy, but
specifically the availability and security requested by the system. As said by guy in
Telecom, 5G timing does not have more stringent time requirement need of timing
for operation... not more stringent, just most critical...

. We also conclude that the activity driven by time dissemination gains we have
discussed

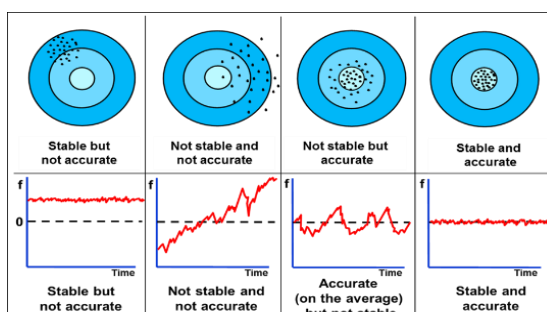
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GLOSSARY

BIPM	Bureau International de l'Heure, collecting data from NMI, performing data treatment and providing UTC time (paper time scale)
DER	Distributed Energy Resource
DTP	Data Center Time Protocol
GNSS	Global Navigation Satellite System (includes GPS, Galileo, Glonass, Beidou,...)
IEEE	Institute of Electrical and Electronics Engineer, providing set of norms
ITU	International Telecom Union, a UN agency dedicated to telecom, providing telecom norms
MiM	Man in the Middle
NTP:	network time protocol RFC
OTN	Optical Transport Network (read <i>full</i> optical), next generation transport Network, full optical
PI	packet injector
PTP :	Precision time protocol, IEEE 1588
PMU	Phasor Measurement Unit : performing voltage and phase measurement of electric signal
RAIM / T.RAIM :	Receiver autonomous Integrity Monitoring
SDH	Synchronous Digital Hierarchy, the telecom transport technology since 90's in Europe, South & Latin Americas, Africa, SEA, Asia (but Japan), Russia,..
SONET	Synchronous Optical Network
TOR	Top of Rack
UTC	Universal Time Coordinated: it is a "paper time scale" defined by BIPM from a set of 100's of atomic clocks disseminated around the world
UTC(k)	UTC local physical representation by a physical clock of lab (k)
WR :	White Rabbit: synchronization protocol developed by CERN, based on PTP 1588,

Some words must in T&F metrology should be accurately defined: See VIM, International vocabulary of metrology, BIPM JCGM 200.2012

Accuracy, stability: described in the graph below, are the proper words to use in time and frequency
Precision is not commonly used in T&F. Include generally ideas of accuracy + noise



Traceability : process able to demonstrate, after use, that the time used in a time stamping or synchronization process was the proper one at time of use (non refutation)

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