HKNOG
Hong Kong Network Operators' Group

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Time Synchronization at various scene @HKNOG6.0 ～NTP&PTP Topics～

2nd March 2018
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- **NTP**

◆ Topics of NTP

◆ NTP DDoS reflection attack white paper from Janog
★Questions about DDos Attack nowadays

◆ Leap second

- **PTP**

◆ Protocol overview

◆ PTP at various scene

1) Telecom
2) Financial
3) Broadcasting

Method of Time Synchronization -NTP&PTP-

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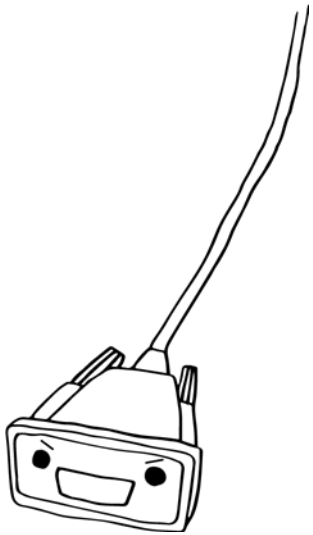
Method of Synchronization	Accuracy	Packet type	use scene（industries）
PTP Precision Time Protocol	nsec・μsec	Ethernet UDP/IP	・Mobile (4G-5G) ・Next Gen. broadcasting ・Financial（Bank・Security） ・Power Grid ・IoT
NTP Network Time Protocol	μsec・msec	Ethernet UDP/IP	・Financial（Bank・Security） ・Transportation (Train・Airplane) ・Medical ・Network and IT related
Others ・PPS ・Frequency ・IRIG ・Serial	msec		・Broadcasting ・CCTV ・Military equipment ・Manufacturing ・Building management

NTP

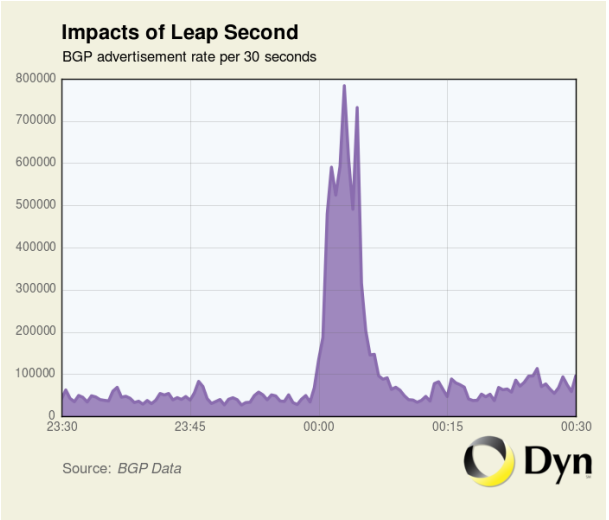


Topics of NTP

- ✓ **2012 Leap second caused so many damages.**
  →Mainly from Linux kernel

- ✓ **2014 NTP reflection/amplification attacks**
  →Famous issue as you know･･･

- ✓ **2015 Janog released white paper**
  “NTP Reflection DDoS Attack Explanatory Document “
  https://www.janog.gr.jp/wg/doc/ntp-wg-en.pdf



2015
https://twitter.com/InternetIntel/status/616059353821487104

- ✓ **2015 1st July Leap second**
  →Still Leap second caused the damages to certain systems

- ✓ **2017 Leap second on 1stday January**
  →It seems not so many troubles were seen.

- ✓ **2018～ Fukuoka Univ. will quit the open NTP server because･･･**

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To whom at ISP, IXP, carrier, iDC, academic, and enterprise.

Nowadays(within 1year), still there are NTP reflection/amplification attack?

Did you have any experiences to deal with a Leap second?

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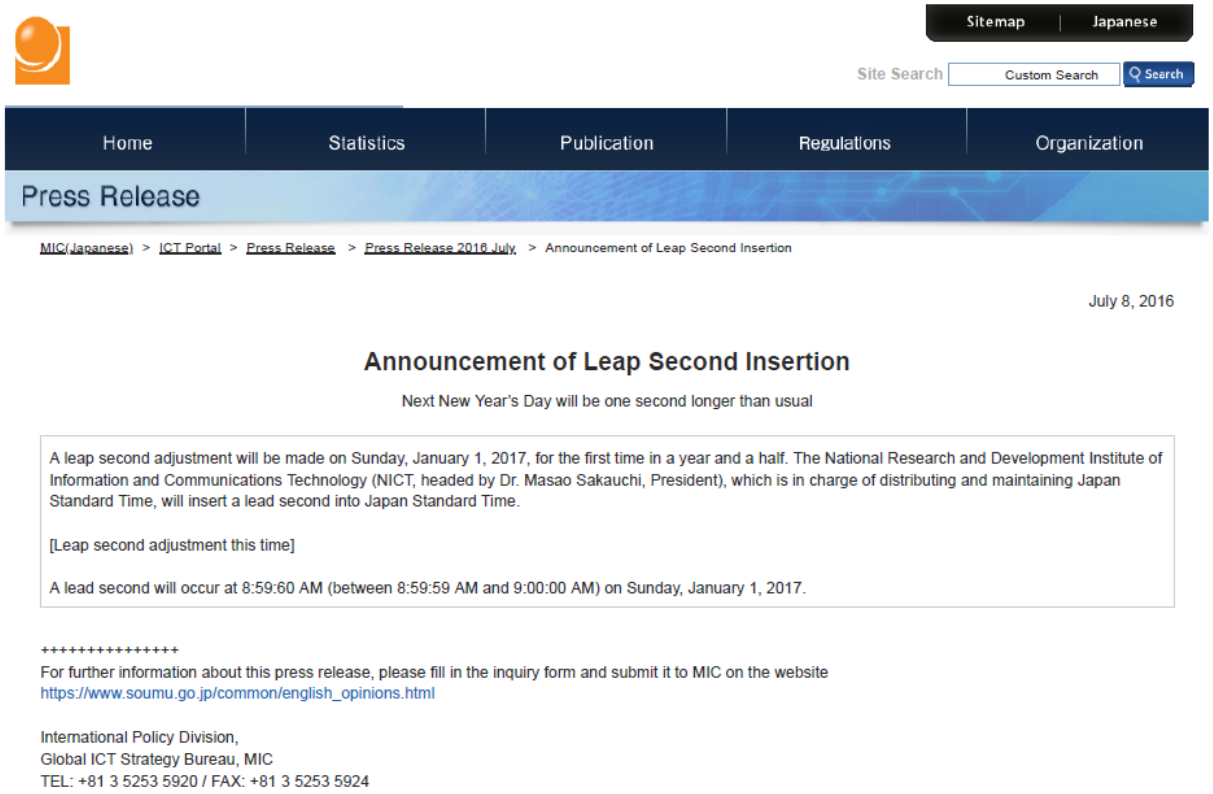
International Earth Rotation and Reference Systems Service

- IERS(International Earth Rotation and Reference Systems Service) : HQ Paris decides it.
  - Basically, half a year before they announce.

In Japan, Ministry of Internal affairs and communications does as below.



Sitemap | Japanese

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Press Release

MIC(Japanese) > ICT Portal > Press Release > Press Release 2016 July > Announcement of Leap Second Insertion

July 8, 2016

Announcement of Leap Second Insertion

Next New Year's Day will be one second longer than usual

A leap second adjustment will be made on Sunday, January 1, 2017, for the first time in a year and a half. The National Research and Development Institute of Information and Communications Technology (NICT, headed by Dr. Masao Sakauchi, President), which is in charge of distributing and maintaining Japan Standard Time, will insert a lead second into Japan Standard Time.

[Leap second adjustment this time]

A lead second will occur at 8:59:60 AM (between 8:59:59 AM and 9:00:00 AM) on Sunday, January 1, 2017.

++++++++++++++++

For further information about this press release, please fill in the inquiry form and submit it to MIC on the website
https://www.soumu.go.jp/common/english_opinions.html

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Global ICT Strategy Bureau, MIC
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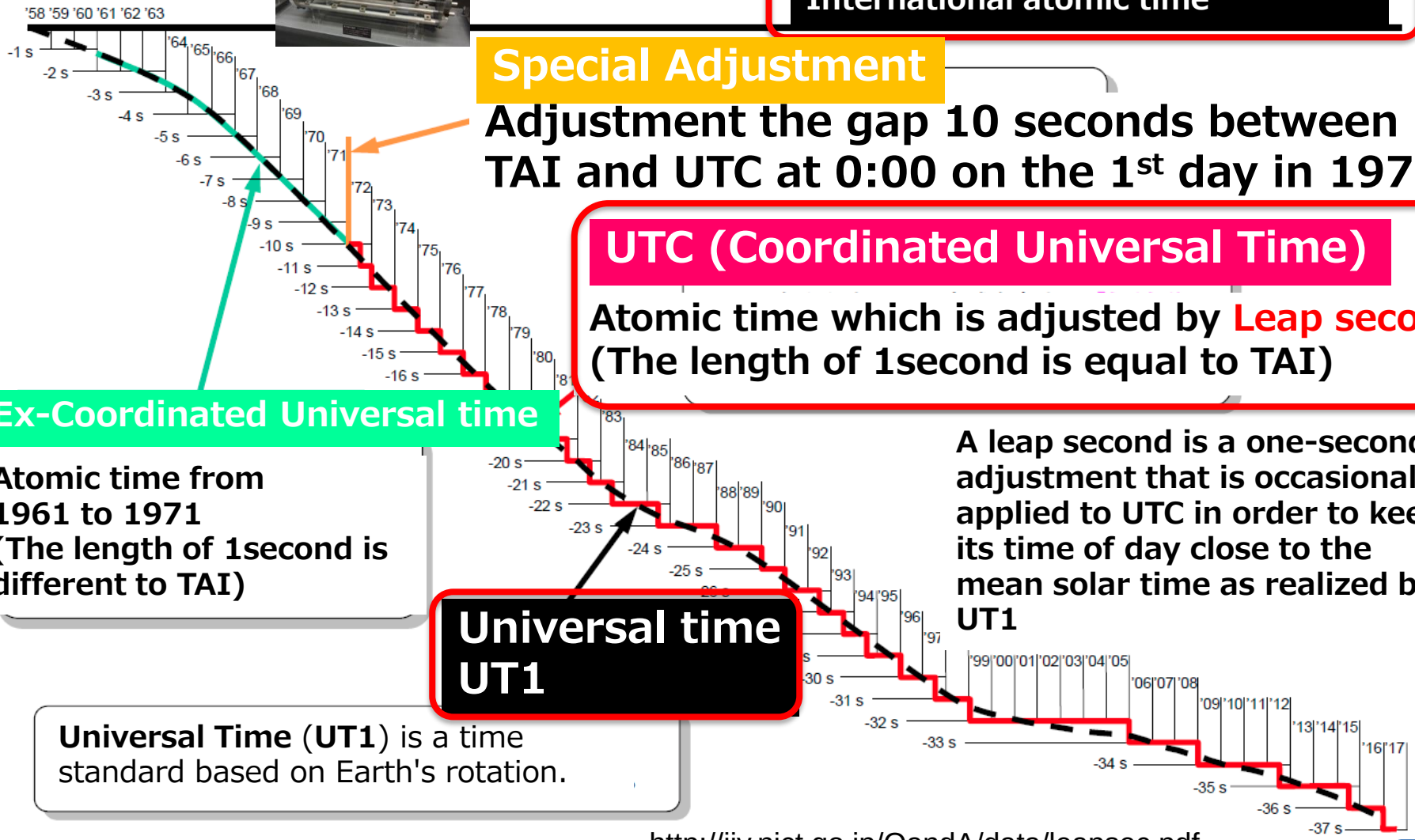
TAI & Leap second

情報通信研究機構
時空標準研究室
NICT

Temps Atomique International(TAI)
International atomic time



Special Adjustment

Adjustment the gap 10 seconds between TAI and UTC at 0:00 on the 1st day in 1972

UTC (Coordinated Universal Time)

Atomic time which is adjusted by Leap second (The length of 1second is equal to TAI)

Ex-Coordinated Universal time

Atomic time from 1961 to 1971 (The length of 1second is different to TAI)

A leap second is a one-second adjustment that is occasionally applied to UTC in order to keep its time of day close to the mean solar time as realized by UT1

Universal time UT1

Universal Time (**UT1**) is a time standard based on Earth's rotation.

http://jjy.nict.go.jp/QandA/data/leapsec.pdf

Distributed inserted (Basically 2hours)

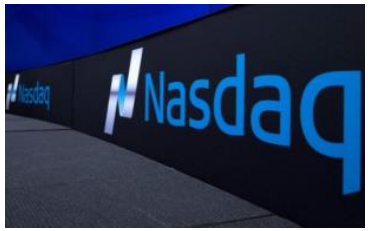
- Tokyo stock market adjusted leap second with taking 2hours in 2015 by distributed inserted.

- Google took the “leap smear” for their servers from leap second on 1st July 2012.

- Sakura Internet in Japan took the method of distributed inserted with taking 2 hours in 2015.

Ignore a leap second

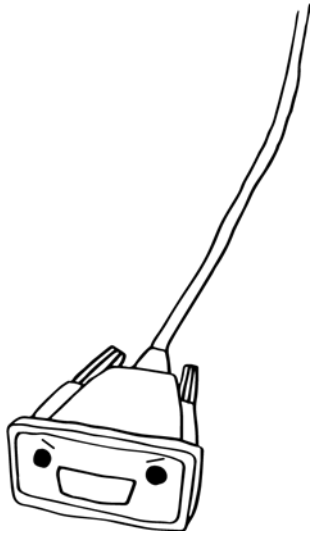
- Nasdaq stopped its system of trading for 15 minutes when a leap second came.



DDoS by NTP

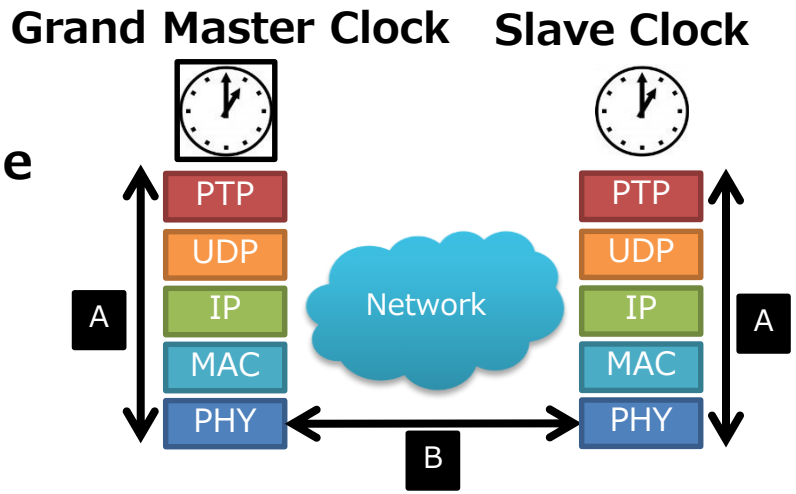
A Leap Second

PTP



What is PTP？ ～Over View of PTP～

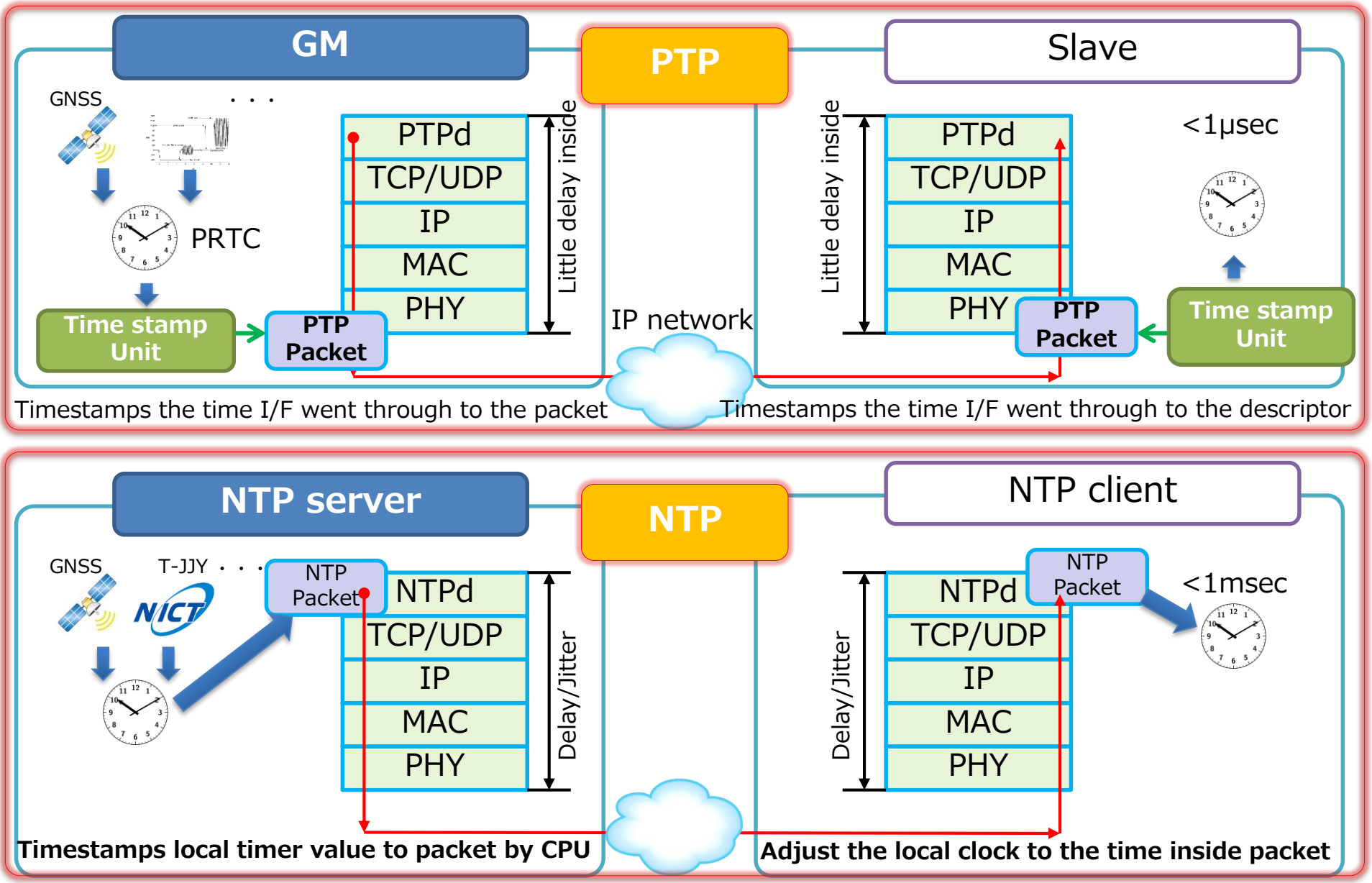
- ✓ **IEEE 1588: Precision Time Protocol(PTP)**
  - ➢ **IEEE1588-2008(v2)**
  - ➢ **Protocol based on the packets similar to NTP**
- ✓ **Basically PTP supposes GNSS as the time source**
- ✓ **Synchronization accuracy**
  - ➢ **Microsecond/Nanosecond order**
    cf. Millisecond order with NTP
  - ➢ **It eliminates the effect of transmission delay which is the main cause of time errors.**
  - ➢ **It is recommended that time when the packet passes the physical layer should be stamped.(see chart)**
    It makes the effect of transmission delay which is the main cause of errors as little as possible
  - ✓ **The more packets are sent and received, the more accurate the statistics information.**



A: Delay and jitter on protocol
B: Delay and jitter on network

Delay: measureable data transmission flow
Jitter: dispersion of delay

Comparison between PTP and NTP



Three types of clocks are defined in PTP as below.

Type	Name	Description	IEEE1588 Version
OC	Ordinary Clock	・PTP node with only 1 port ・Timing packet is terminated. ・It works as Master or Slave. ※Master =Grand Master Clock (GM)	V1(2002) V2(2008)
BC	Boundary Clock	・PTP node with multi ports ・Timing packet is terminated and re-delivered ・It works as Master and Slave.	V1(2002) V2(2008)
TC	Transparent Clock	・PTP relay with multi ports ・Timing packet is relayed. ・E2E/P2P formation ・P2P has Master/Slave conception.	V2(2008)

PTP Organizations which define PTP standard

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IEEE — **Default, Power, Audio, Video**

The Institute of Electrical and Electronics Engineers

AVnu — **Automotive**

AVnu Alliance

ITU International Telecommunication Union — **Telecom**

CableLabs® — **Cable**

IEC — **Power, Industrial**

International Electrotechnical Commission

I E T F® — **Financial Enterprise**

Internet Engineering Task Force

AUDIO AES — **Audio**

Audio Engineering Society

LXI LAN eXtensions for Instrumentation — **Instrumentation**

SMPTE — **Video**

Society of Motion Picture & Television Engineers

CERN — **Nuclear**

European Organization for Nuclear Research

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- ✓ **Each industry group proceeds the standardization based on IEEE 1588 along with its requirements, assuming replacing to IP/Ethernet based network which can boast high performance.**

- ✓ **Synchronization technology to apply to industries is called "Profile". There are no interoperability among these profiles.**

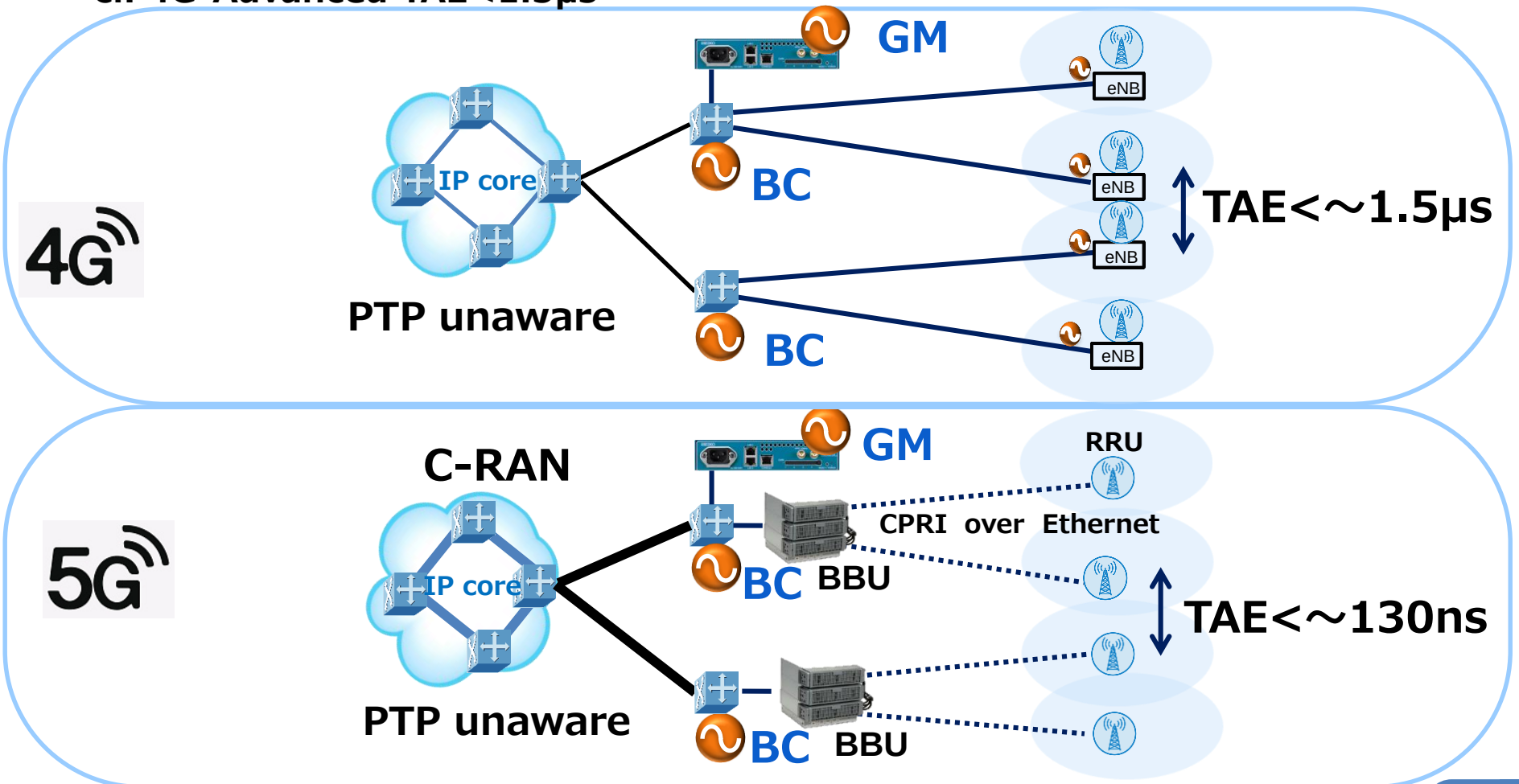
Industry (Profile)	Standardization organization	Standard	Layer
Default	IEEE	1588v1, 1588v2, (1588v3)	IPv4/IPv6/L2 ETH
Telecom	ITU-T	Frequency : G.8265.1 Time & Phase : G.8275.1, G.8275.2	IPv4/IPv6 L2 ETH, (IPv4/IPv6)
Power	IEEE	C37.238-2011	L2 ETH
Automotive, Audio & Video	IEEE	802.1AS	L2 ETH
Broadcast	SMPTE	ST 2059-1, ST 2059-2	IPv4/(IPv6)
Finance	IETF	(Draft Enterprise Profile for PTP)	

PTP for telecom mainly for mobile network

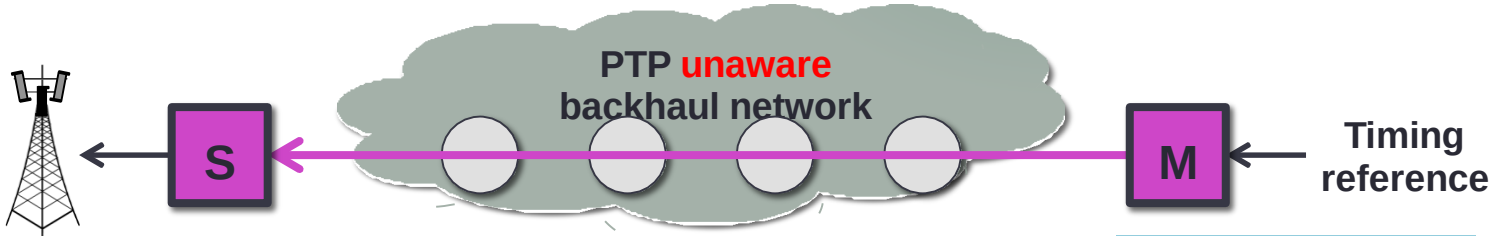
The requirement for synchronization of 4G and 5G

- **Intra-band, contiguous TAE<130ns will be newly defined by 3GPP for 5G CA.**
- **5G requires 10 times strict budget of accuracy comparing with 4G LTE-Advanced.**

cf. 4G-Advanced TAE<1.5μs

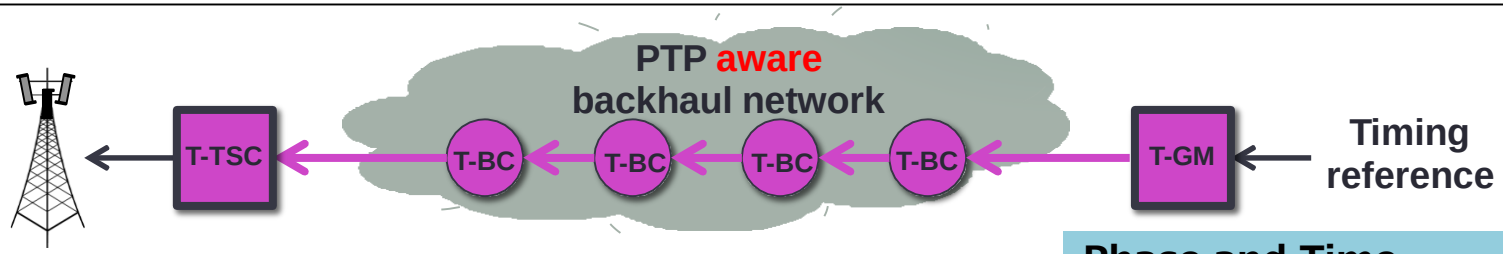


PTP for telecom profiles overview



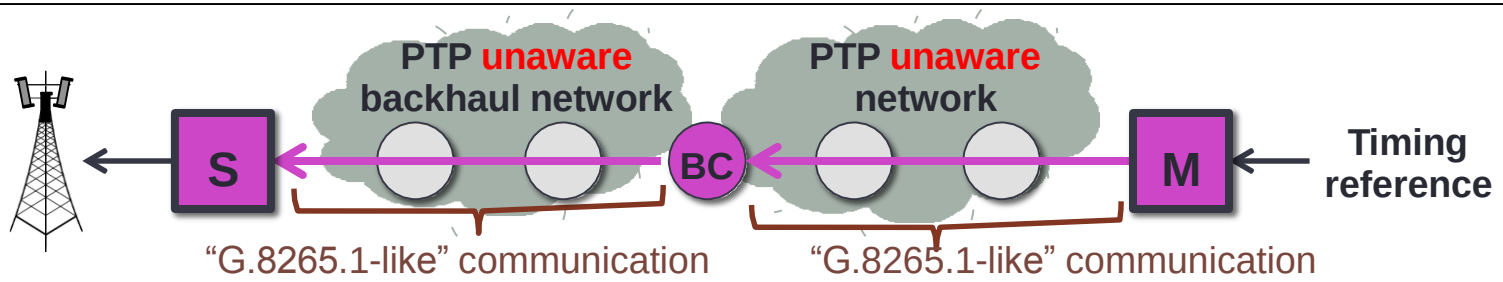
PTP in end-to-end mode
ITU-T G.8265.1 telecom profile

Frequency only



PTP with full timing support from the network
ITU-T G.8275.1 telecom profile

Phase and Time



PTP with partial timing support from the network
ITU-T G.8275.2 telecom profile

Phase and Time

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Because of “MiFID-2”

About MiFID-2

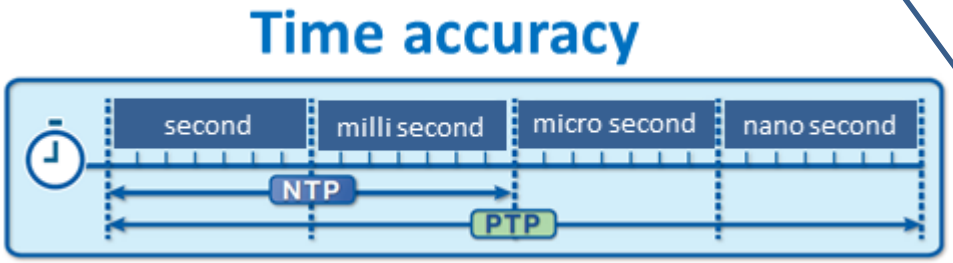
- MiFID-2 was formulated by European Securities and Markets Authority(ESMA).
- Regulatory technical standards(RTS) is defined in MiFID-2.
- MiFID-2 has already executed from 2018.

RTS-25 defines the followings

- An accuracy of the time synchronization.
- The request of the reference time and the timestamp used in the financial trade.

RTS-25 defines the following requirements of time synchronization

- Reference time : Synchronization with Coordinated Universal Time(UTC)
- Time accuracy : 100 micro second(100μsec)
- Time particle size : 1 micro second(1μsec)
- Conventionally, NTP has been used for the timestamp of logs.
  But NTP is beginning to be considered insufficient in terms of the time accuracy.



The existing customers who use NTP are beginning to consider PTP

PTP at Financial Industry

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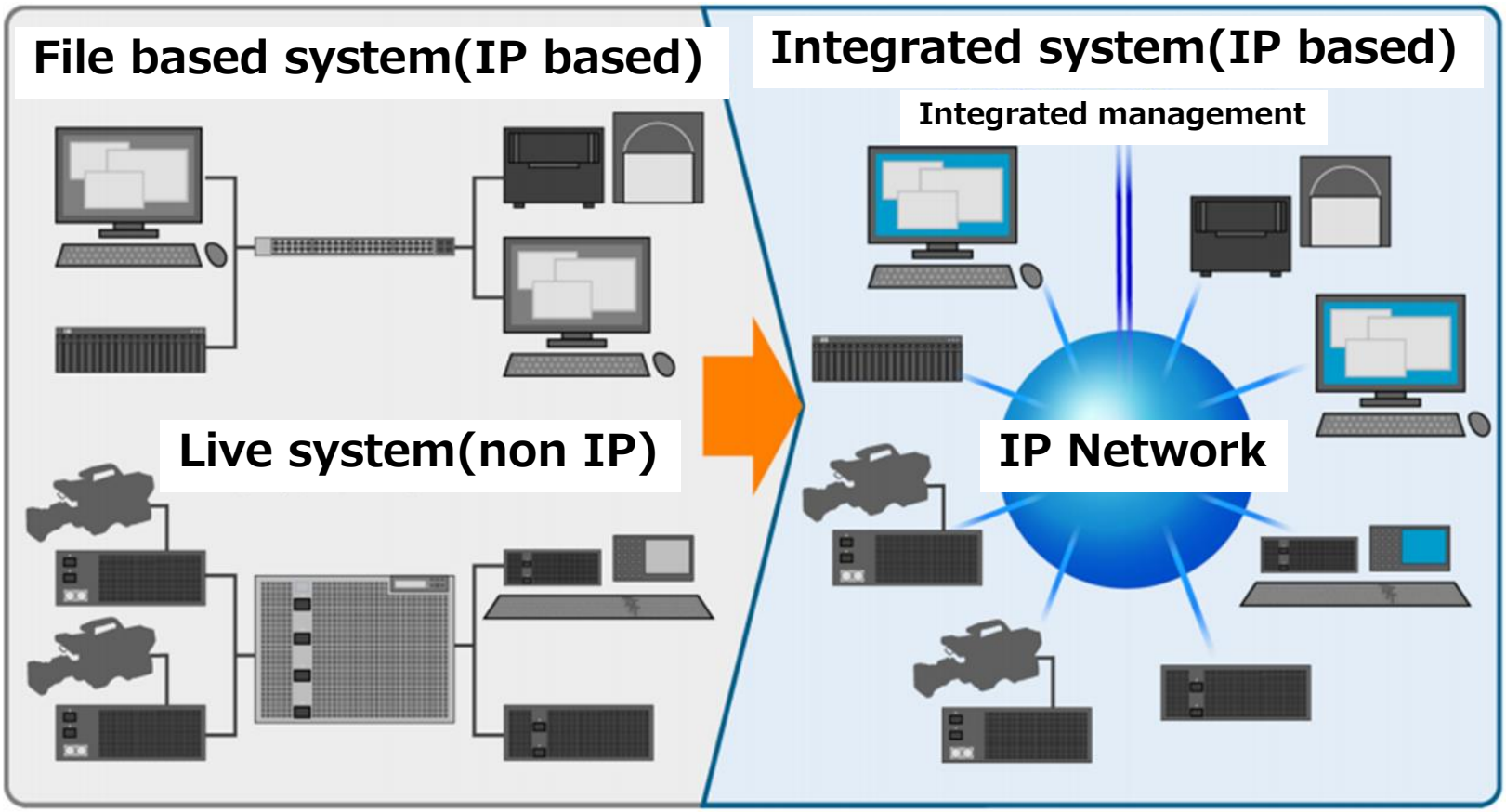
- The action of financial industry in Japan
- The requirements of time synchronization in MiFID-2 are aimed at EU.
- But some financial companies in Japan are corresponding the requirements. In fact, some of them has already started to use PTP.

- The profile for financial is “Enterprise Profile”

- Only UDP over IPv4/IPv6 communication
- Combination Unicast with Multicast
- Redundancy by Best Master Clock Algorism(BMCA)
- Multi domain can be used as the number of PTP domain
- The maximum of message interval is 128 PPS

It is recommend that PTP time server can provide time synchronization of nano second order.

Overview and future of Broadcasting system



Sony発行「IP LIVE PRODUCTION SYSTEM メリットとテクノロジーのご紹介」p.6

PTP for Broadcasting

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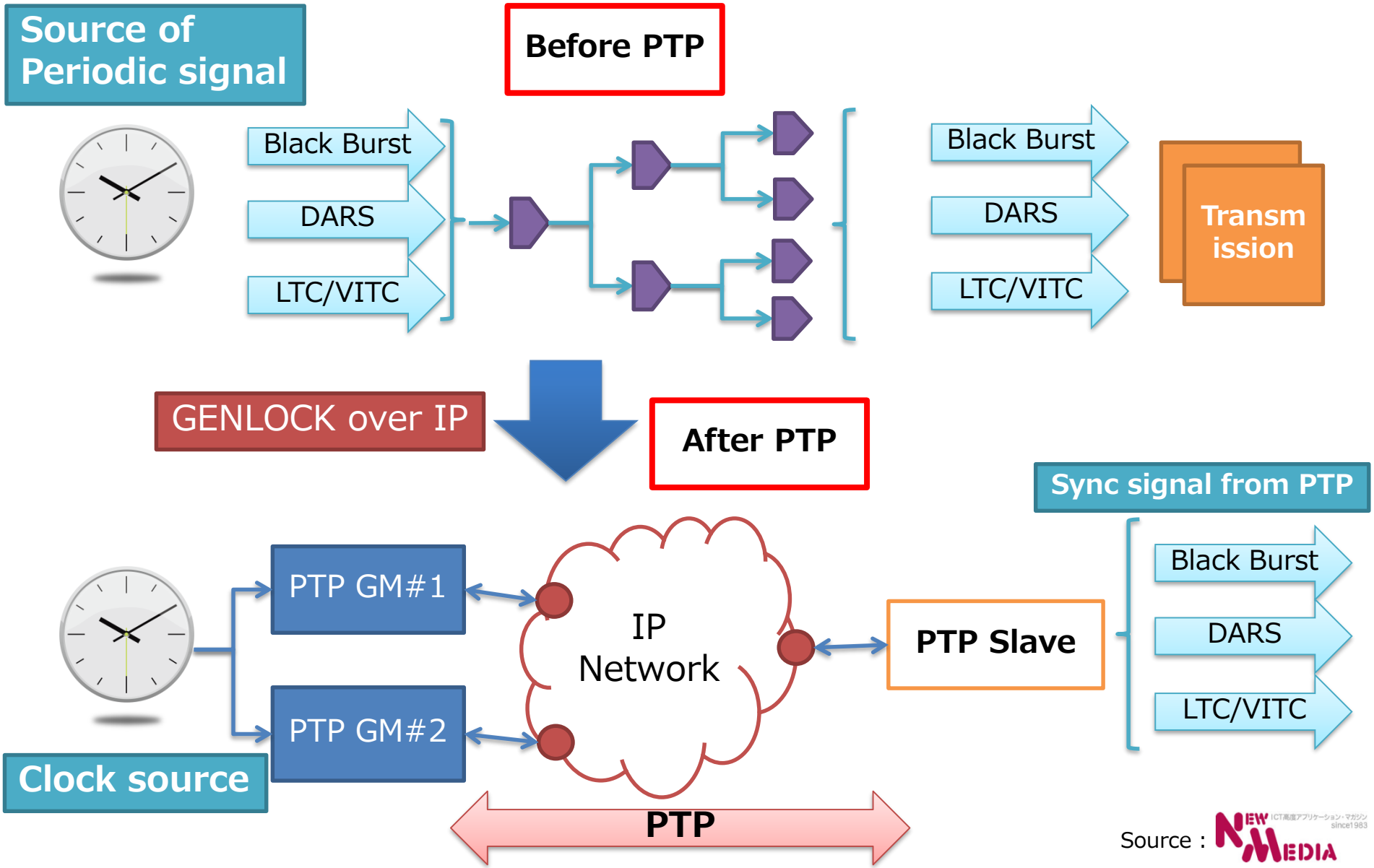

Source : NEW MEDIA ICT高度アプリケーション・マガジン since1983

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PTP for many Industries

Mobile

4G 5G LTE Advanced

Broadcasting

Financial

Smart City and IoT

Smart Grid

RT-Ether

and
Protocol and Interoperability are still on going

多謝

ありがとうございました
（arigatougozaimashita）

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