

Towards Carrier Grade White Rabbit

WRS customization @Orange Polska

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Radio Access Development

22nd March 2024

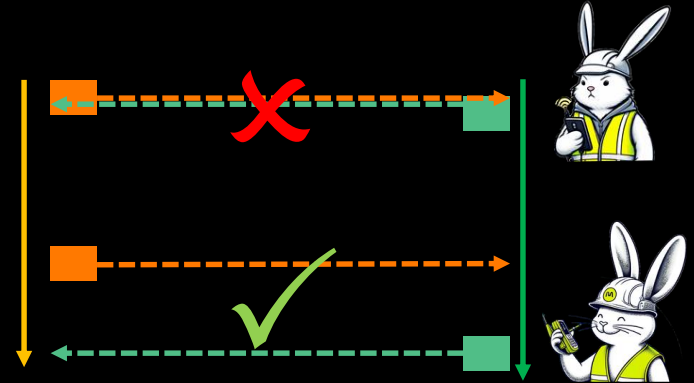


Why do we need Time & Frequency synchronization in Telecom

- Precise **time synchronization** is necessary for 5G TDD where base stations and mobile terminals transmit on the same frequency.

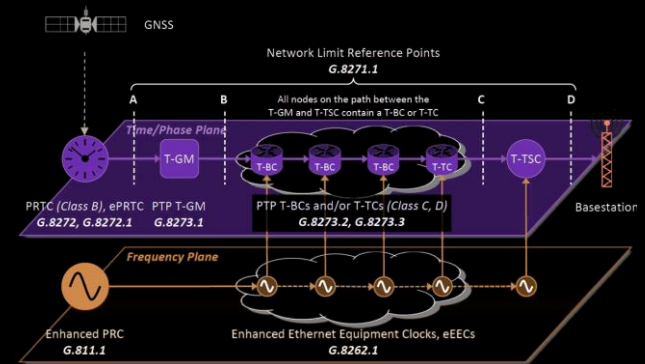
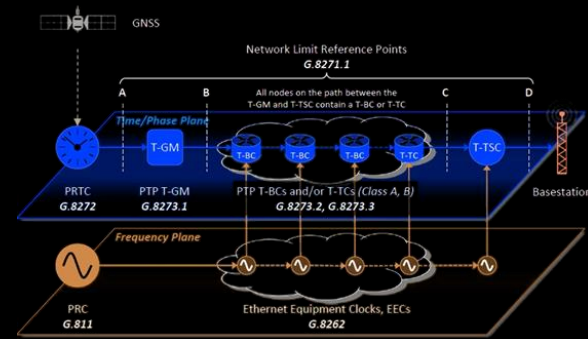
To avoid interferences the radio channel is shared in Time Division Duplex mode (TDD)

- **Frequency synchronization** is necessary to stabilize the frequency of the base station radio transmitters
- Telecom like any other IT-like infrastructure is timestamping log events, billing records, etc.



Telecom

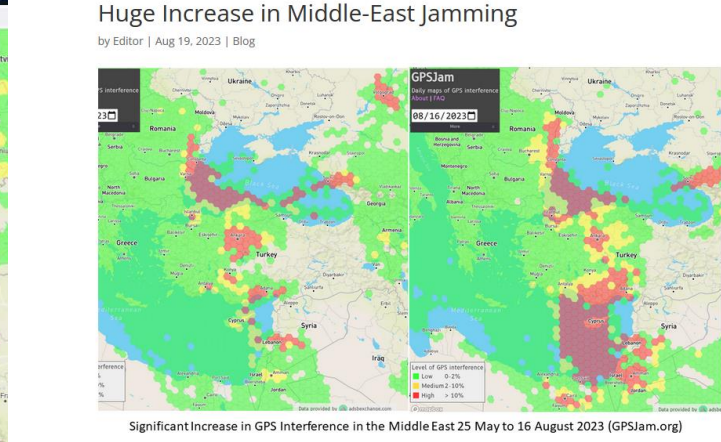
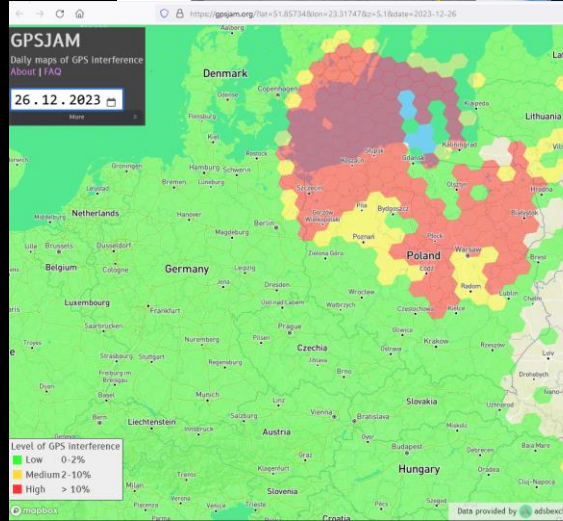
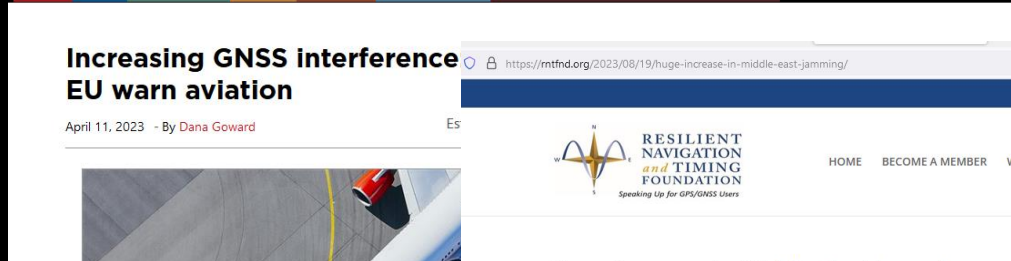
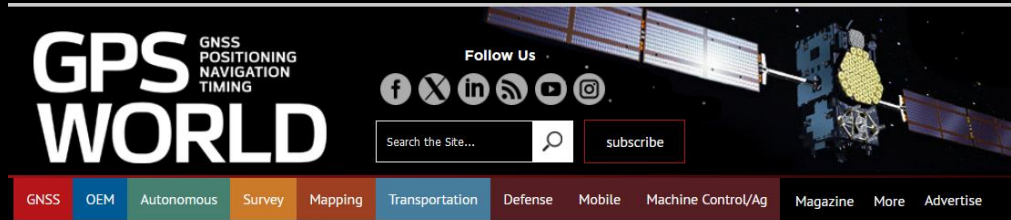
- Time transfer is based on **IEEE 1588v2 PTP** and **G.8275.1** profile (full on path support)
- Dominant transit clock implementation is T-BC
- 1500ns**(classic) and **130ns**(enhanced) network Time Error budget variants
- HW level PTP support & cost determines the architecture & topology
- Since **GNSS** is a primary time reference **resiliency is a major concern**



GNSS

GNSS is still reliable time reference, but diversity and network resiliency hardening is a must

Jamming and spoofing attacks are realistic threat

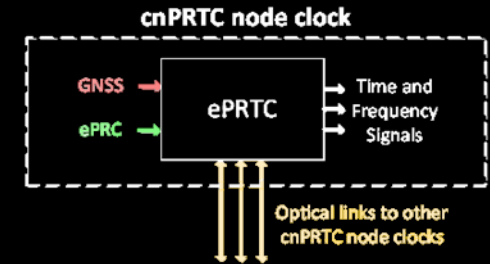
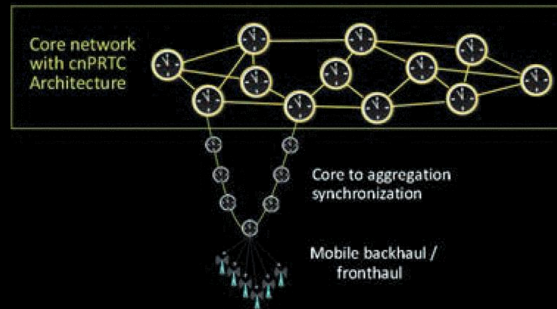
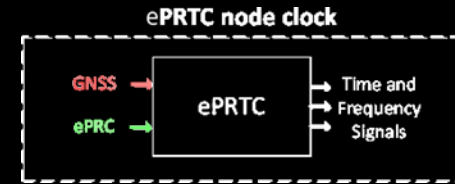
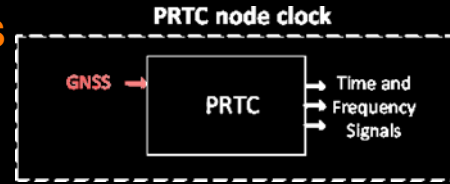


Telecom

Resiliency is enhanced by supplementing GNSS with independent primary references and advanced features

- PRTC → geo-redundancy
- ePRTC → +independent cesium(s)
- cnPRTC → +(mesh architecture)

Where is a mesh, there must be a lot of connections...



Raising a shield and looking for defender

- Primary reference sharing
- HATT connection with UTC (national)
- cnPRTC mesh
- Reference measurement network (measurements in the absence of GNSS)

... sounds like a task for the small animal



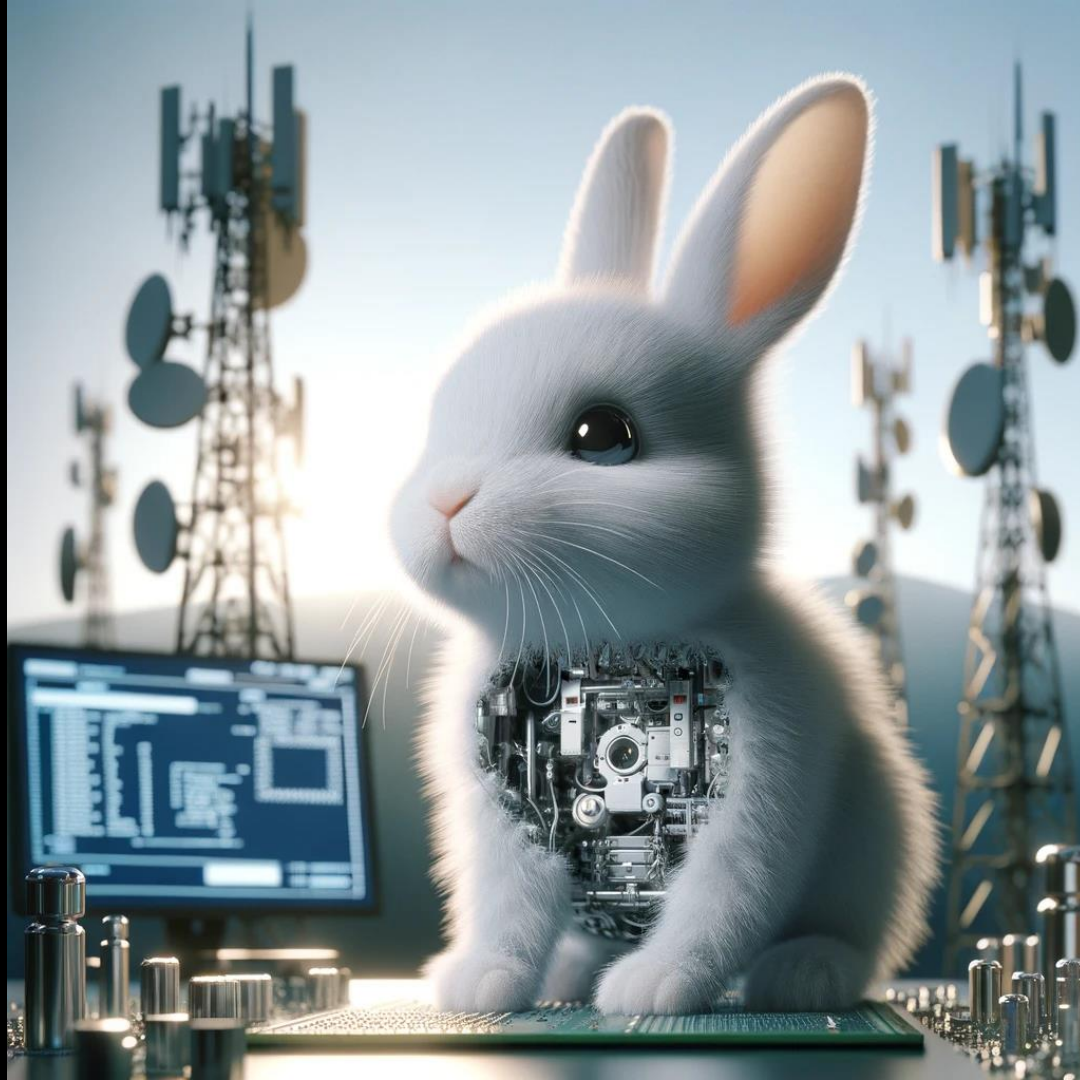
Reliable & friendly time provider

- Familiar technology components: PTP & SyncE
- Best accuracy & precision for the price
- Open technology SW* and HW* (mostly)
- Customizable
- Field proven



White Rabbit Switch

The device



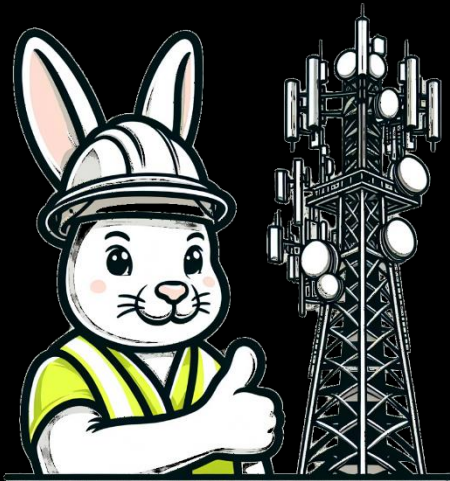
White Rabbit and the Telecom World

Our (Telco) expectations

- **Reboot-less configuration**
 - runtime parameters update
 - runtime enabling/disabling/creating/deleting resources
- **Robust, flexible in-band and out-band management**
 - L2
 - L3



White Rabbit and the Telecom World



Telco expectations – cont.

- Configuration preservation during firmware upgrades
- CLI that comply with industry standards
- Diagnostic tools and extensive logging capability
- Umbrella systems integration (events report/read/write)
- Web GUI (complementary)

White Rabbit and the Telecom World

Telco expectations – cont.

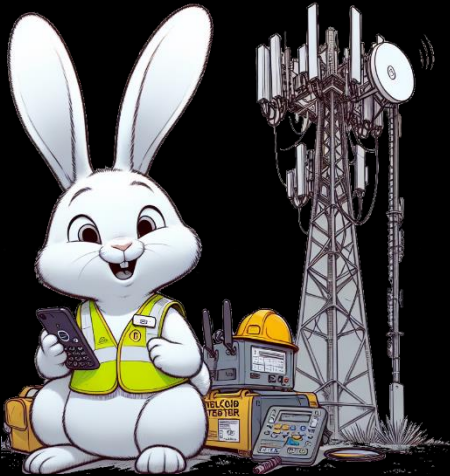
- Security
- ITU G.8275.1 PTP profile
- ITU G.8262/G.8264 ESMC + adaptation to WRS



White Rabbit general enhancements

Advanced features

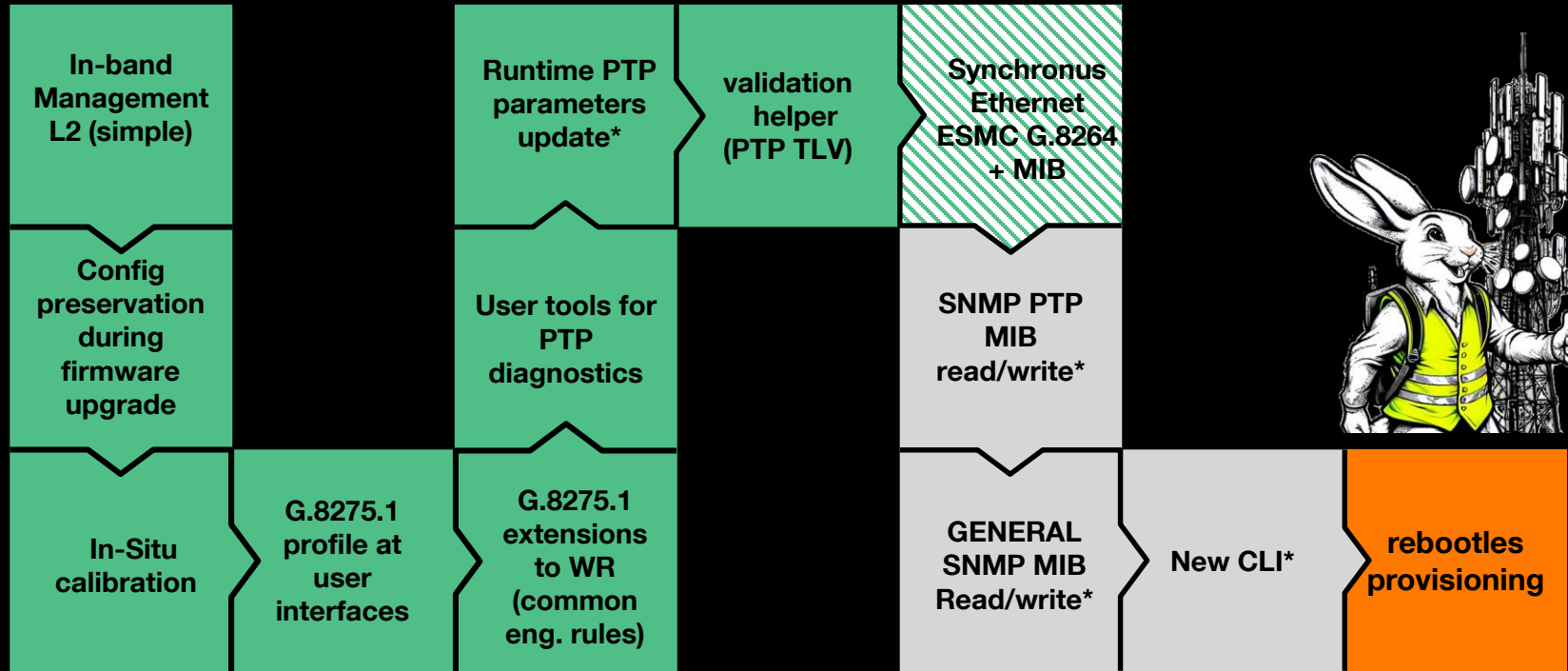
- Insitu calibration
- HATT time validation enhancement
- Adaptation between telco and White Rabbit specific timing ecosystem
 - common engineering rules



**We are about to make
a huge jump ...**



... in small steps

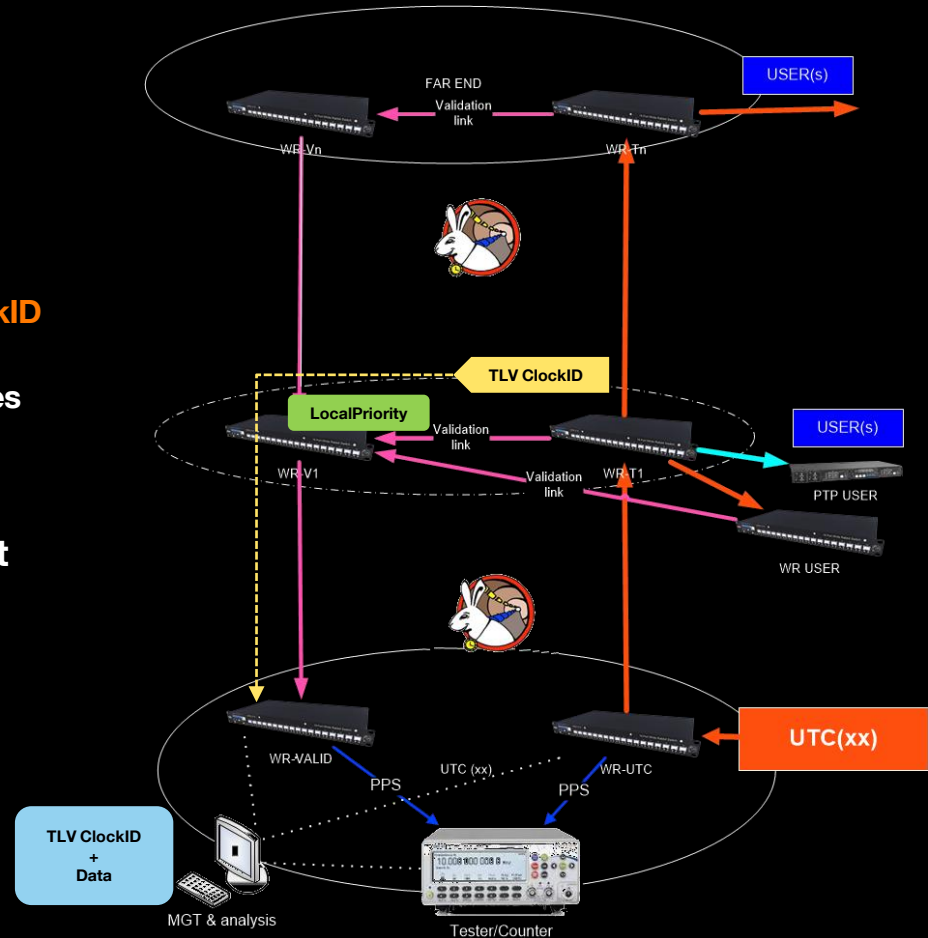


Orange HATT setup enhancement

High accuracy Time Transfer with validation loop

Default Profile BMCA limitation

- Remote Clock related: Priority1, ClockClass, Accuracy, offsetScaledLogVariance, Priority2, ClockID
 - Topology related (stepsRemoved, PortId,...)
 - **There is** no parameter to control the selection process in the local context
- **Solution: G.8275.1 alt BMCA in the White Rabbit core**
 - LocalPriority
 - Runtime PTP datasets manipulation
 - Clock ID in announce TLV
 - Default ClockID overwrite

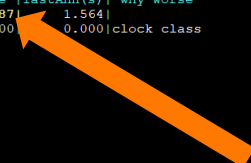


wrs_bmca_stat

```
WR Switch BMCA Monitor v6.1-86-g4b8e09a5 [q = quit]
WR time (TAI) : 2023-03-02 19:55:08.008333 Leap seconds: 37
Switch time (UTC): 2023-03-02 19:54:31.008323 TAI-UTC : +37.000010
PLL mode: BC PLL locking state: LOCKED BMCA: Telecom IPU-T G.8275.1
Servo state: wr1l:White-Rabbit: TRACK_PHASE

----- Grand Master History Info -----
Grand Master Id |prio1|clockClass| accuracy |logVar|prio2|stepsRm|sourcePortIdentity(peerPort)| timeSource |YYYY-MM-DD hh:mm:ss.ms GM activated
70:b3:d5:ff:fe:91:ea:d7| 128| 6(GM)| 0x21(100ns)| 47360| 128| 3rdHop|70:b3:d5:ff:fe:91:ea:fd.0002| 0x20(GNSS)|2023-03-02 19:53:48.496( 0d 0h 0m42s512ms ago)
70:b3:d5:ff:fe:91:e2:3b| 128| 248(BC)| 0xFE(unkn)| 65535| 128| 1stHop|70:b3:d5:ff:fe:91:e2:3b.0001| 0xA0(intOscillator)|2023-03-01 19:31:01.986( 1d 0h23m29s022ms ago)
70:b3:d5:ff:fe:91:e9:ba| 128| 248(BC)| 0xFE(unkn)| 65535| 128| 0thHop|70:b3:d5:ff:fe:91:e9:ba.0000| 0xA0(intOscillator)|2023-03-01 19:30:57.213( 1d 0h23m33s195ms ago)
70:b3:d5:ff:fe:91:e0:87| 128| 248(BC)| 0xFE(unkn)| 65535| 128| 2ndHop|70:b3:d5:ff:fe:91:ea:fd.0002| 0xA0(intOscillator)|2023-02-09 16:29:35.371( 21d 3h24m55s637ms ago)
70:b3:d5:ff:fe:91:e2:3b| 128| 248(BC)| 0xFE(unkn)| 65535| 128| 1stHop|70:b3:d5:ff:fe:91:e2:3b.0001| 0xA0(intOscillator)|2023-02-09 16:29:27.950( 21d 3h25m 3s053ms ago)
70:b3:d5:ff:fe:91:e9:ba| 128| 248(BC)| 0xFE(unkn)| 65535| 128| 0thHop|70:b3:d5:ff:fe:91:e9:ba.0000| 0xA0(intOscillator)|2023-02-09 16:28:25.081( 21d 3h26m 5s927ms ago)
----- Foreign master (received in announce) Info (sorted) -----
iface|inst| Grand Master Clock Id |clockClass| accuracy |logVar|prio2|locPrio|stepsRm|sourcePortIdentity(peerPort)| timeSource |tlvClockId in announce |lastAnn(s)| why worse
wr1l | 0 |70:b3:d5:ff:fe:91:ea:d7| 6(GM)| 0x21(100ns)| 47360| 128| 128| 3rdHop|70:b3:d5:ff:fe:91:ea:fd.0002| 0x20(GNSS)|70:b3:d5:ff:fe:91:e0:87| 1.564|
localClock|70:b3:d5:ff:fe:91:e9:ba| 248(BC)| 0xFE(unkn)| 65535| 128| 128| 0thHop|70:b3:d5:ff:fe:91:e9:ba.0001| 0xA0(intOscillator)|100:00:00:00:00:00:00| 0.000|clock class

r - refresh; f - freeze GUI; frgn master list: a - enable extra columns, s - enable sorting;
```



Orange HATT setup enhancement

Runtime modifications of PTP datasets with ppsi_conf enhancements

- LocalPriority
- ClockID
- Domain
- Priority1
- Priority2

```
wrs-192.168.1.16# ppsi_conf --help
pps_i_conf: Use: ppsi_conf [-v] [-h] [option]
The program has the following options:
-h|--help          - print help
-v|--verbose       - verbose output
Global parameters:
--alpha=<alpha64bit>
    - change currently used alpha
    the value is in fpa format, like displayed in wr_mon
    NOTE: the changed value is lost on link down/up
--announce-send-clockid=<year|month|>
    - configure sending clockId in a TLV attached to announce
    messages
--clock-identity=<XX:XX:XX:XX:XX:XX:XX:XX>
    - overwrite default clock identity
--diags=<num>
    - change PPSi's global diagnostics to <num>
    order: FSM, Time, Frames, Servo, BMC, Extension, Configuration
--domain=<num>
    - change the domain number to <num>
--bmca=<ptp|standard|externalPortConfiguration|extPortConf|telecom>
    - select BMCA to used
    ptp=standard; externalPortConfiguration=extPortConf
    NOTE: changing the role for externalPortConfiguration is not implemented
--global-profile=<ptp|wr|ha|ha_wr|telecom|custom>
    - sets the global profile; ha_wr, ha and wr are the same profile;
    setting a global profile (also to the current one) may change number
    of global attributes to its default values (not necessary the same
    as defined in ppsi.conf);
    changing a global profile to custom does not change any parameters;
--local-clock-local-priority=<num>
    - sets the local priority for local clock used by BMCA as defined in
    ITU-T G.8275.1 profile
--insitu-log=<coeff|disable|0|on|enable|1|crtr>
    - enable/disable printout of timestamps used for insitu
    calculations; use parameter crtt to print round-trip-time
    instead of timestamps
--insitu-log-file=<file>
    - define file for insitu logs;
    "-" to print to stdout
--insitu-log-samples=<n>
    - print only defined number of t3t4 samples; 0 - infinite
--prio1=<num>
--priority1=<num> - set priority 1 to <num>
--prio2=<num>
--priority2=<num> - set priority 2 to <num>
--tracking=<coeff|disable|0|on|enable|1|toggle|2|insitu|3>
    - enable/disable/toggle tracking in servo; or enable insitu mode
Parameters specific for PPSi instance:
--instance=<num|all>
--ppi=<num|all> - Select PPSi instance <num> or all instances
--port=<num|all> - Select all instances on a defined port <num> or all
    instances
--autonegotiation=<coeff|enable|disable|1|0>
    enable or disable extension autonegotiation
--announce-interval=<num>
    - sets logarithm to the base 2 of the mean interval of
    announce message transmission; used when a port is in Master state
--delay-req-interval=<num>
    - sets logarithm to the base 2 of the mean interval of delay
    request message transmission; used when a port is in Slave state
--diags-inst=<num>
    - change PPSi's instance/port diagnostics to <num>
    order: FSM, Time, Frames, Servo, BMC, Extension, Configuration
--extension=<none|wr|ha|ha_wr|sync>
    - sets the extension; extension has to be supported by a selected profile
--profile=<ptp|wr|ha|ha_wr|telecom|custom>
    - sets the profile; ha_wr, ha and wr are the same profile
    setting a profile (also to the current one) may change number
    of attributes to its default values (not necessary the same
    as defined in ppsi.conf);
    changing a profile to custom does not change any parameters;
--sync-interval=<num>
    - sets logarithm to the base 2 of the mean interval of sync
    message transmission; used when a port is in Master state
--local-priority=<num>
    - sets the local priority used by BMCA defined in
    ITU-T G.8275.1 profile
```

```
Version: wr-switch-sw-v6.1-218-gf49c1c0e compiled by Adam Wujek on Feb 22 2024, 01:38:37
wrs-192.168.1.16#
```

Orange ppsi_conf

ppsi_conf extra features

- BMCA mode
- Insitu calibration

```
wrs-192.168.1.16#ppsi_conf --help
ppsi_conf: Use: ppsi_conf [-v] [-h] [option]
The program has the following options:
  -h|--help          - print help
  -v|--verbose       - verbose output
Global parameters:
  --alpha=<alpha64bit>
    - change currently used alpha
    the value is in spa format, like displayed in wr_mon
    NOTE: the changed value is lost on link down/up
  --announce-send-clockid=<yes|no|1|0>
    - configure sending clockid in a TLV attached to announce
    messages
  --clock-identity=<XX:XX:XX:XX:XX:XX>
    - overwrites default clock identity
  --diags=<num>
    - change PPSI's global diagnostics to <num>
    order: FSM, Time, Frames, Servo, BMC, Extension, Configuration
  --domain=<num>
    - change the domain number to <num>
  --bmca=<ptp|standard|externalPortConfiguration|extPortConf|telecom>
    - select BMCA to use
    ptp=standard; externalPortConfiguration=extPortConf
    NOTE: changing the role for externalPortConfiguration is not implemented
  --global-profile=<ptp|wr|ha|ha_wr|telecom|custom>
    - sets the global profiler; ha_wr, ha and wr are the same profile;
    setting a global profile (also to the current one) may change number
    of global attributes to its default values (not necessary the same
    as defined in ppsi.conf);
    changing a global profile to custom does not change any parameters;
  --local-clock-local-priority=<num>
    - sets the local priority for local clock used by BMCA as defined in
    ITU-T G.8275.1 profile
  --insitu-log=<off|disable|0|on|enable|1|crtt>
    - enable/disable printout of timestamps used for insitu
    calculations; use parameter crt to print round-trip-time
    instead of timestamps
  --insitu-log-file=<file>
    - define file for insitu logs;
    "-" to print to stdout
  --insitu-log-samples=<n>
    - print only defined number of t3t4 samples; 0 - infinite
  --prio1=<num>
  --priority1=<num> - set priority 1 to <num>
  --prio2=<num>
  --priority2=<num> - set priority 2 to <num>
  --tracking=<off|disable|0|on|enable|1|toggle|2|insitu|3>
    - enable/disable/toggle tracking in servo; or enable insitu mode

Parameters specific for PPSI instance:
  --instance=<num|all>
    - Select PPSI instance <num> or all instances
  --port=<num|all>
    - Select all instances on a defined port <num> or all
    instances
  --autonegotiation=<on|off|enable|disable|1|0>
    - enable or disable extension autonegotiation
  --announce-interval=<num>
    - sets logarithm to the base 2 of the mean interval of
    announce message transmission; used when a port is in Master state
  --delay-req-interval=<num>
    - sets logarithm to the base 2 of the mean interval of delay
    request message transmission; used when a port is in Slave state
  --diags-inst=<num>
    - change PPSI's instance/port diagnostics to <num>
    order: FSM, Time, Frames, Servo, BMC, Extension, Configuration
  --extension=<none|wr|lls|llsync>
    - sets the extension; extension has to be supported by a selected profile
  --profile=<ptp|wr|ha|ha_wr|telecom|custom>
    - sets the profile; ha_wr, ha and wr are the same profile
    setting a profile (also to the current one) may change number
    of attributes to its default values (not necessary the same
    as defined in ppsi.conf);
    changing a profile to custom does not change any parameters;
  --sync-interval=<num>
    - sets logarithm to the base 2 of the mean interval of sync
    message transmission; used when a port is in Master state
  --local-priority=<num>
    - sets the local priority used by BMCA defined in
    ITU-T G.8275.1 profile
```

```
Version: wr-switch-sw-v6.1-218-gf49c1c0e compiled by Adam Wujek on Feb 22 2024, 01:38:37
wrs-192.168.1.16#
```

```

bravamar@quazinet-server-
WR Switch BMCA Monitor v6.1-86-g4b8e09a5 [q = quit]

WR time (TAI)      : 2023-02-19 09:38:10.005162  Leap seconds: 37
Switch time (UTC) : 2023-02-19 09:37:33.005154  TAI-UTC      : +37.000008
PLL mode: BC      PLL locking state: LOCKED      BMCA: Telecom ITU-T G.8275.1
Servo state:      wrll:White-Rabbit: TRACK_PHASE

----- Grand Master History Info -----
Grand Master Id |prio1|clockClass| accuracy |logVar|prio2|stepsRm|           timeSource |YYYY-MM-DD hh:mm:ss.ms |GM activated
70:b3:d5:ff:fe:91:e0:87| 128 | 248 (BC) | 0xFE (unkn)| 65535| 128 | 4thHop| 0xA0 (intOscillator) |2023-02-09 16:29:55.957( 9d17h 7m37s048ms ago)
70:b3:d5:ff:fe:91:e2:3b| 128 | 248 (BC) | 0xFE (unkn)| 65535| 128 | 1stHop| 0xA0 (intOscillator) |2023-02-09 16:29:28.281( 9d17h 8m 4s724ms ago)
70:b3:d5:ff:fe:91:ea:b1| 128 | 248 (BC) | 0xFE (unkn)| 65535| 128 | 0thHop| 0x20 (GNSS) |2023-02-09 16:22:55.790( 9d17h14m37s215ms ago)
70:b3:d5:ff:fe:91:ea:d7| 128 | 6 (GM) | 0x21 (100ns)| 20061| 128 | 5thHop| 0x20 (GNSS) |2023-02-09 16:22:12.130( 9d17h15m20s875ms ago)
70:b3:d5:ff:fe:91:e2:3b| 128 | 248 (BC) | 0xFE (unkn)| 65535| 128 | 1stHop| 0xA0 (intOscillator) |2023-02-09 16:22:09.829( 9d17h15m23s176ms ago)
70:b3:d5:ff:fe:91:ea:d7| 128 | 6 (GM) | 0x21 (100ns)| 20061| 128 | 5thHop| 0x20 (GNSS) |2023-02-09 16:21:06.958( 9d17h16m26s047ms ago)
70:b3:d5:ff:fe:91:ea:b1| 128 | 248 (BC) | 0xFE (unkn)| 65535| 128 | 0thHop| 0xA0 (intOscillator) |2023-02-09 16:20:06.470( 9d17h17m26s535ms ago)

----- Foreign master (received in announce) Info (sorted) -----
iface|inst| Grand Master Clock Id |clockClass| accuracy |logVar|prio2|locPrio|stepsRm|           timeSource |lastAnn(s) |why worse
wrll | 0 |70:b3:d5:ff:fe:91:e0:87| 248 (BC) | 0xFE (unkn)| 65535| 128 | 128 | 4thHop| 0xA0 (intOscillator) | 1.952|
localClock|70:b3:d5:ff:fe:91:ea:b1| 248 (BC) | 0xFE (unkn)| 65535| 128 | 128 | 0thHop| 0xA0 (intOscillator) | 0.000|clock id

r - refresh; f - freeze GUI; frgn master list: a - enable extra columns, s - enable sorting;

```

```

bravamar@quazinet-server-
WR Switch BMCA Monitor v6.1-86-g4b8e09a5 [q = quit]

WR time (TAI)      : 2023-02-19 09:32:02.007208  Leap seconds: 37
Switch time (UTC) : 2023-02-19 09:31:25.007201  TAI-UTC      : +37.000007
PLL mode: BC      PLL locking state: LOCKED      BMCA: Telecom ITU-T G.8275.1
Servo state:      wrll:White-Rabbit: TRACK_PHASE

----- Grand Master History Info -----
Grand Master Id |prio1|clockClass| accuracy |logVar|prio2|stepsRm|sourcePortIdentity(peerPort)|           timeSource |YYYY-MM-DD hh:mm:ss.ms |GM activated
70:b3:d5:ff:fe:91:e0:87| 128 | 248 (BC) | 0xFE (unkn)| 65535| 128 | 4thHop|70:b3:d5:ff:fe:91:e2:3b.0002| 0xA0 (intOscillator) |2023-02-09 16:29:55.957( 9d17h 1m29s050ms ago)
70:b3:d5:ff:fe:91:e2:3b| 128 | 248 (BC) | 0xFE (unkn)| 65535| 128 | 1stHop|70:b3:d5:ff:fe:91:e2:3b.0002| 0xA0 (intOscillator) |2023-02-09 16:29:28.281( 9d17h 1m56s726ms ago)
70:b3:d5:ff:fe:91:ea:b1| 128 | 248 (BC) | 0xFE (unkn)| 65535| 128 | 0thHop|70:b3:d5:ff:fe:91:ea:b1.0000| 0x20 (GNSS) |2023-02-09 16:22:55.790( 9d17h 8m29s217ms ago)
70:b3:d5:ff:fe:91:ea:d7| 128 | 6 (GM) | 0x21 (100ns)| 20061| 128 | 5thHop|70:b3:d5:ff:fe:91:e2:3b.0002| 0x20 (GNSS) |2023-02-09 16:22:12.130( 9d17h 9m12s877ms ago)
70:b3:d5:ff:fe:91:e2:3b| 128 | 248 (BC) | 0xFE (unkn)| 65535| 128 | 1stHop|70:b3:d5:ff:fe:91:e2:3b.0002| 0xA0 (intOscillator) |2023-02-09 16:22:09.829( 9d17h 9m15s178ms ago)
70:b3:d5:ff:fe:91:ea:d7| 128 | 6 (GM) | 0x21 (100ns)| 20061| 128 | 5thHop|70:b3:d5:ff:fe:91:e2:3b.0002| 0x20 (GNSS) |2023-02-09 16:21:06.958( 9d17h10m18s049ms ago)
70:b3:d5:ff:fe:91:ea:b1| 128 | 248 (BC) | 0xFE (unkn)| 65535| 128 | 0thHop|70:b3:d5:ff:fe:91:ea:b1.0000| 0xA0 (intOscillator) |2023-02-09 16:20:06.470( 9d17h11m18s537ms ago)

----- Foreign master (received in announce) Info (sorted) -----
iface|inst| Grand Master Clock Id |clockClass| accuracy |logVar|prio2|locPrio|stepsRm|sourcePortIdentity(peerPort)|           timeSource |tlvClockId in announce |lastAnn(s) |why worse
wrll | 0 |70:b3:d5:ff:fe:91:e0:87| 248 (BC) | 0xFE (unkn)| 65535| 128 | 128 | 4thHop|70:b3:d5:ff:fe:91:e2:3b.0002| 0xA0 (intOscillator) |00:00:00:00:00:00:00:00| 0.565|
localClock|70:b3:d5:ff:fe:91:ea:b1| 248 (BC) | 0xFE (unkn)| 65535| 128 | 128 | 0thHop|70:b3:d5:ff:fe:91:ea:b1.0001| 0xA0 (intOscillator) |00:00:00:00:00:00:00:00| 0.000|clock id

r - refresh; f - freeze GUI; frgn master list: a - enable extra columns, s - enable sorting;
GUI Frozen!

```

Orange extra In situ calibration ported to WRS firmware

Peter Jansweijer, Henk Peek

<https://ieeexplore.ieee.org/abstract/document/8886632>



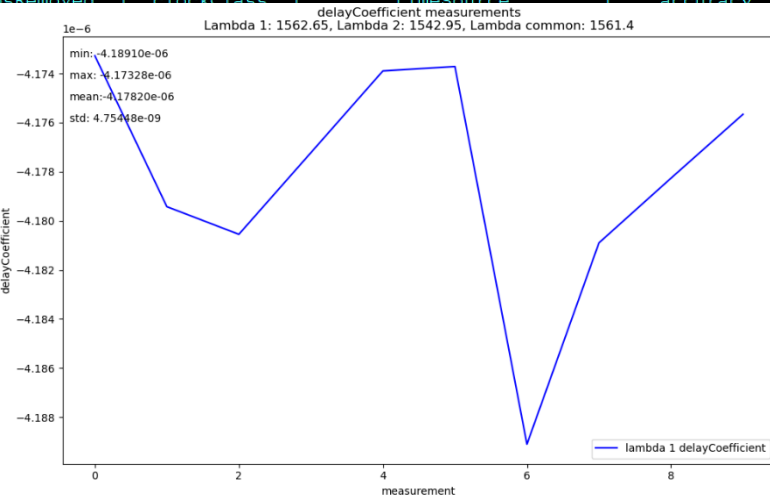
```

WRS time (TAI) : 2023-03-01 20:19:14.007354 Leap seconds: 37
Switch time (UTC): 2023-03-01 20:18:37.007344 TAI-UTC : +37.000010
PLL mode: BC PLL locking state: LOCKED globalProfile: Telecom BMCA: Telecom Domain:
-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
Grand Master Info
70:b3:d5:ff:fe:91:ea:d7 |
-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
HAL
-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
Iface | Freq | Inst | Name | C
+ wri1 | -- | | | 
+ wri2 | 0 | wri2-1 | mast
-*wri3 | 1 | wri3-1 | auto
-*wri4 | 2 | wri4-1 | auto
-*wri5 | 3 | wri5-1 | auto
-*wri6 | 4 | wri6-1 | auto
-*wri7 | 5 | wri7-1 | auto
-*wri8 | 6 | wri8-1 | auto
-*wri9 | 7 | wri9-1 | auto
- wri10 | Lock | 8 | wri10-1 | auto
-*wri11 | 9 | wri11-1 | auto
-*wri12 | 10 | wri12-1 | auto
-*wri13 | 11 | wri13-1 | auto
-*wri14 | 12 | wri14-1 | auto
-*wri15 | 13 | wri15-1 | auto
-*wri16 | 14 | wri16-1 | auto
-*wri17 | 15 | wri17-1 | auto
-*wri18 | 16 | wri18-1 | auto
Iface: +/- SFP in DB; PrConf-Pro

-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
Sync
Servo state: wri10:White-Rabbit: SYNC_NSEC
Tracking in insitu mode (only syntonization)

+- Timing parameters -----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
| meanDelay : 103803.950 nsec err state: 16
| delayMS : 103803.950 nsec err offset: 16
| delayMM : 208642.952 nsec err delta: 2
| delayAsymmetry : 0.000 nsec
| delayCoefficient : +0.00000000000000000000 fpa : 0
| ingressLatency : 278.678 nsec
| egressLatency : 238.848 nsec
| semistaticLatency: 0.000 nsec
| offsetFromMaster : -1140895.422 nsec
| Phase setpoint : 0.510 nsec
| Skew : 0.000 nsec
| Estimated link len: 21187.120 meters
| Update counter : 52 times
| Master PHY delays TX: 238.848 nsec RX: 278.678 nsec
| Slave PHY delays TX: 238.848 nsec RX: 278.678 nsec

-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
Temperatures
FPGA: 49.44 PLL: 51.12 PSL: 36.38 PSR: 38.00
  
```



Implementation and way forward

Where we are & plans

- Implementation of the planned functionality into the White Rabbit Switch firmware - progress 60%
- Merge into CERN release in two phases (preliminary plan):
 - Q4 2024 – feature set 1*
 - Q3 2025 – feature set 2*
- Joining White Rabbit Collaboration*



Thank you

Marek Brawański



22nd March 2024



Backup slides



22nd March 2024

Credits

All cute rabbit pictures generated by AI

Provisioning

- Dynamic (runtime) via ppsi_conf with **no permanent effect**
- Static via wrs_menuconfig – **permanent change**

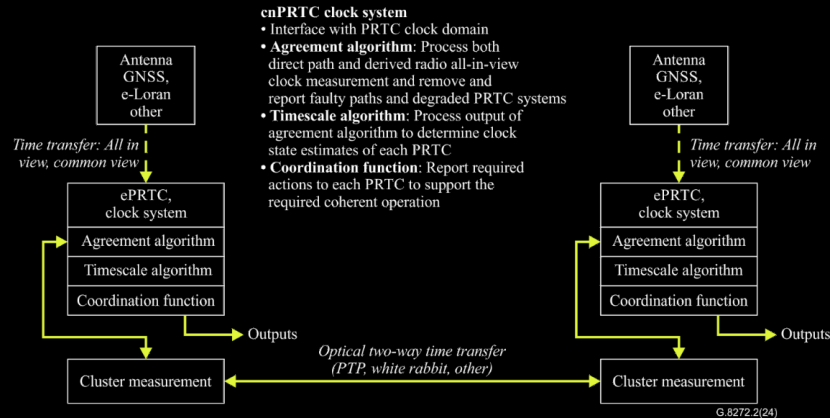
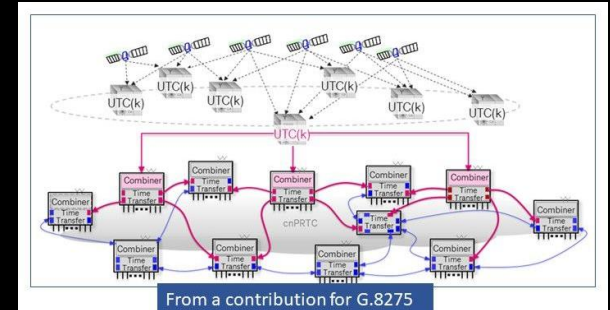
Monitoring & tools

New CLI tool wrs_bmca_stat

ppsi_conf **extensions**

G.8272.2 introduce coherent network primary reference time clocks

White Rabbit / IEEE1588 HA profile links between clock in the mesh



cnPRTC clock system

- Interface with PRTC clock domain
- **Agreement algorithm**: Process both direct path and derived radio all-in-view clock measurement and remove and report faulty paths and degraded PRTC systems
- **Timescale algorithm**: Process output of agreement algorithm to determine clock state estimates of each PRTC
- **Coordination function**: Report required actions to each PRTC to support the required coherent operation

Figure I.2 – Coherent network PRTC functional architecture

White Rabbit positioning in the Telecom

- **Core**
 - Reference signals
- **TaaS HA core/access**

- **Aggregation**
- **Access**
- **Mobile backhaul/fronthaul**

White Rabbit / IEEE1588 - High Accuracy Profile



PTP G.8275.1 + SyncE

future expansion area of IEEE1588 HA ??
(I wish)