

ITSF: Sync in the Infrastructure

# Response of Devices to PTP Time Sync Signals in a Digital Substation

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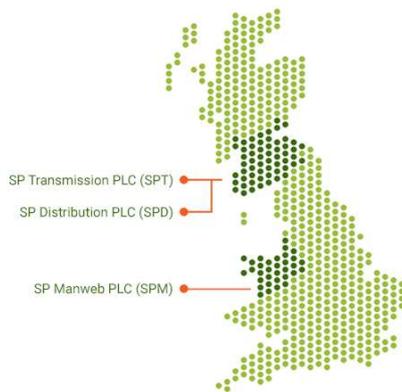
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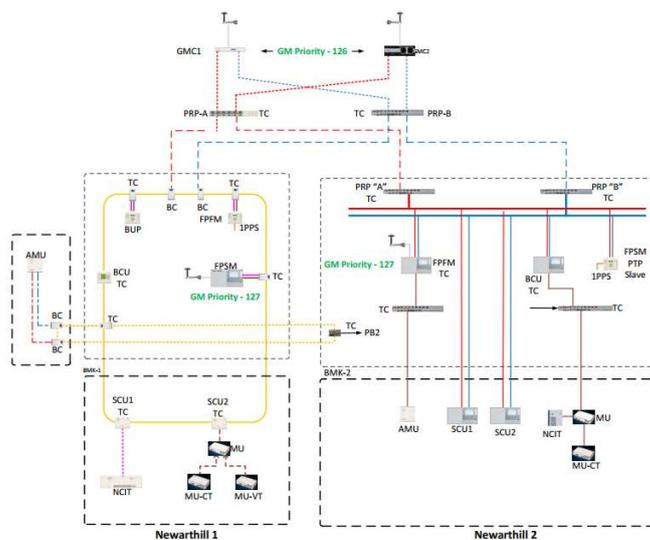


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### Introduction: Who we are



### Introduction: Digital substations transition

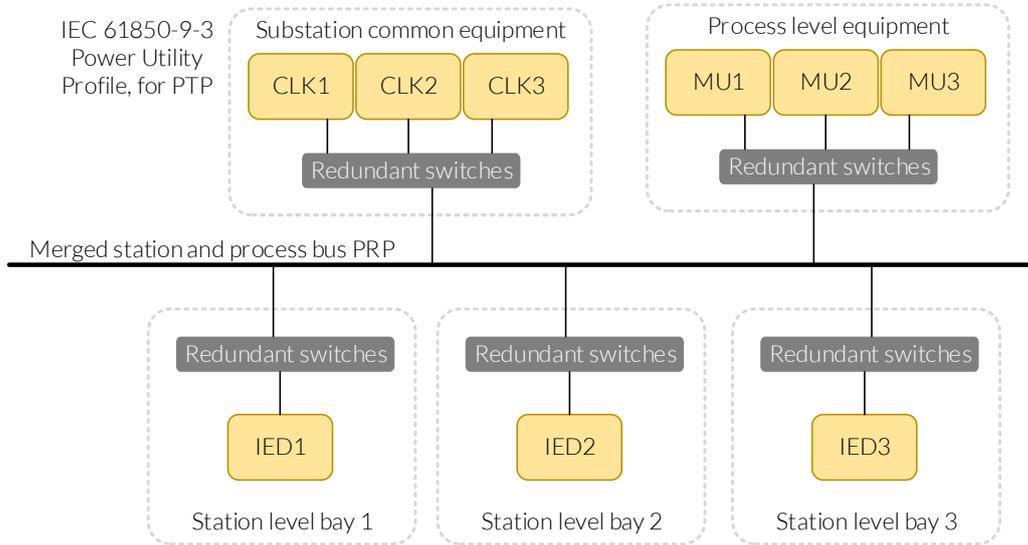


GNSS previously limited mainly to monitoring functions.

Partially digital substations made use of SNTP and IRIG-B to meet 1ms accuracy requirement.

Trial fully digital substation made use of 1PPS and PTP to meet 4µs accuracy requirement.

## RESPONSES OF DEVICES TO PTP TIME SYNC IN DIGITAL SUBSTATIONS

**Test System: Set up**

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## RESPONSES OF DEVICES TO PTP TIME SYNC IN DIGITAL SUBSTATIONS

**Test System: Clock response**

Stage	Supplementary Flags	CLK1	CLK2	CLK3
1	Locked	TRUE	TRUE	TRUE
	clock class 6, <100ns	TRUE	TRUE	TRUE
2	Holdover in spec	TRUE	FALSE	TRUE
	clock class 7, <250ns	FALSE	TRUE	TRUE
3	Holdover extended spec	FALSE	FALSE	TRUE
	clock class 52, <1us	FALSE	TRUE	TRUE
4	Holdover out of spec	FALSE	FALSE	FALSE
	clock class 187, >1us	FALSE	TRUE	TRUE
5	GNSS reacquired	TRUE	TRUE	TRUE
		TRUE	TRUE	TRUE

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RESPONSES OF DEVICES TO PTP TIME SYNC IN DIGITAL SUBSTATIONS

### Test System: SV stream content

```
IEC61850 Sampled Values
APPID: 0x4000
Length: 123
  Reserved 1: 0x0000 (0)
    0... .. = Simulated: False
  Reserved 2: 0x0000 (0)
  savPdu
    noASDU: 1
    seqASDU: 1 item
      ASDU
        svID: WIYH2002U1MU01
        smpCnt: 1876
        confRev: 1
        smpSynch: local (1)
        PhsMeas1
          value: -157
          > quality: 0x00000000, validity: good, source: process
          value: -685
          > quality: 0x00000000, validity: good, source: process
          value: 31
          > quality: 0x00000000, validity: good, source: process
          value: -247
          > quality: 0x00000000, validity: good, source: process
          value: -444
          > quality: 0x00000000, validity: good, source: process
          value: -103
          > quality: 0x00000000, validity: good, source: process
          value: 302
          > quality: 0x00000000, validity: good, source: process
          value: -75
          > quality: 0x00000000, validity: good, source: process
        gmIdentity: 0xec4670ffffe10fd70
```

timing: smpCnt

sync status: smpSynch

clock source: gmIdentity



SAMPLED VALUES

### Test System: SV synchronism status

smpSynch	MU1	MU2	MU3
<b>Method</b>	Checks clock accuracy against a user-definable setting (equivalent to 250ns or 1us)	Checks <b>quality flags</b> for traceability to a global source	Uses clock class, with checks on <b>quality flags</b> to ensure validity
<b>Local (1)</b>	Insufficiently accurate to ensure overall user accuracy requirements are met	e.g. timeTraceable FALSE	Clock class 52, 187 and 248, and clock class 6 and 7 where quality is deemed invalid
<b>Global (2)</b>	Sufficiently accurate to ensure overall user requirements are met	e.g. timeTraceable TRUE	Clock class 6 and 7 with good quality



### Test System: SV response to time jumps

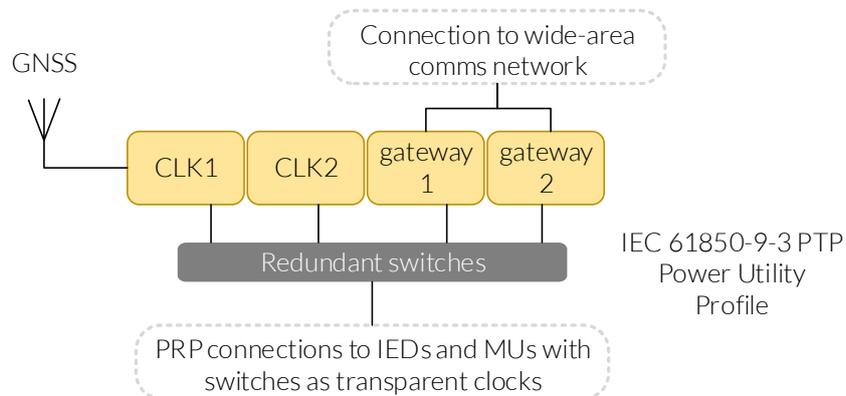


MUs have varying holdover times, and can take a significant time to regain synchronism

	0s				4s					82s					
MU1	1817	1886	1887	...	212	-	-	3997	3998	...	3930	3932	3933	-	3966
MU2	1816	1886	1887	...	213	214	215	216	217	...	3503	3504	3505	3537	3538
MU3	1817	1887	1888	...	212	213	214	215	216	...	3930	3932	3933	3965	3966

Variation in timestamping leads to blocking, or maloperation, as the IEDs are unable to align the samples correctly

### Design Results: Proposed system



RESPONSES OF DEVICES TO PTP TIME SYNC IN DIGITAL SUBSTATIONS

## Design results: Key challenges

Avoid time jumps

Work with manufacturers

Keep testing to build knowledge

Investigate alternatives

Necessary to optimise the design, and to enable innovation.

