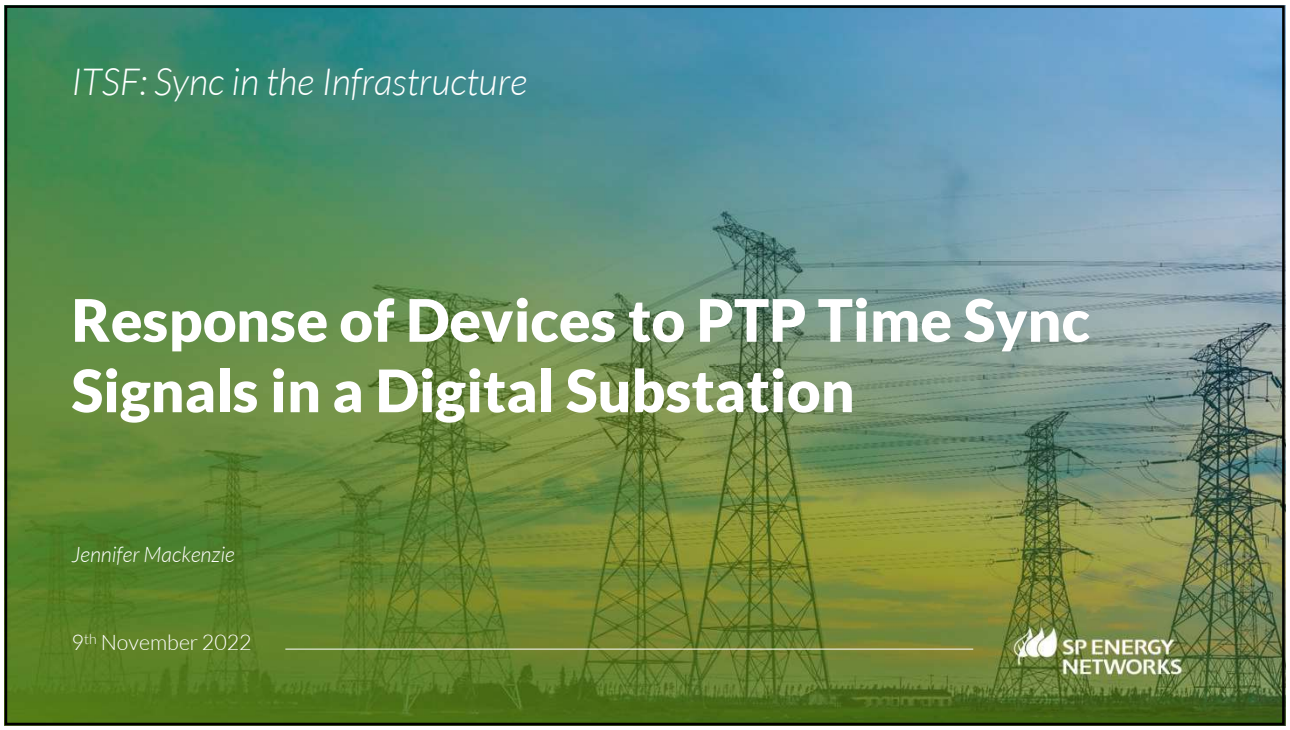

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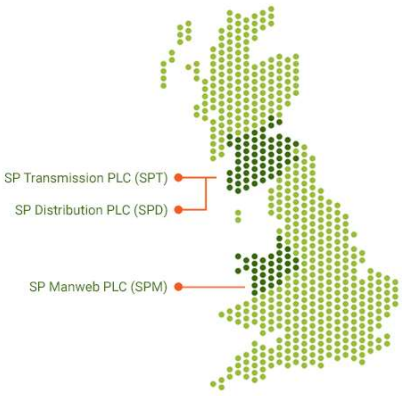
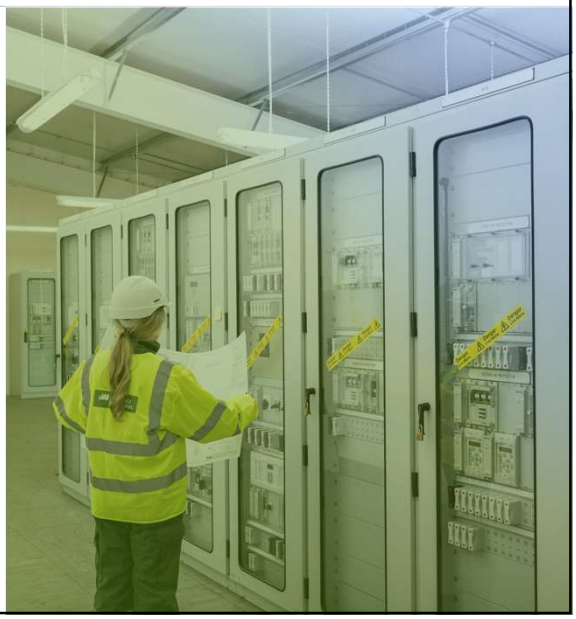
RESPONSES OF DEVICES TO PTP TIME SYNC IN DIGITAL SUBSTATIONS

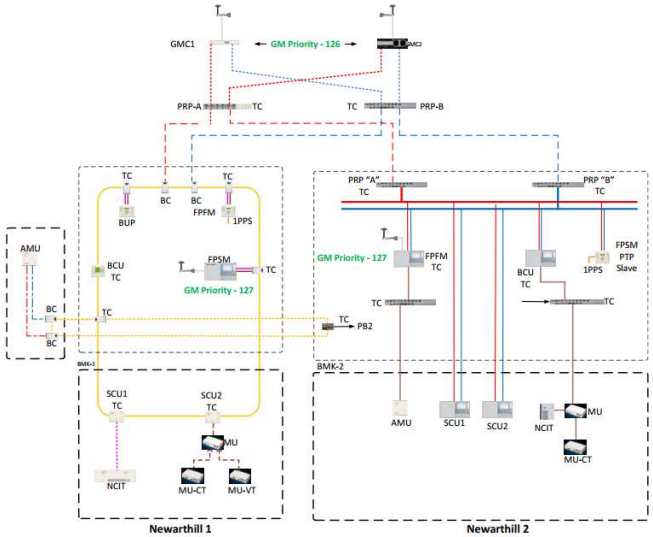
Introduction: Who we are





RESPONSES OF DEVICES TO PTP TIME SYNC IN DIGITAL SUBSTATIONS

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.

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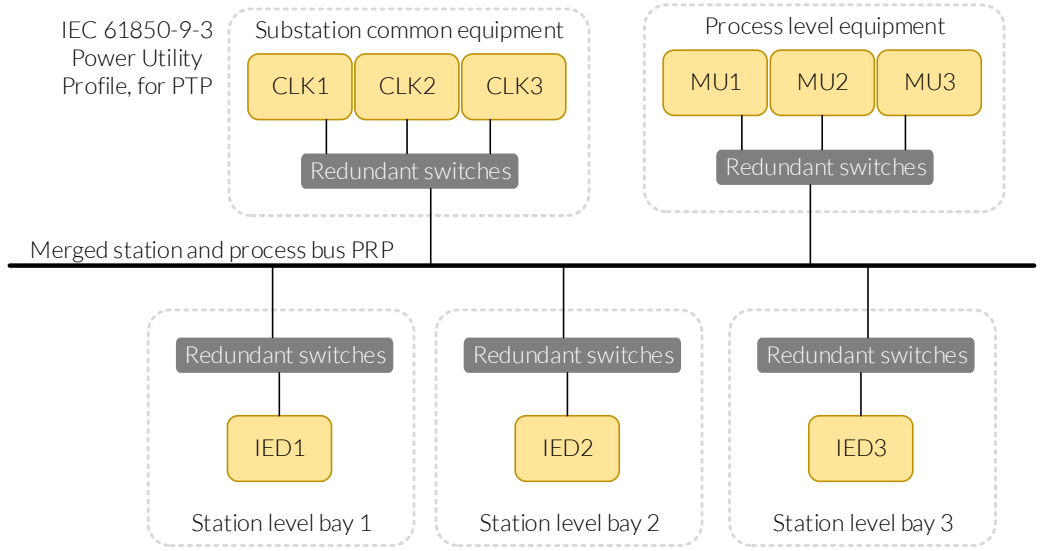
RESPONSES OF DEVICES TO PTP TIME SYNC IN DIGITAL SUBSTATIONS

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 clock class 6, <100ns	timeTraceable	TRUE	TRUE	TRUE
		currentUtcOffsetValid	TRUE	TRUE	TRUE
2	Holdover in spec clock class 7, <250ns	timeTraceable	TRUE	FALSE	TRUE
		currentUtcOffsetValid	FALSE	TRUE	TRUE
3	Holdover extended spec clock class 52, <1us	timeTraceable	FALSE	FALSE	TRUE
		currentUtcOffsetValid	FALSE	TRUE	TRUE
4	Holdover out of spec clock class 187, >1us	timeTraceable	FALSE	FALSE	FALSE
		currentUtcOffsetValid	FALSE	TRUE	TRUE
5	GNSS reacquired	timeTraceable	TRUE	TRUE	TRUE
		currentUtcOffsetValid	TRUE	TRUE	TRUE

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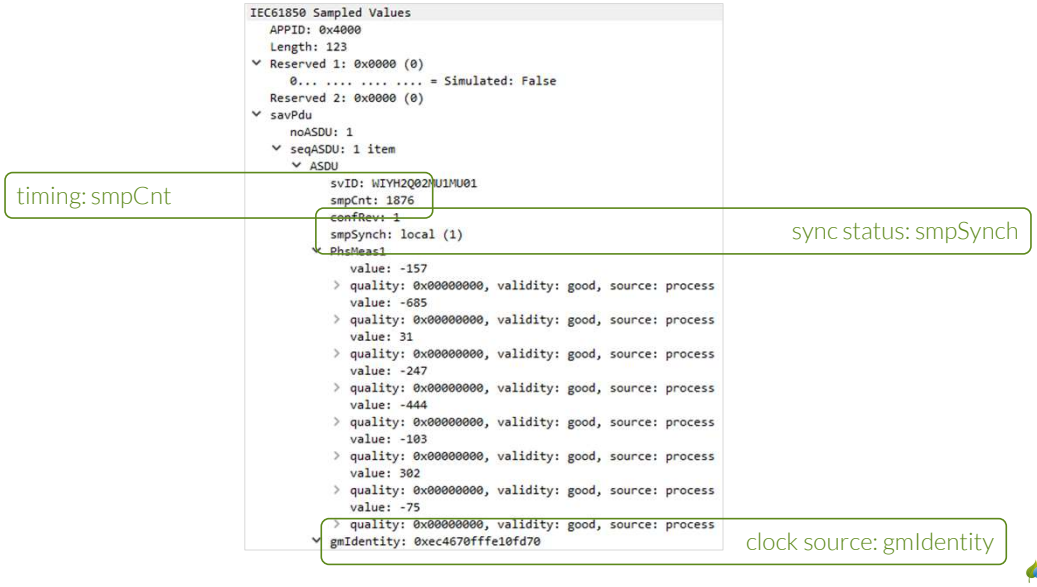
RESPONSES OF DEVICES TO PTP TIME SYNC IN DIGITAL SUBSTATIONS

Test System: SV stream content



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SAMPLED VALUES

Test System: SV synchronism status

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

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RESPONSES OF DEVICES TO PTP TIME SYNC IN DIGITAL SUBSTATIONS

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

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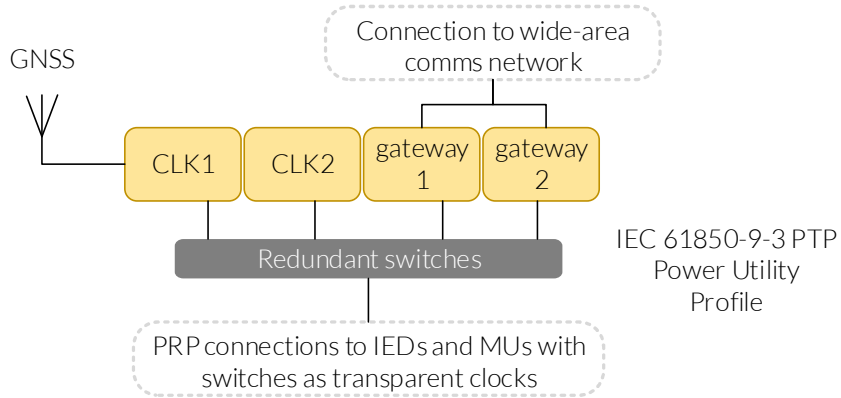
RESPONSES OF DEVICES TO PTP TIME SYNC IN DIGITAL SUBSTATIONS

Design Results: Proposed system



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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**.

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