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For power system expertise

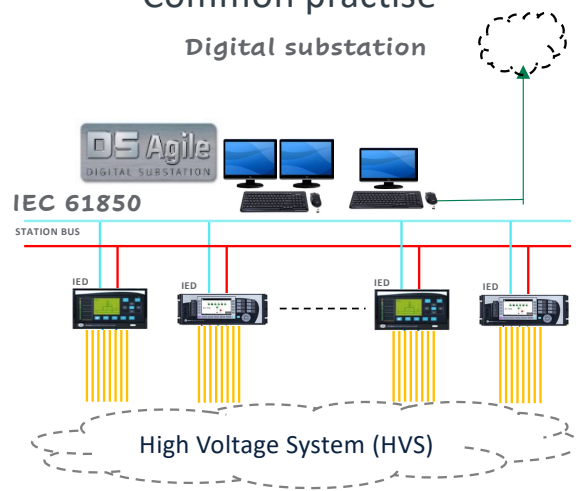
Progress of Digital Substations

22/11/2023

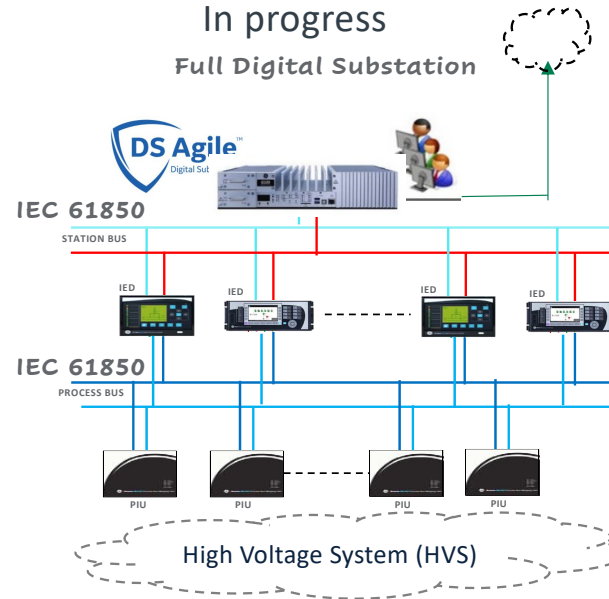
Chee-Pinp TEOH

Evolution of Digital Substation

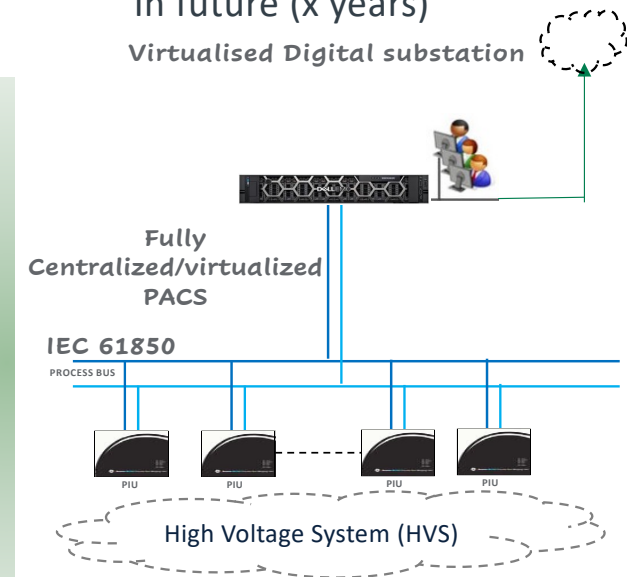
Common practise
Digital substation



In progress
Full Digital Substation



In future (x years)
Virtualised Digital substation



Hardware -> Software

Why Digital Substation?



A typical P&C IED
(Conventional substation)



A typical P&C panel
(Conventional substation)



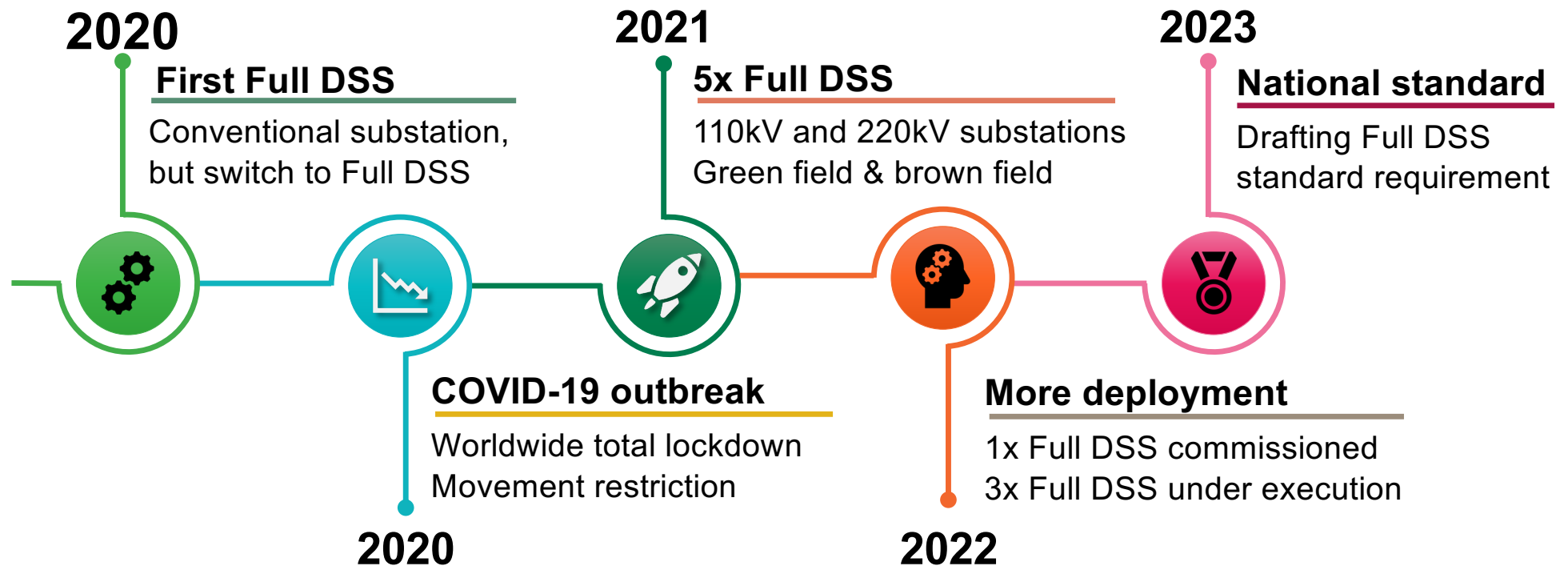
A typical conventional substation



A typical P&C IED Device
(Digital substation)

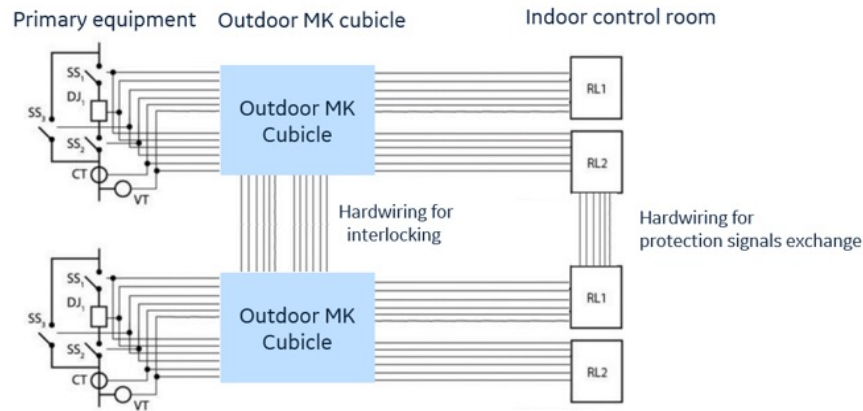
- **Safety issues** – equipment isolation, touch and step potentials, EMC
- **Copper** – raw material cost has increased 400% in 10 years
- **Material cost** – cubicle wiring and test costs, labor cost per wire end termination
- **Schematic design** - verification cost, excessive on-site work content
- **Civil work costs** – trays, cable access/egress...
- **Maintainability cost** – Self supervision, simpler testing

Case Study: A Customer Digital Substation Journey



Rapid but NO compromise

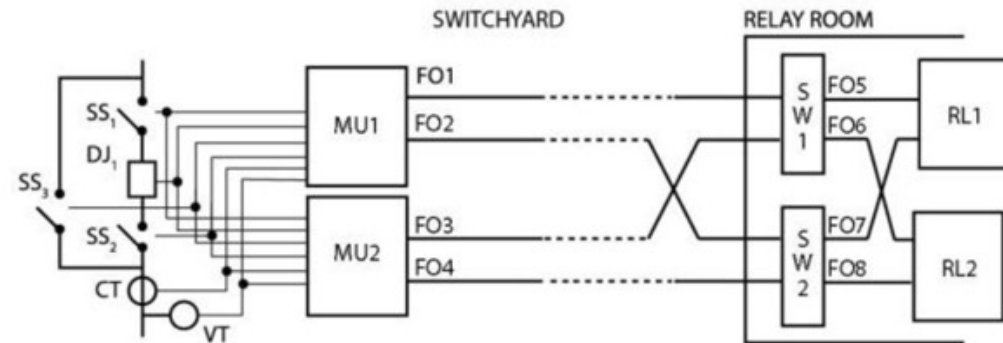
No compromise – PACS Performance & Reliability



A typical conventional substation

Operating time = <100ms (including primary CB)

$$\text{Reliability} = R_{\text{copper cables}} \& R_{\text{relay}} \\ = 0.9998$$



A typical full digital substation

Operating time = <100ms (including primary CB)

$$\text{Reliability} = R_{\text{fibre cables}} \& R_{\text{relay}} \& R_{\text{E-SW}} \& R_{\text{MU}} \\ = 0.9999$$

Lesson learned & next deployment

Lessons learned

- Protection engineer must learn about networking, time synch
- E-SW to MU, non 87B, non 87T: 100 Mbps
- E-SW to E-SW, 87B, 87T: 1000 Mbps

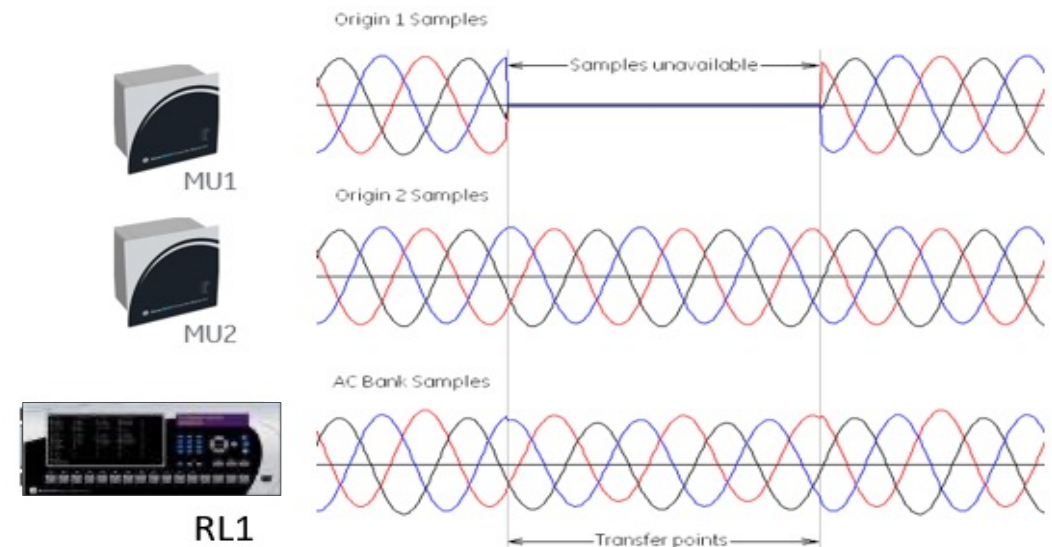
< CAPEX

- Bay & Process design standardisation
- Less drawings, cables & terminations, human mistakes
- Fast, 67% reduction in Engineering time

< OPEX

- SW Interlock with live status and metering access remotely
- Help achieve “Unmanned Substation” goal
- Asset condition monitoring & less trips to substation

Next deployment: Extra Resiliency



Cross checking and Redundancy

End of Meeting



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