



# RESILIENT LAN

PS 2 , Q2.1

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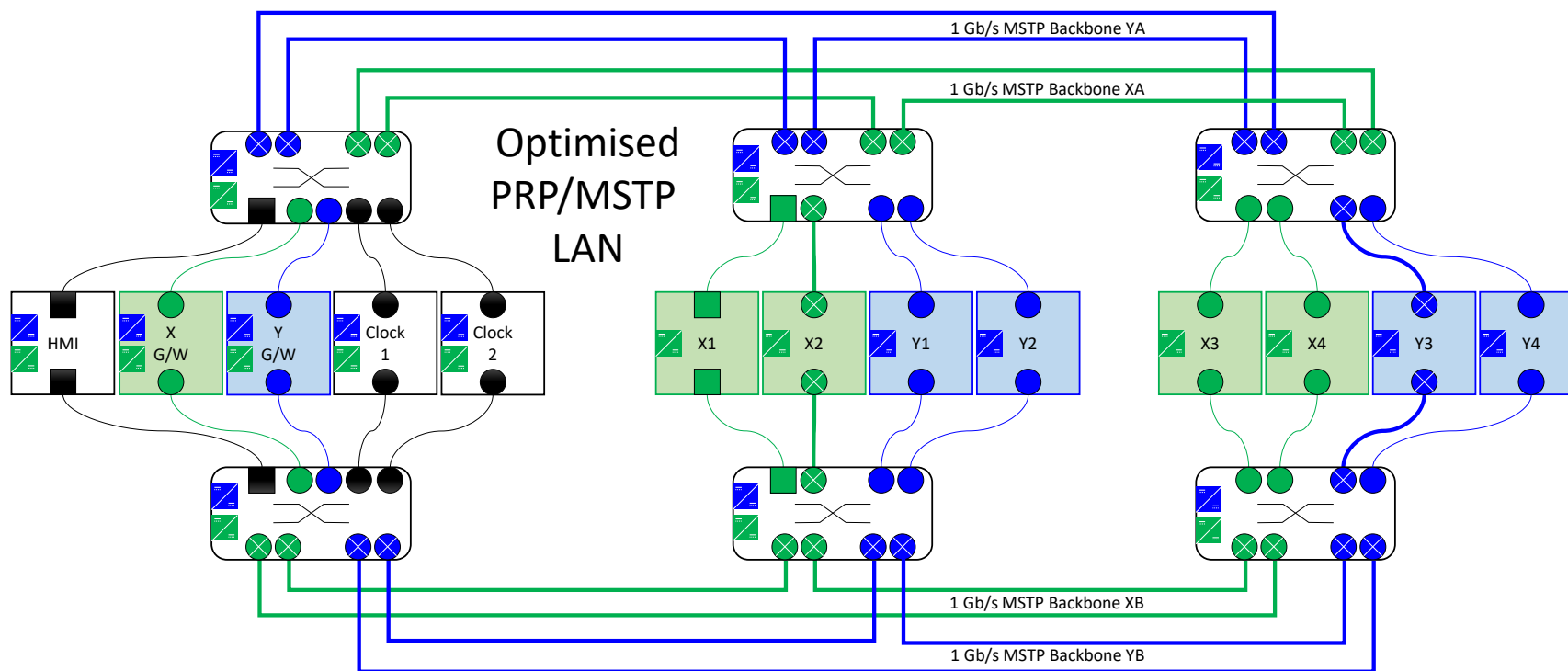
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presented by Peter Bishop

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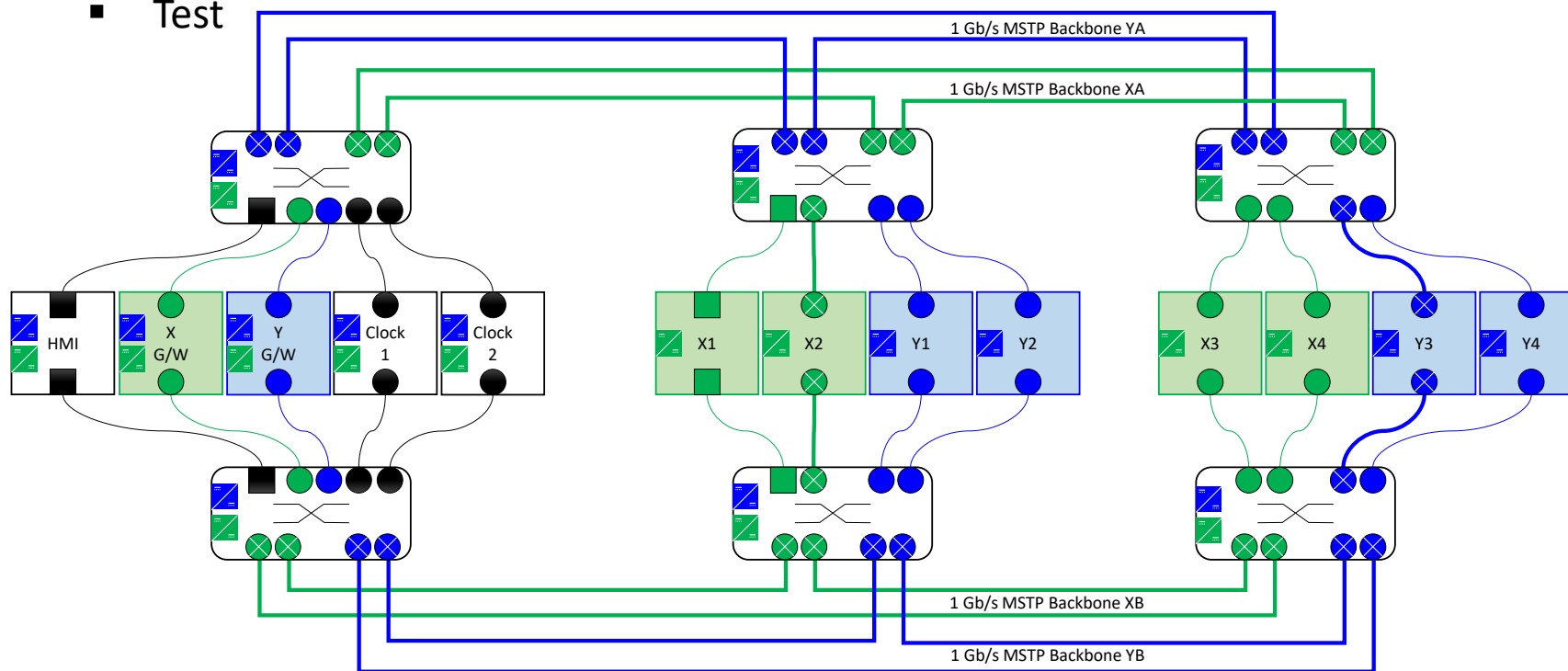
- Australian National Electricity Rules:**  
 S5.1.9 Protection systems and fault clearance times  
 (d) If the fault clearance time determined under clause S5.1.9(e) of a primary protection system for a two phase to ground short circuit fault is less than 10 seconds, the primary **protection system must have sufficient redundancy** to **ensure** that it can clear short circuit faults of any fault type within the relevant fault clearance time with **any single protection element (including any communications facility upon which the protection system depends) out of service**.
- This does not specifically state “**physically independent duplication**”, i.e. **does not** specifically require fully physically segregated X and Y



## Configuration

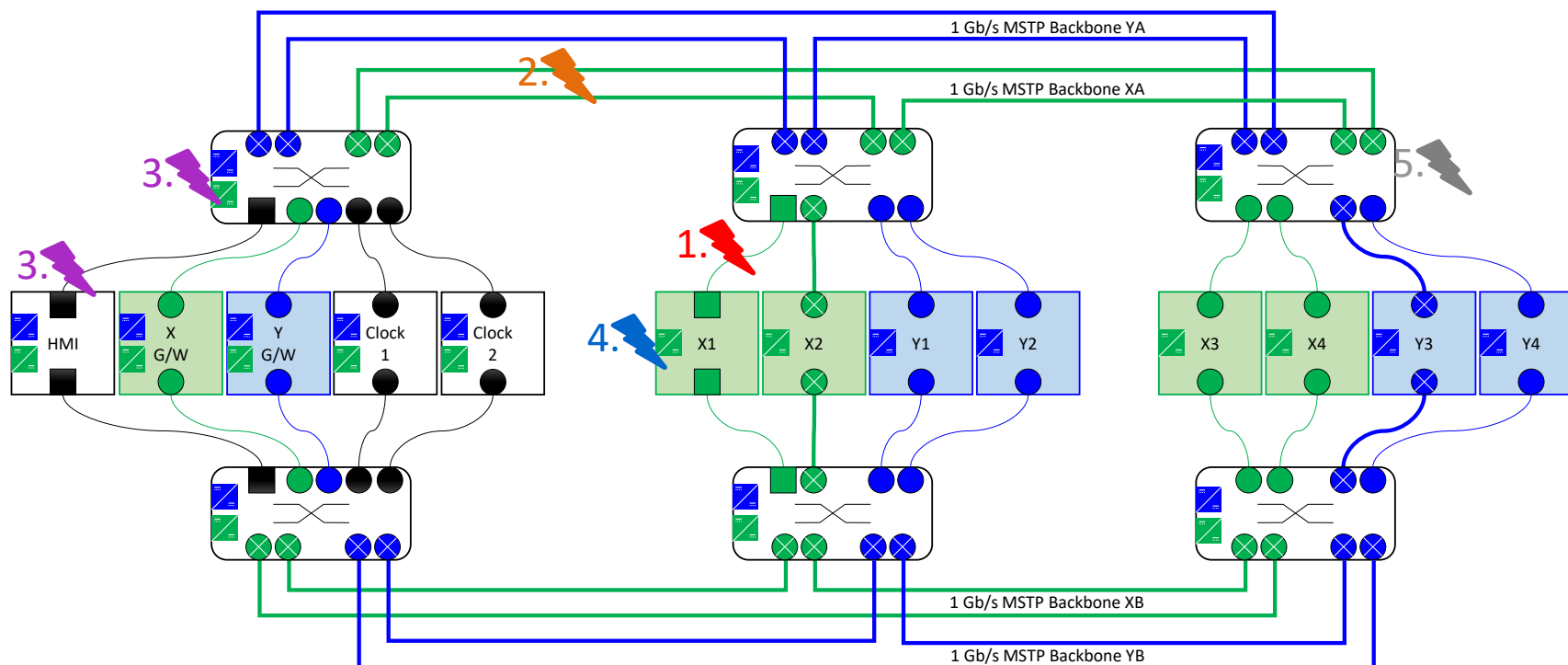
- Switch modules only have X or Y connections
  - X modules can be hot-swapped without disruption of Y system, and vice-versa
- VLANs segregate general X and Y traffic over segregated fibre backbone
- Specific VLANs carry “common” traffic
  - HMI/SCADA commands/reports
  - Clock
  - Cross-connected X:Y messages (RBRF, RREC, RDRE)
  - Test

MSTP Ring	VLAN 1-999 Common	VLAN 1000 – 1999 X Protection	VLAN 2000-2999 Y Protection
XA	Yes	Yes	
YA			Yes
XB		Yes	
YB	Yes		Yes



## Resilience: Failure Mode Effects Analysis

1. Failure of IED link:
  - covered by bumpless alternative PRP link
2. Failure of backbone:
  - covered by self-healing MSTP recovery (perhaps >100 ms reconvergence)
    - reconvergence covered by bumpless alternative PRP link
3. Failure of dual powered IED/switch power supply:
  - covered by dual power supplies
4. Failure of single CPU/power supply IED:
  - covered by duplicate X/Y IEDs
5. Failure of single CPU switch:
  - covered by alternative PRP LAN



## Duplicate Clocks and RSTP



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*“It was a challenge to find all the correct settings for the switches. As an example, it was intended to use Rapid Spanning Tree Protocol (RSTP) as redundancy protocol both on the stations bus and the process busses, but RSTP did not work in combination with PTP. The PTP Announcement messages were looping, leading to the PTP protocol being disabled. The PTP IEEE1588 standard says that PTP Link Layer messages must not be blocked by the RSTP; it seems that also the **Announcement messages (which are Multicast messages but not Link Layer messages), are forwarded by blocking RSTP ports.** Therefore, the redundancy protocol in the rings was changed .....*”

### Summary of ad-hoc comments from the IEEE 1588 Working Group:

- Dual Clocks will be arbitrated by Best Master Clock Algorithm (BMCA) so that only one clock is providing the master sync to the LAN
- PTP is compatible with both PRP, HSR and RSTP
- PTP prescribes that all messages be multicast, i.e. they are not distinguishable from GOOSE or SV in their behaviour with respect to RSTP, PRP or HSR.
- so if Announce messages would loop, GOOSE and SV would also, which is obviously not the case.
- **Announce or Sync messages should never be sent by a BLOCKING port.**