

Looking into the Future Protection, Automation and Control Systems

Power System Relaying Committee

Substation Subcommittee

Working Group K15

‘Centralized Substation Protection and Control’

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Outline

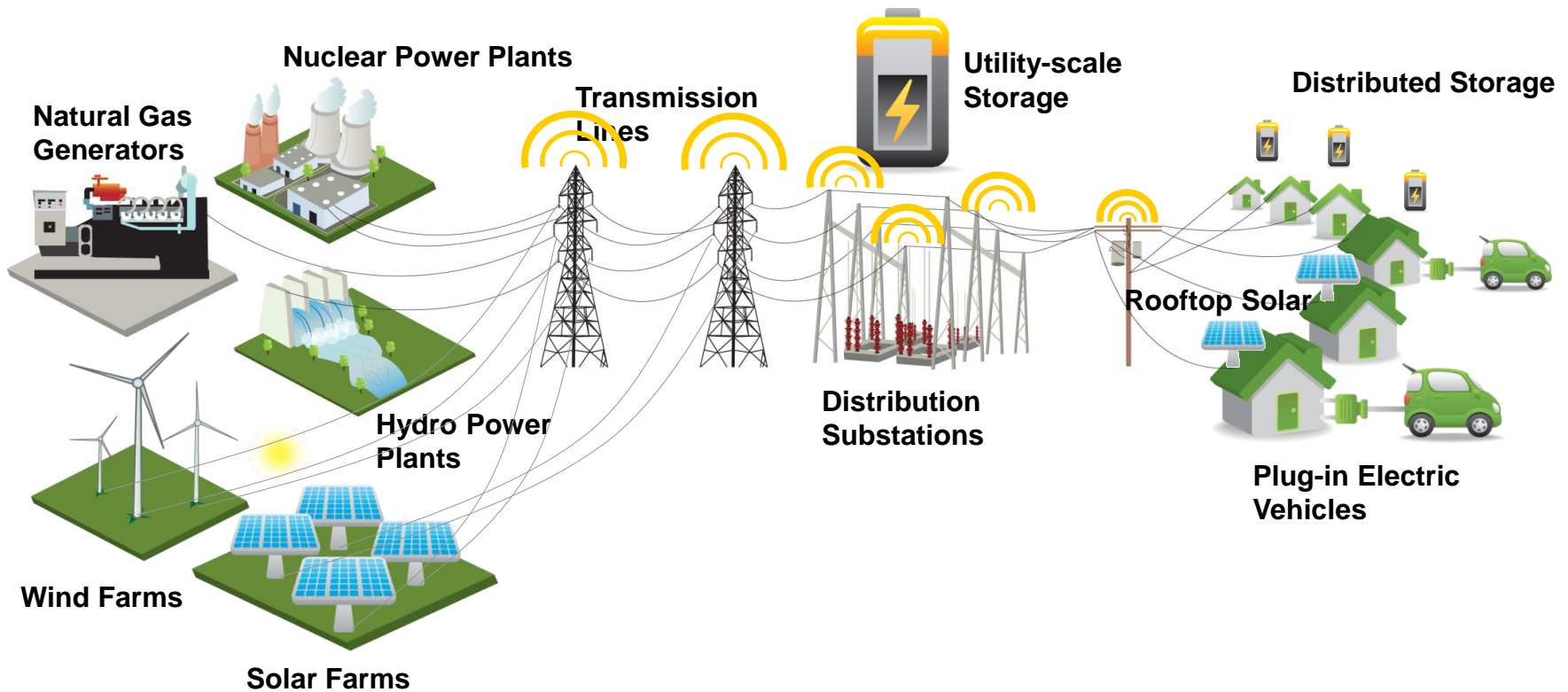
- Evolving Electric Grid
- IEEE PSRC WG K15
- Protection & Control (P&C) within a Substation
- Centralized Protection & Control (CPC) within a Substation
 - Architecture, Cost and Reliability
 - Comparison with Traditional System
 - Testing and Maintenance
- Demonstration Project
- Advanced, Emerging and Future Applications

Evolving Electric Grid

Power Plants

Electric Grid

Customers

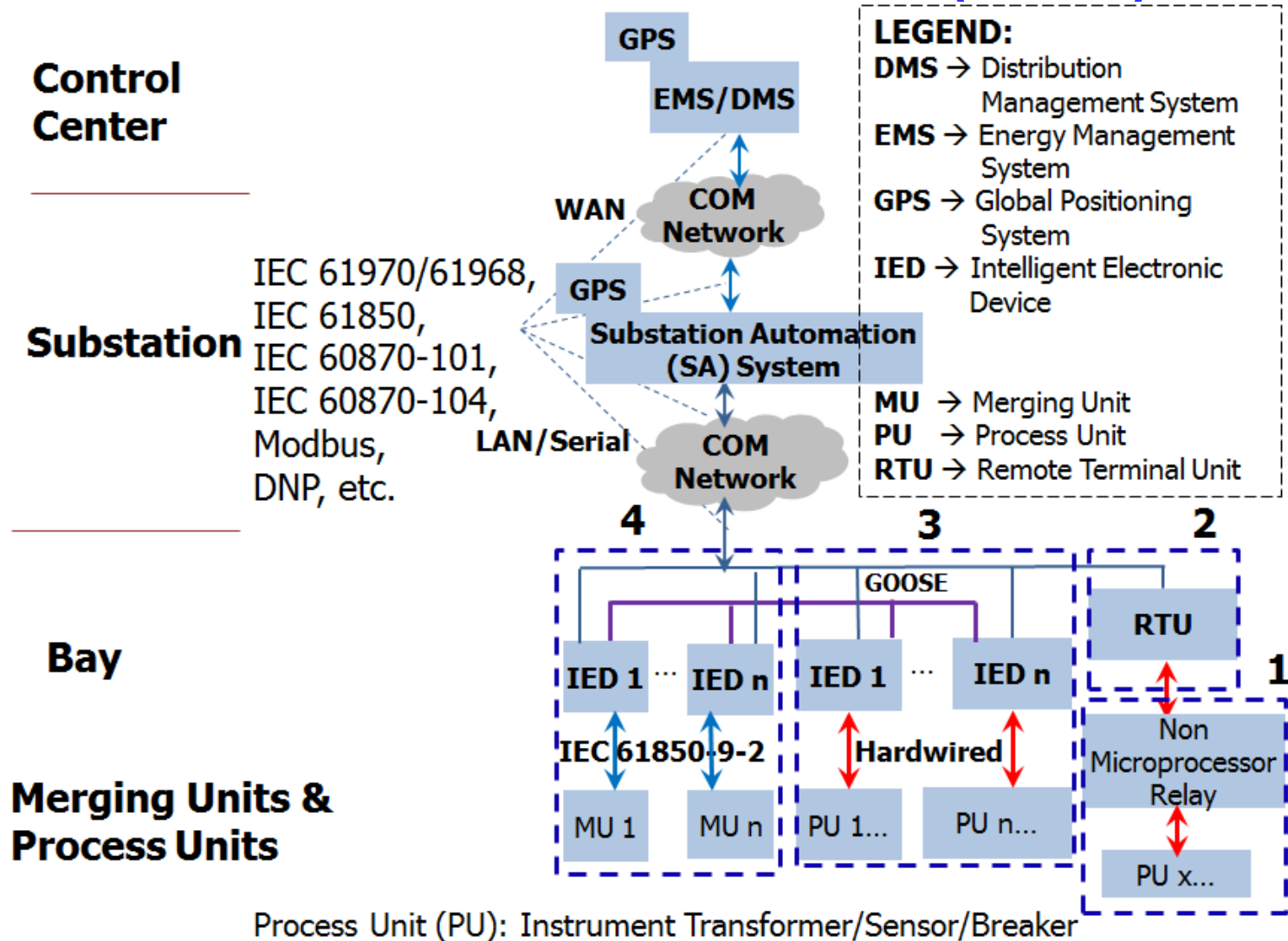


IEEE PSRC WG K15

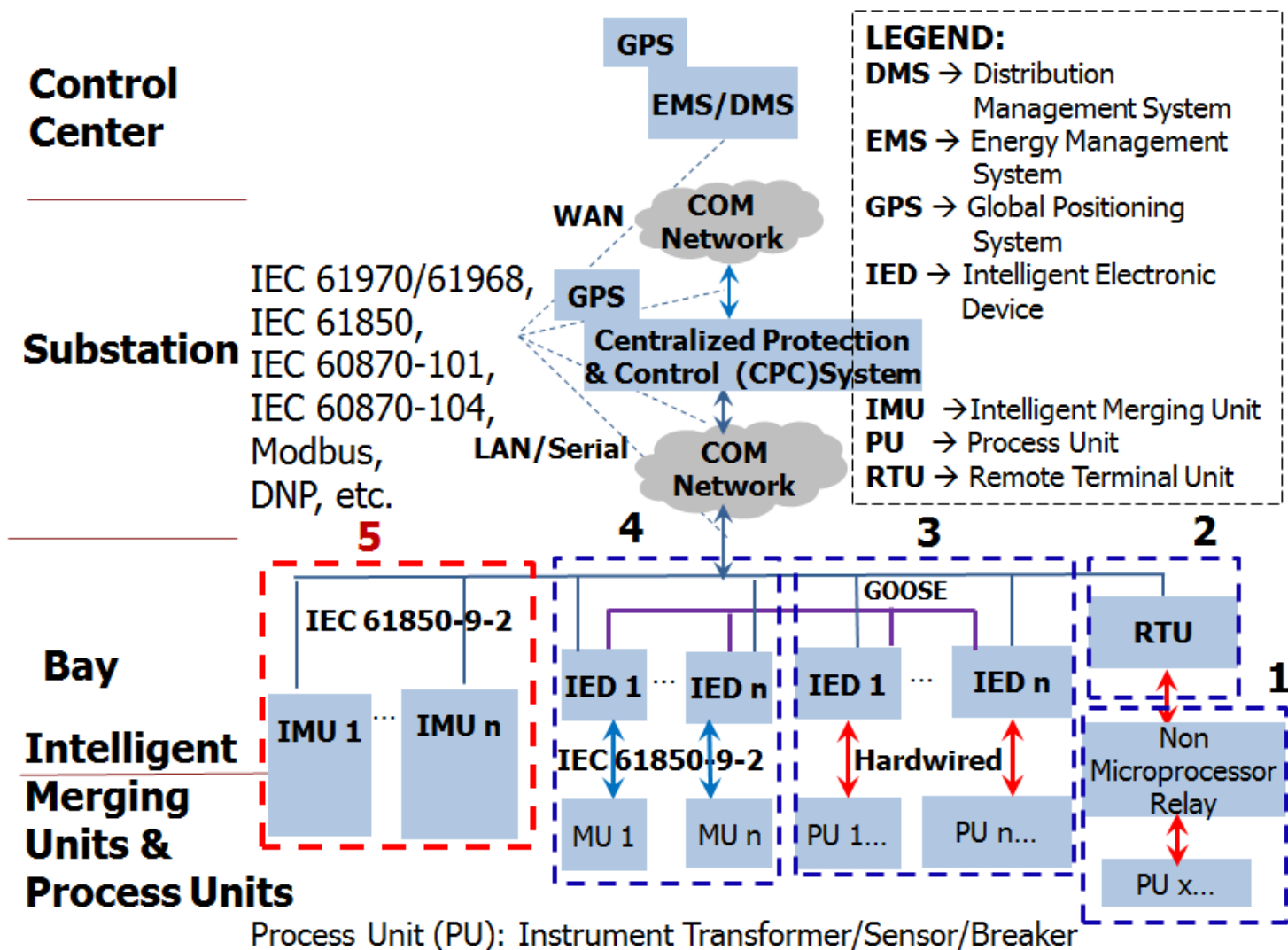
ASSIGNMENT:

Write a PSRC report describing and analyzing existing and emerging technologies for centralized protection and control within a substation.

Protection and Control (P&C)

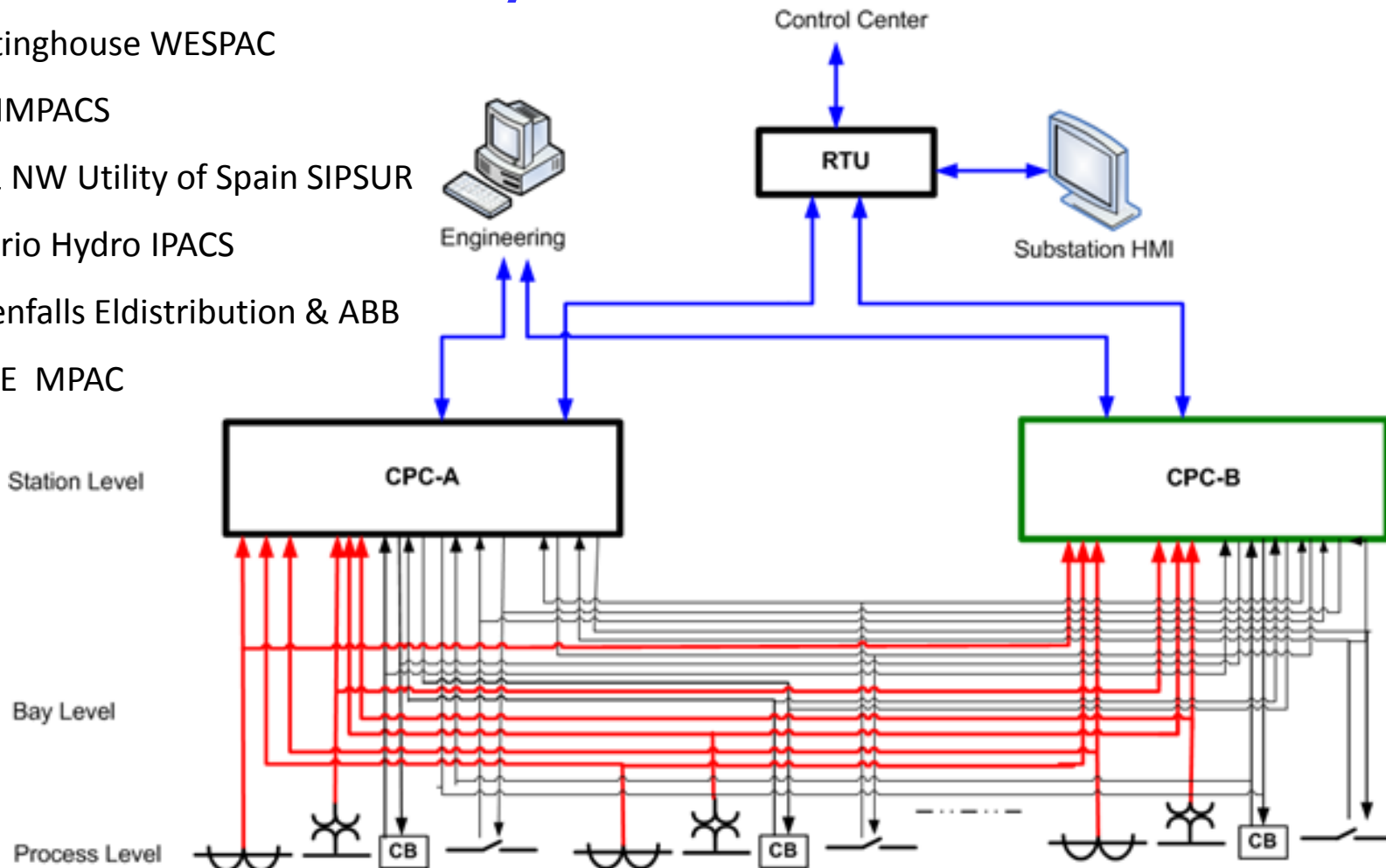


Centralized Protection and Control (CPC)

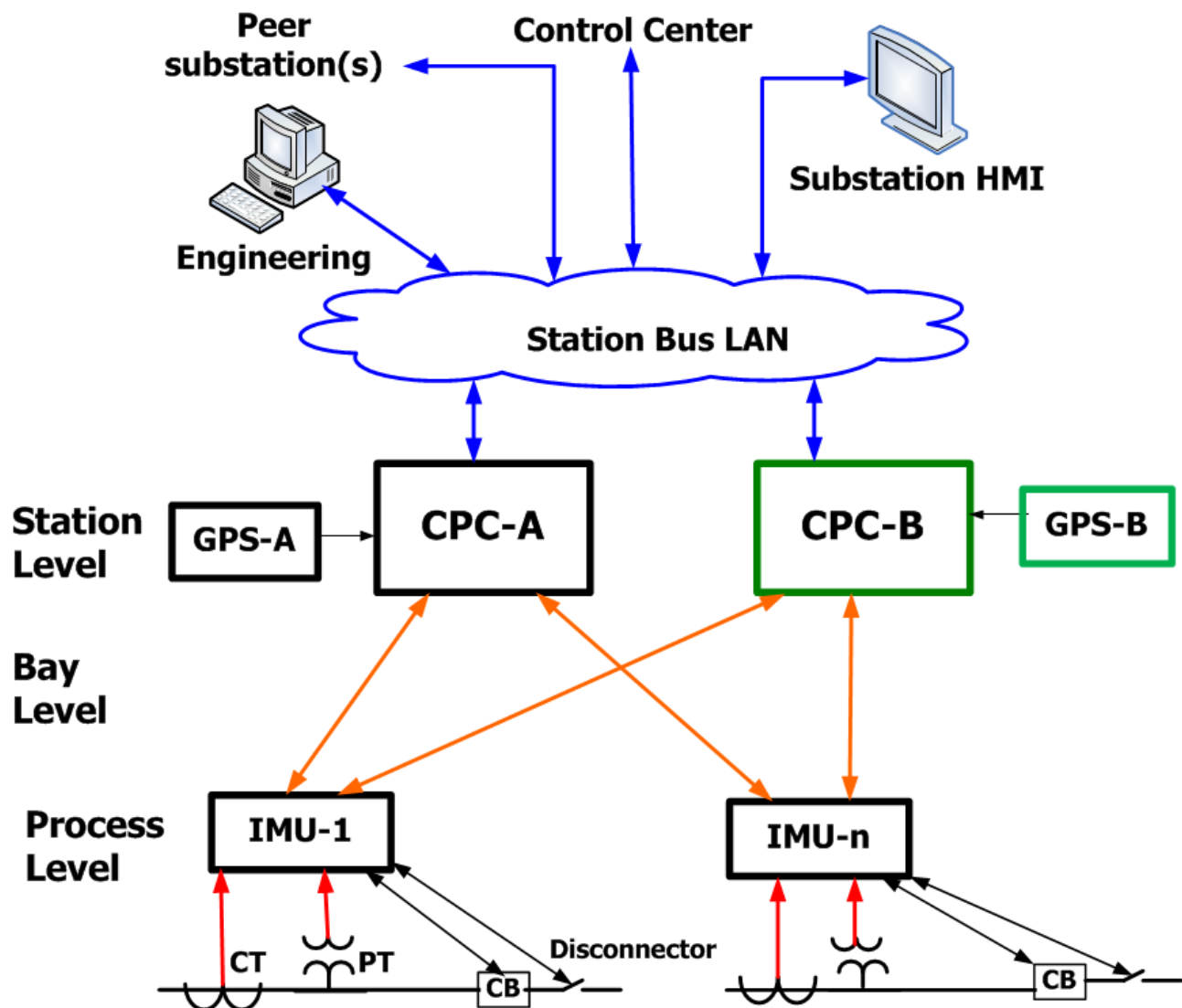


History of CPC

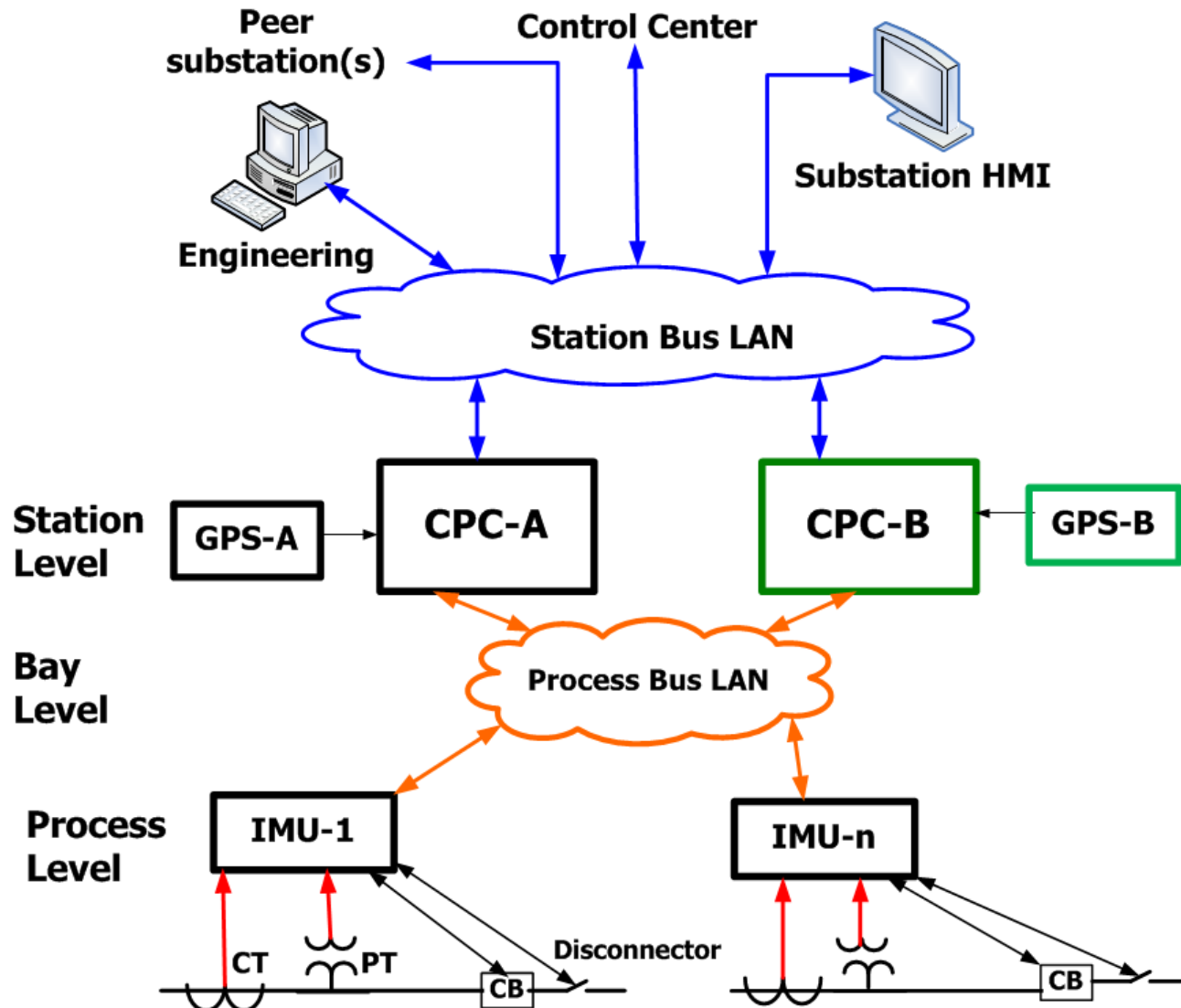
- 1980 Westinghouse WESPAC
- 1985 AEP IMPACS
- 1990 GE & NW Utility of Spain SIPSUR
- 1992 Ontario Hydro IPACS
- 2000 Vattenfalls Eldistribution & ABB
- 2003 PG&E MPAC



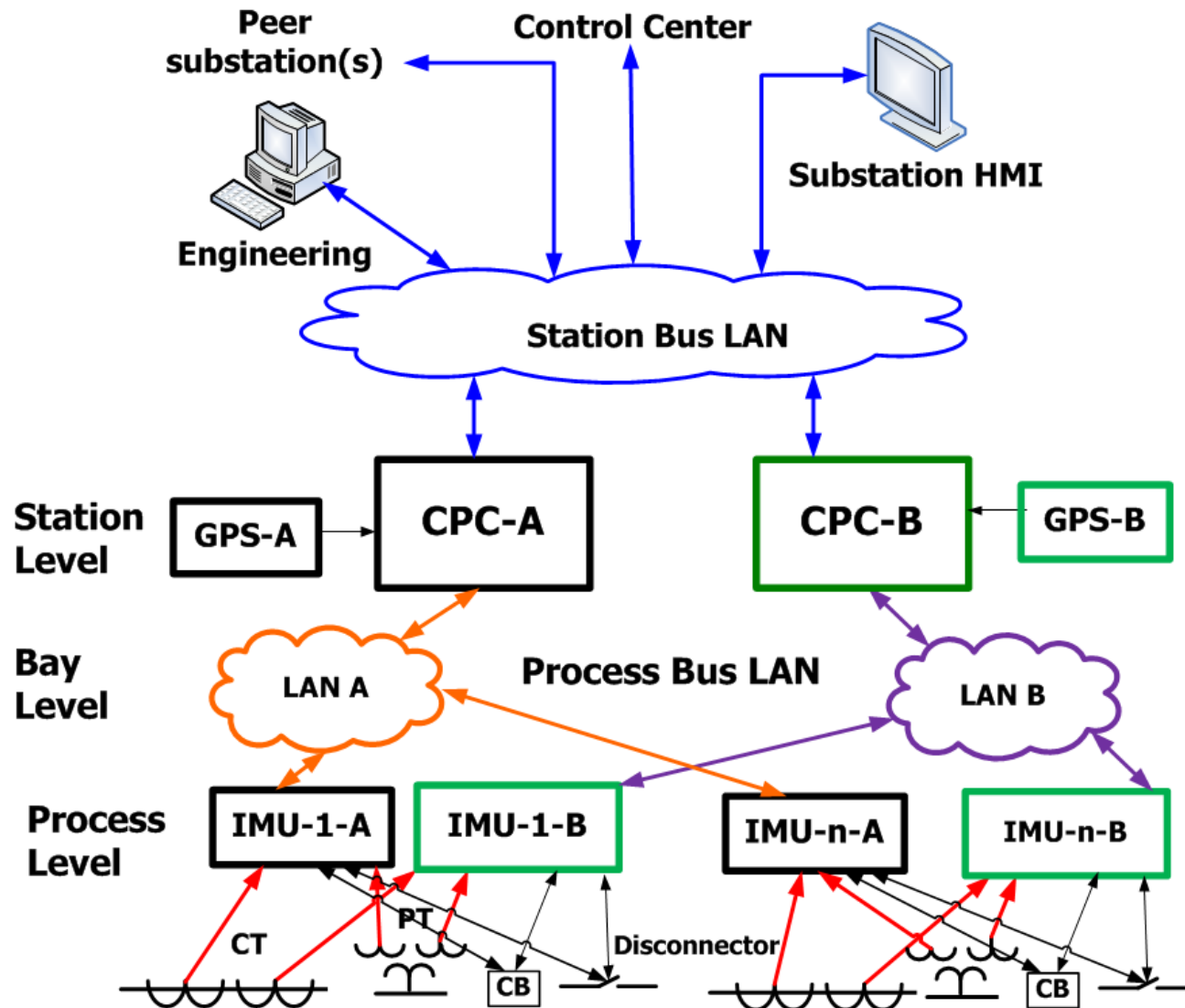
CPC Architecture 3



CPC Architecture 5



CPC Architecture 5a



CPC Cost and Reliability

	Cost	Cost Rank	Reliability Rank
Architecture 3	$2 * C_{CPC} + 72000$	1	2
Architecture 5	$2 * C_{CPC} + 76000$	2	3
Architecture 5a	$2 * C_{CPC} + 150000$	3	1

Traditional vs CPC

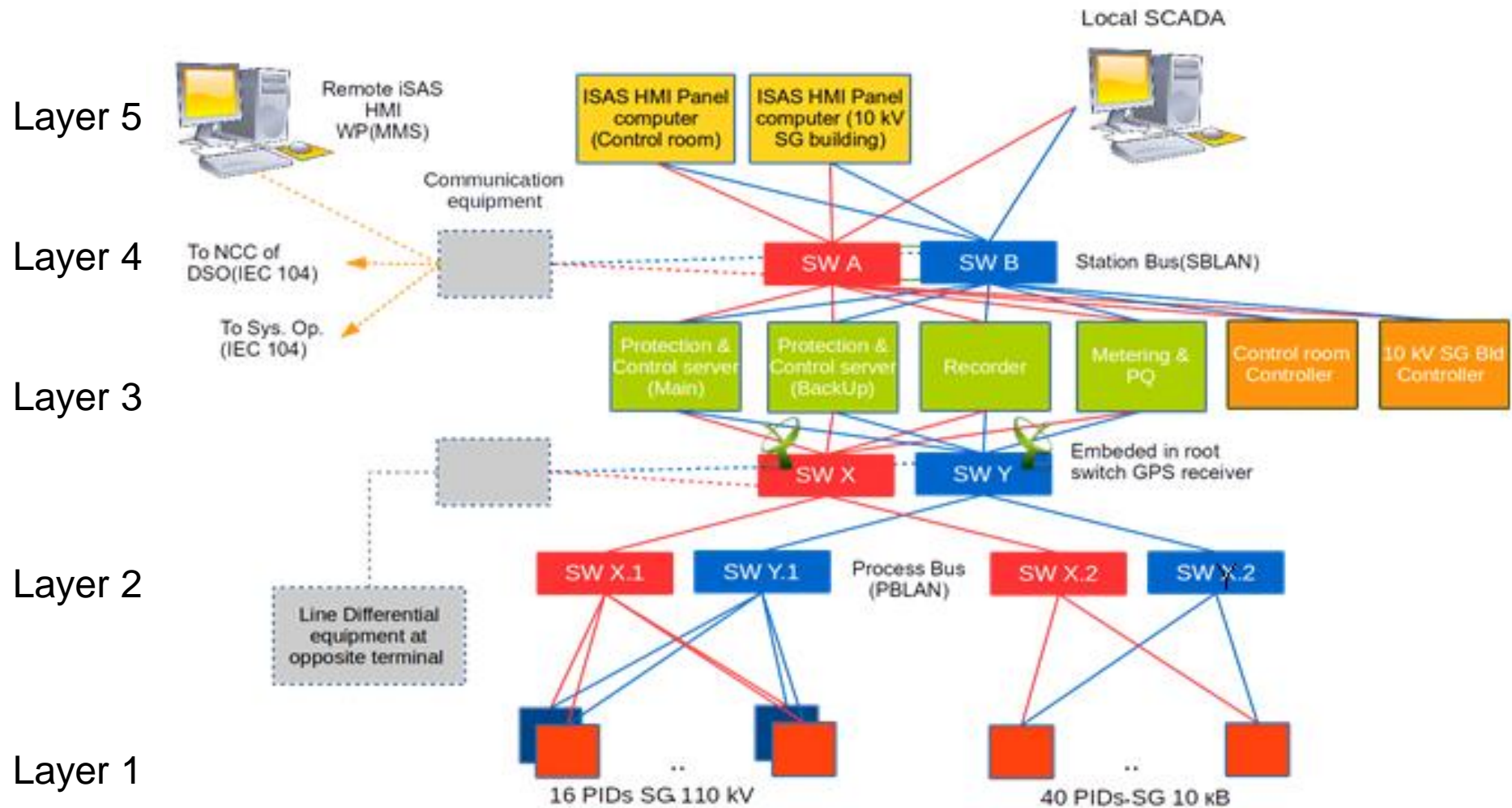
Feature	Traditional Approach	CPC Approach
Asset Mgmt	Many relays/devices	Limited number of devices
Device Mgmt	Many configuration tools	Less configuration tools
Maintenance	<ul style="list-style-type: none"> • Routine maintenance can be challenging • Per bay maintenance 	<ul style="list-style-type: none"> • Less maintenance • Per bay maintenance is an avoidable challenge
Security	Multitude access points	Very limited number of access points
Interoperability	<ul style="list-style-type: none"> • Disparate protocols • Modifications to SAS is complicated 	Configuration between IEDs will not be required as it will be internal to the system
Substation Master Interface	Protection IEDs tightly integrated into a RTU/SAS with limited intelligence	CPC becomes the “Gatekeeper”; provides a master intelligent node for substation-to-substation and substation-to-EMS/DMS communication.

CPC Testing and Maintenance

- Elements to Test
- Acceptance Testing
- Commissioning Testing
- Maintenance Testing
- Troubleshooting

Paradigm shift necessary for design, manufacturing, installation, testing, operation and maintenance

Demonstration Project: Olympic S/S, Siberia, Russia



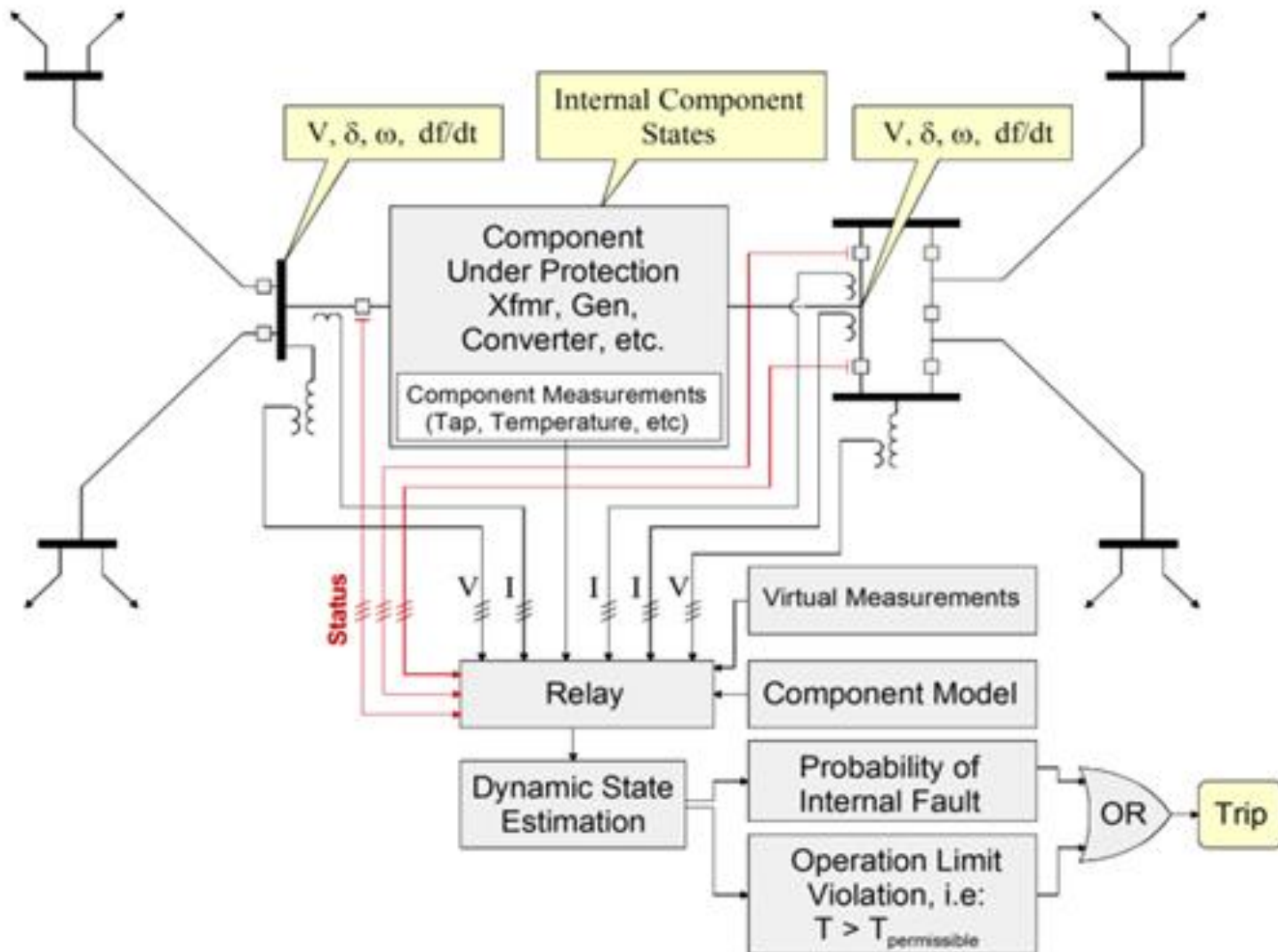
Advanced Applications

- Detection of Hidden Failures
- Incipient Fault Detection
- Data Analytics
 - Fault Location
 - Power Quality Disturbance Classification
- Distributed Asset Management

Emerging and Future Applications

- Dynamic State Estimation Based Protection
- Pattern Recognition Based Protection
- Time Synchronization Based Protection & Control

Dynamic State Estimation Based Protection



Summary

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Acknowledgements

Members of IEEE PSRC Working Group K15

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IEEE PSRC WG K15 Report Reference

Centralized Substation Protection and Control

http://www.pes-psrc.org/Reports/IEEE_PES_PSRC_WG%20K15_Report_CPC_Dec_2015.pdf