Looking into the Future Protection, Automation and Control Systems

Power System Relaying Committee

Substation Subcommittee

Working Group K15 on

'Centralized Substation Protection and Control'

Presented By:

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icaPower

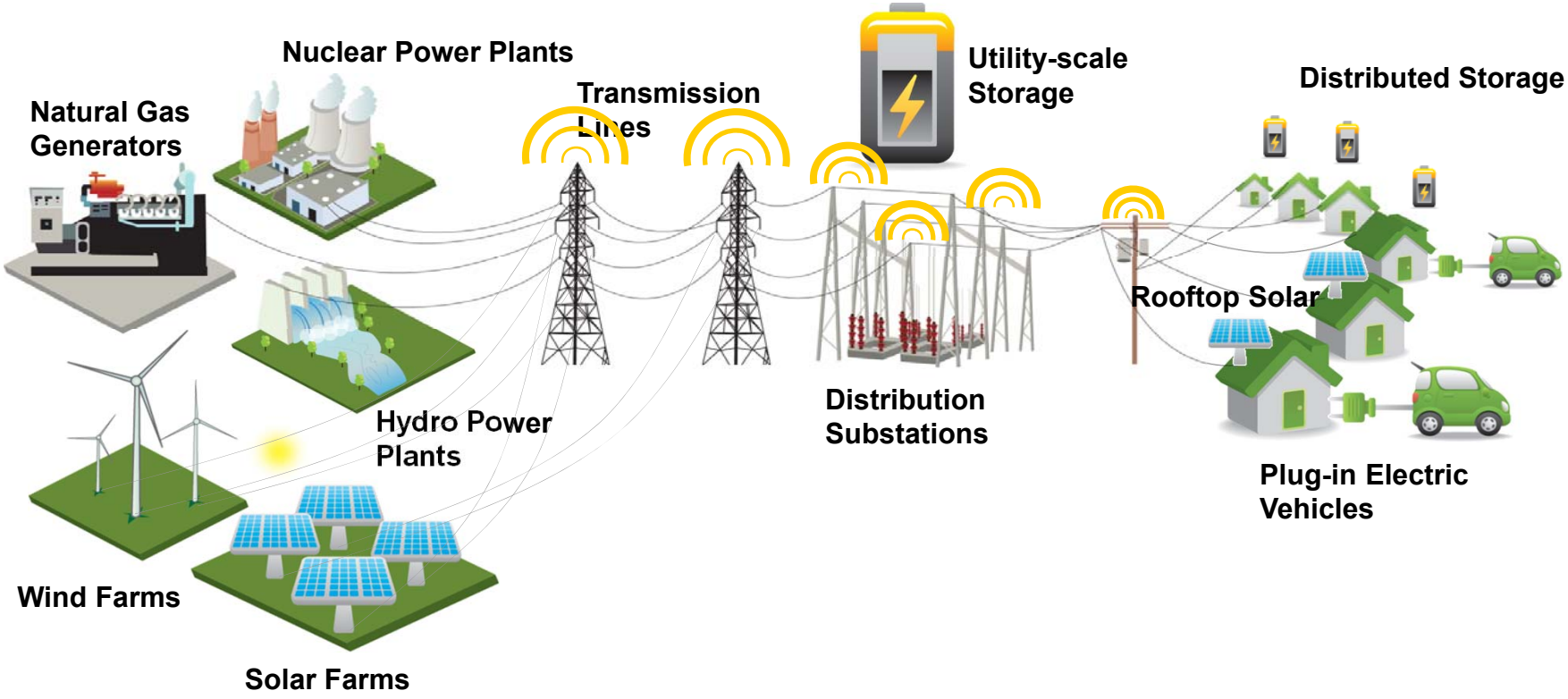
EPCC 14 Workshop, Wiesloch, Germany, May 16, 2017

Outline

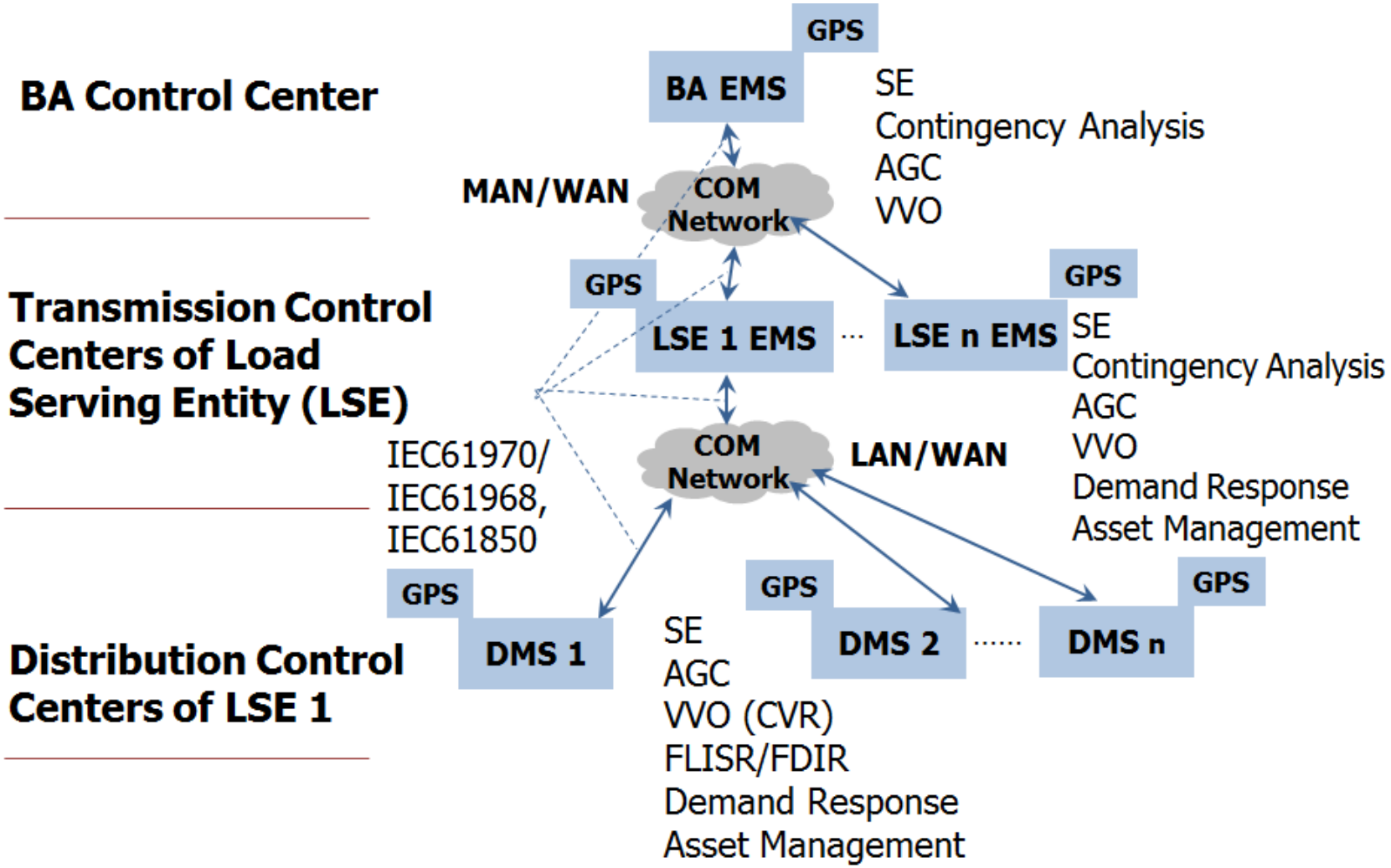
- Evolving Electric Grid
- IEEE PSRC WG K15
- Protection & Control (P&C) within a Substation
- Centralized Protection & Control (CPC) within a Substation
  - Architecture, Cost and Reliability
  - Comparison with Traditional System
  - Testing and Maintenance
- Demonstration Project
- Advanced, Emerging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

Evolving Electric Grid

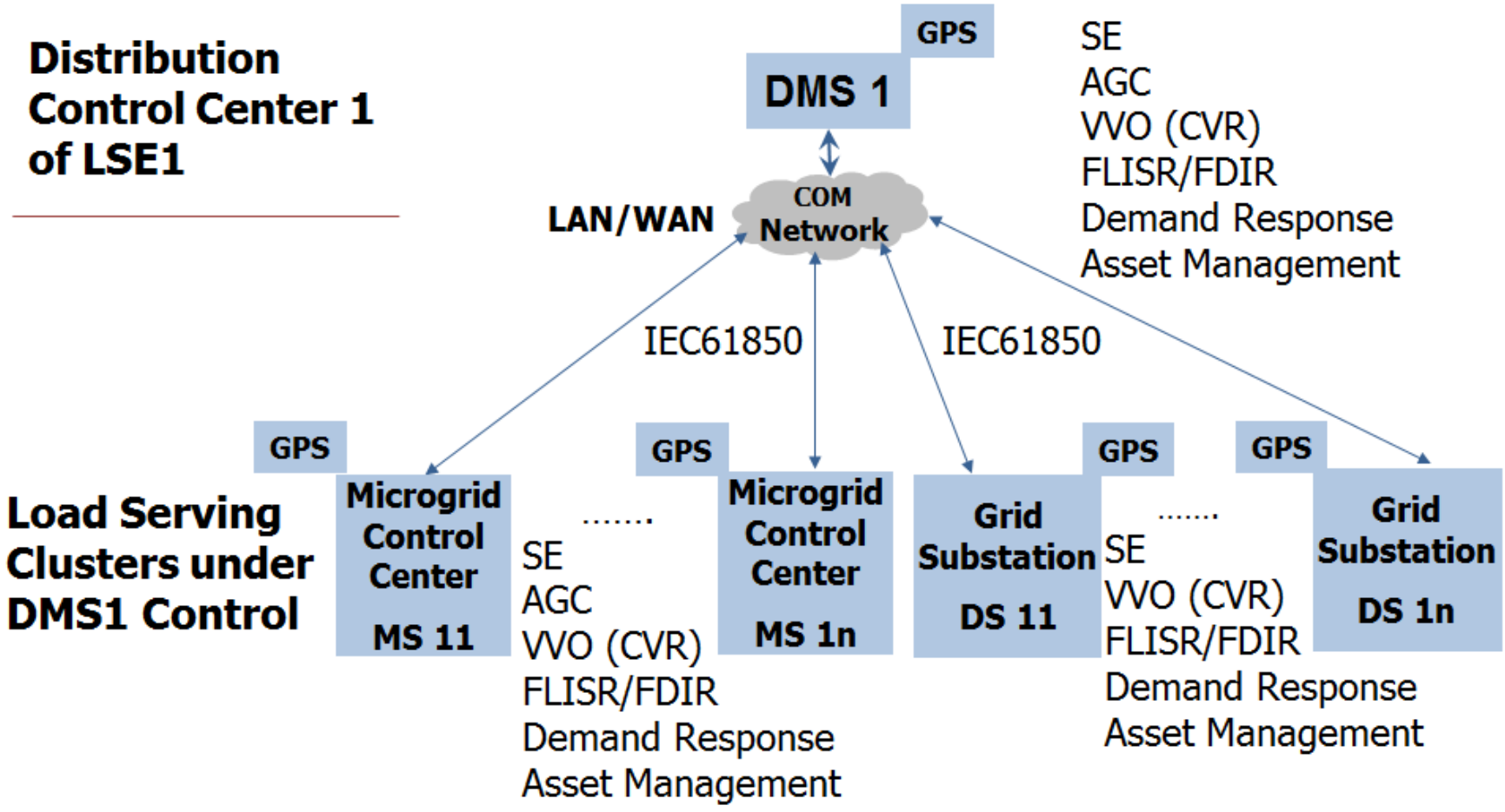
Power Plants | **Electric Grid** | **Customers**



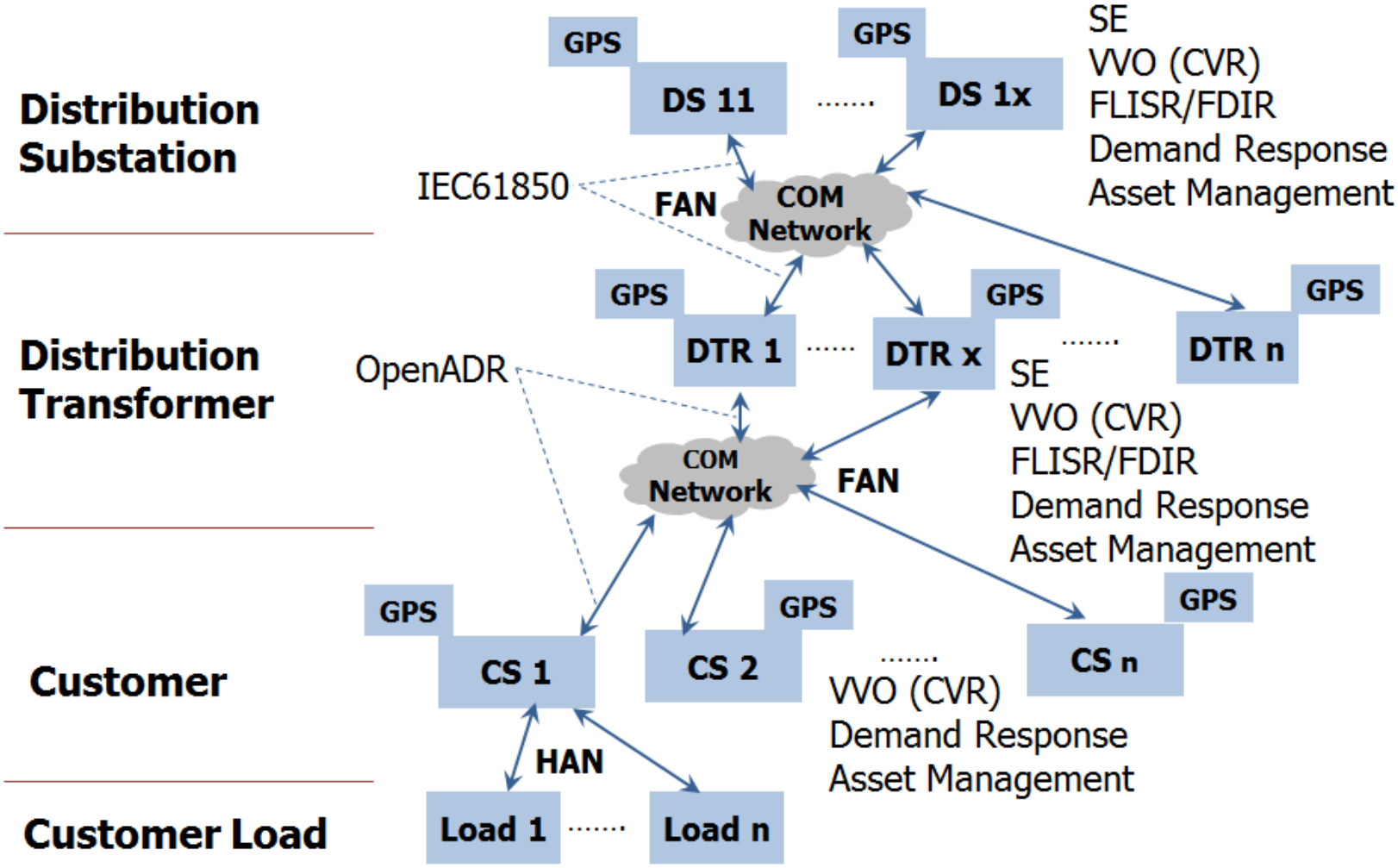
TIER-1: EMS to DMS



TIER-2: DMS to DSub & Microgrid CC



TIER-3: DSub to Customers

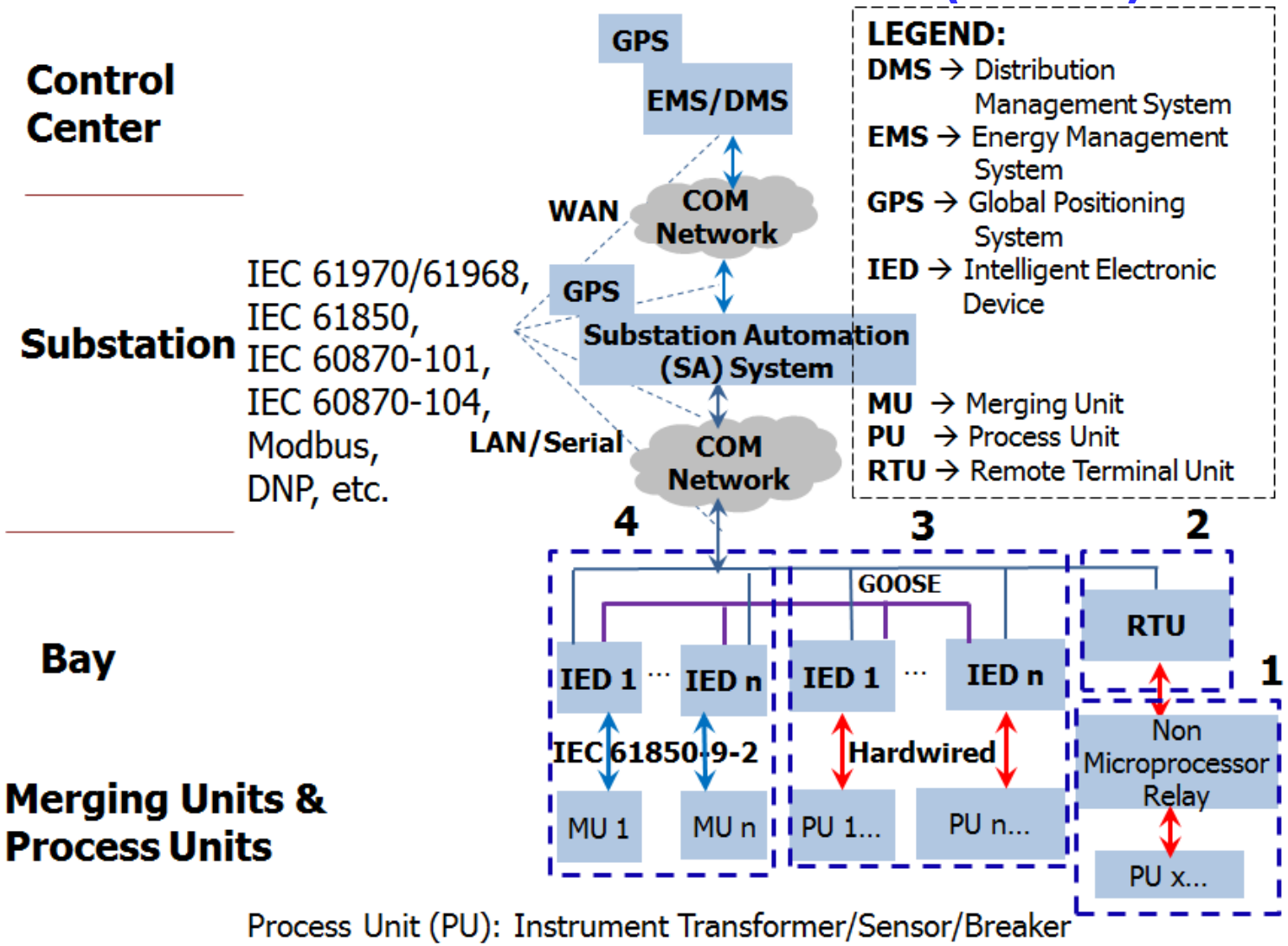


IEEE PSRC WG K15

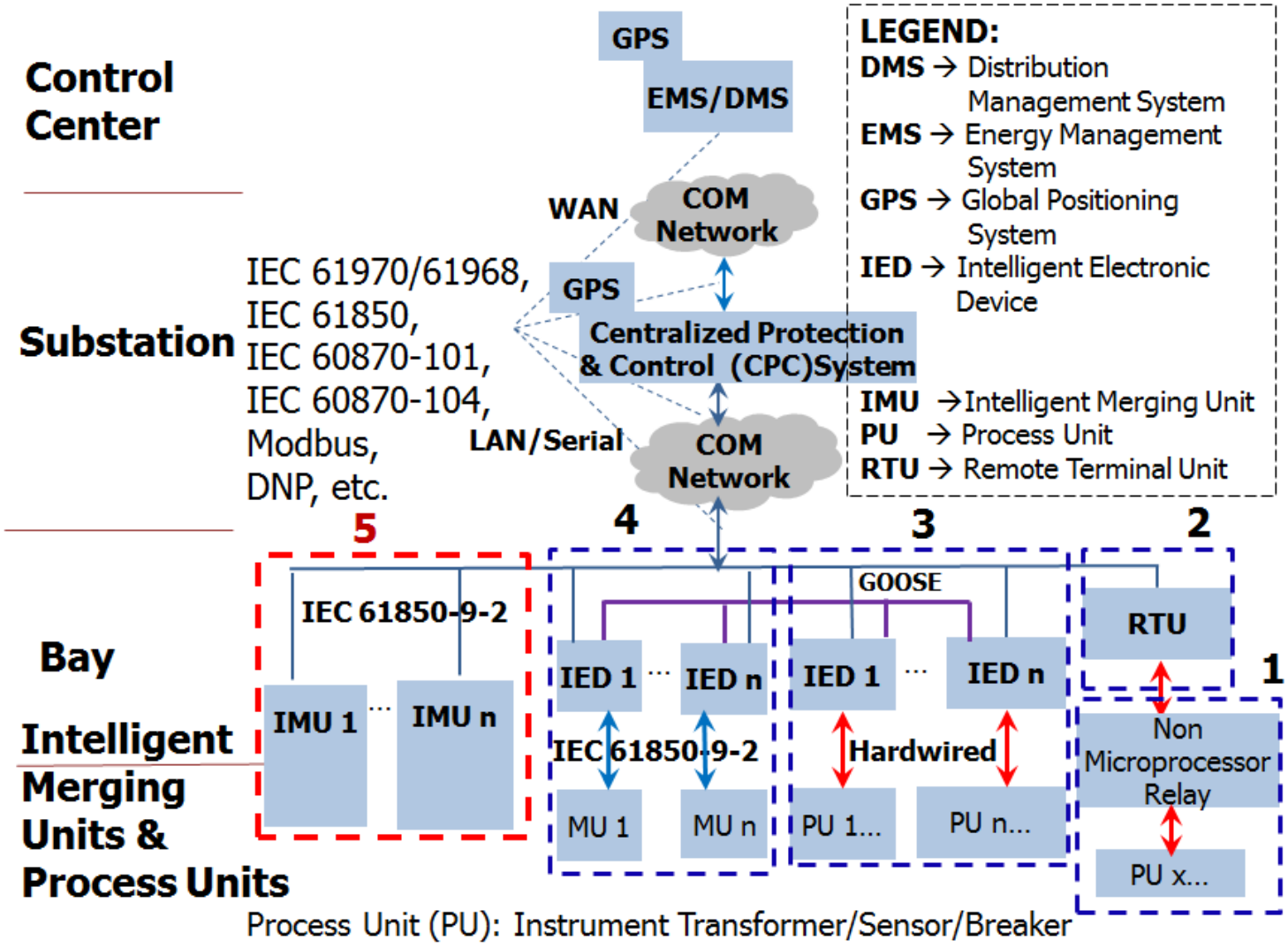
ASSIGNMENT:

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

Protection and Control (P&C)

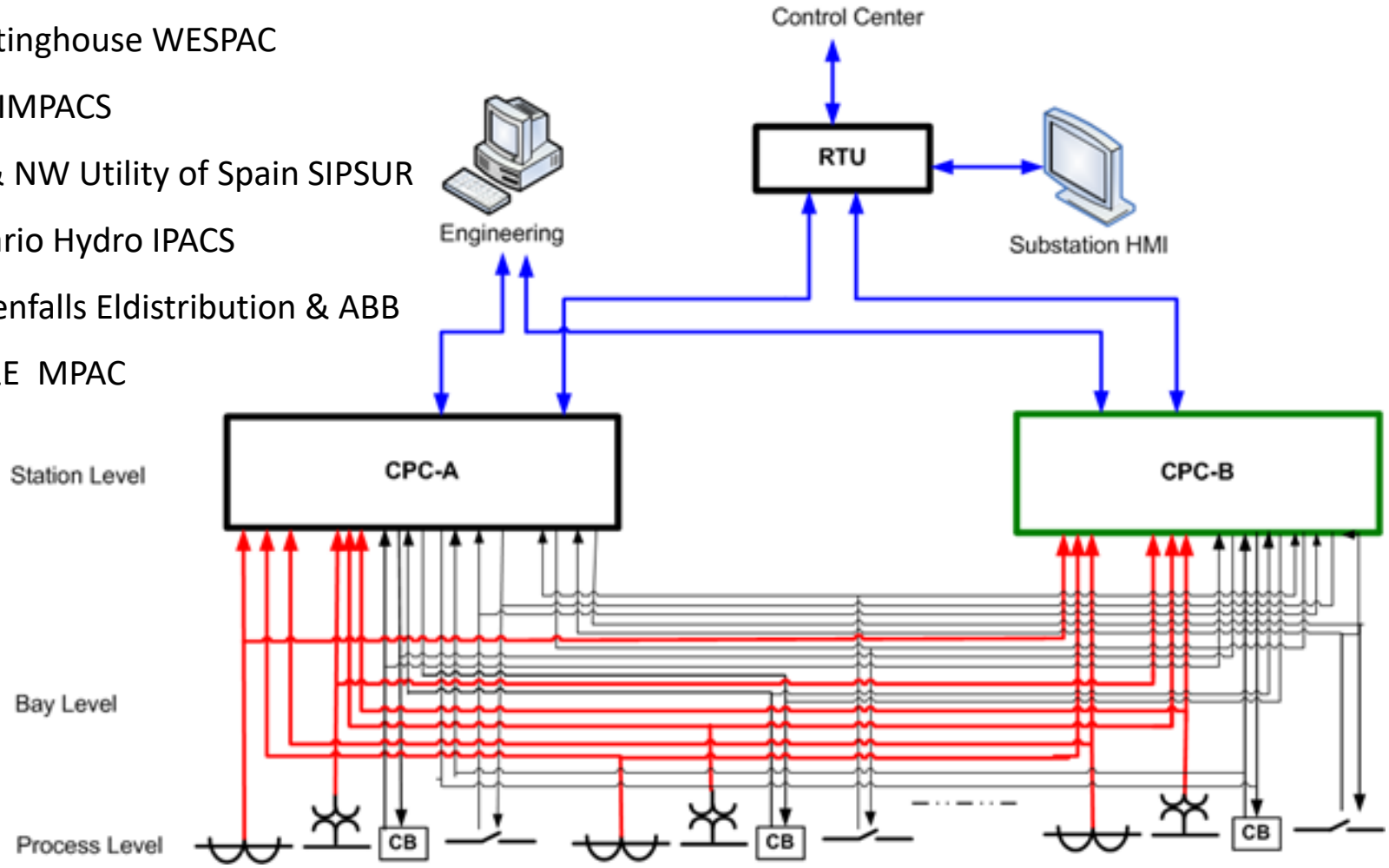


Centralized Protection and Control (CPC)

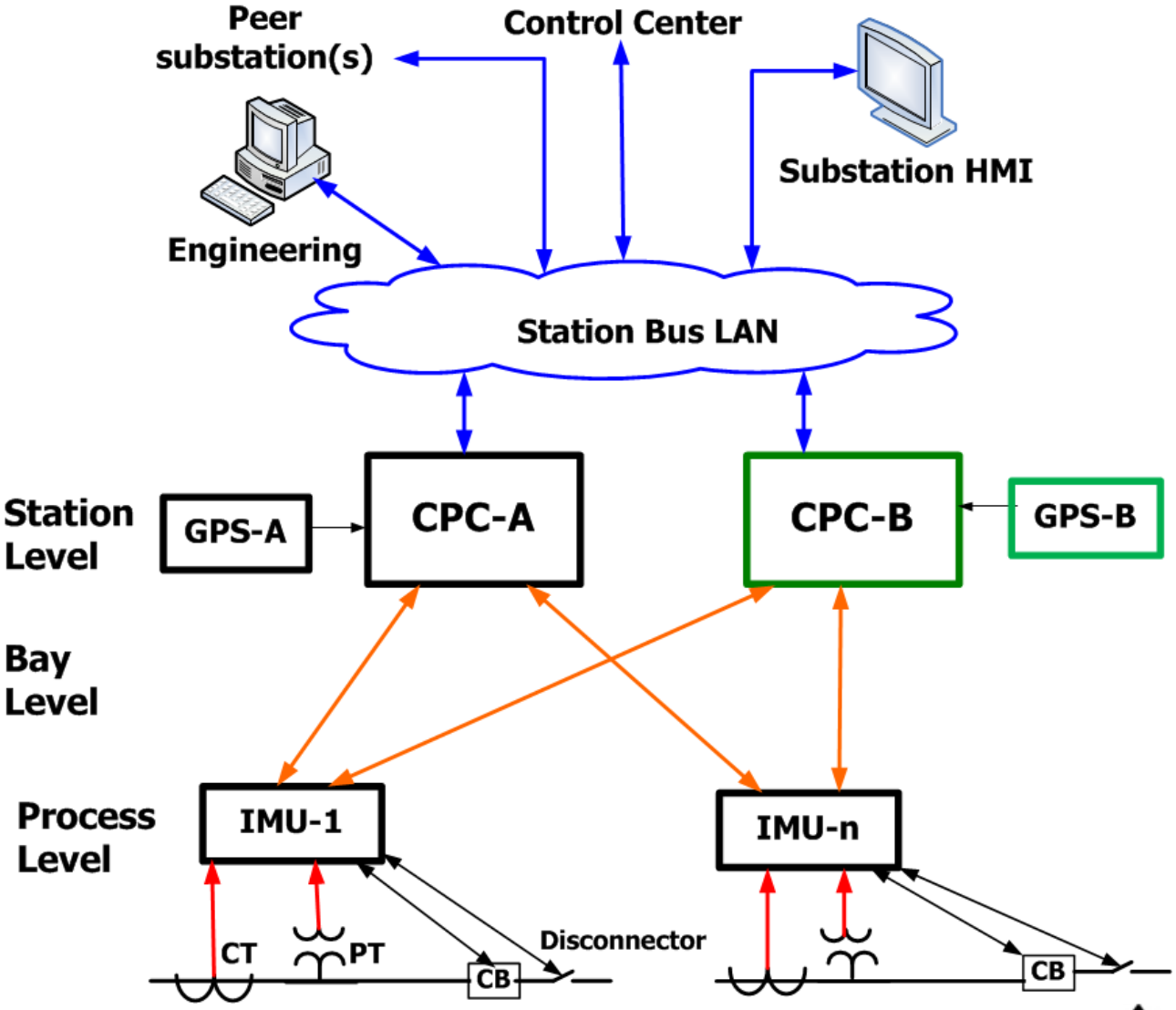


History of CPC

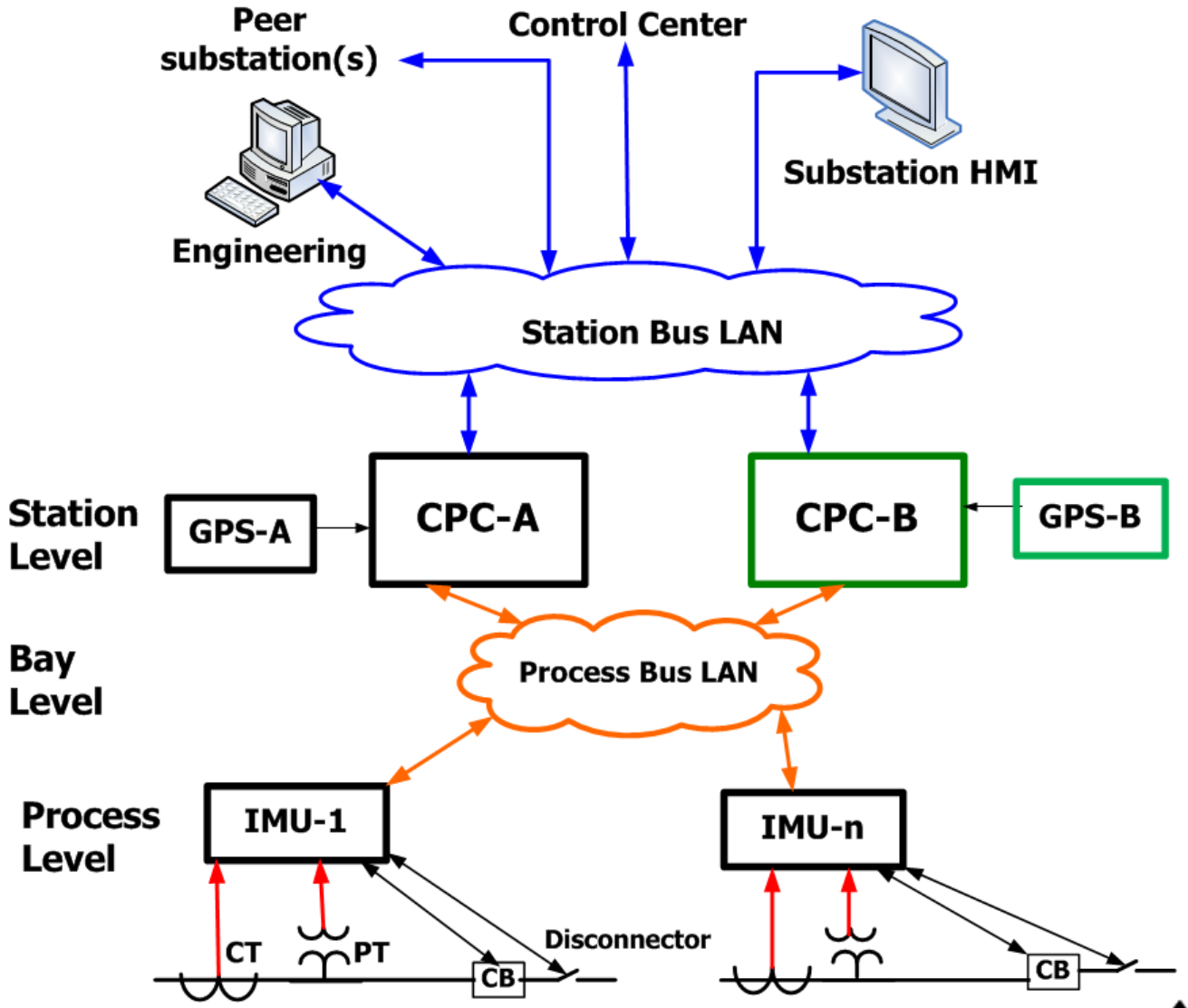
- 1980 Westinghouse WESPAC
- 1985 AEP IMPACS
- 1990 GE & NW Utility of Spain SIPSUR
- 1992 Ontario Hydro IPACS
- 2000 Vattenfalls Eldistribution & ABB
- 2003 PG&E MPAC



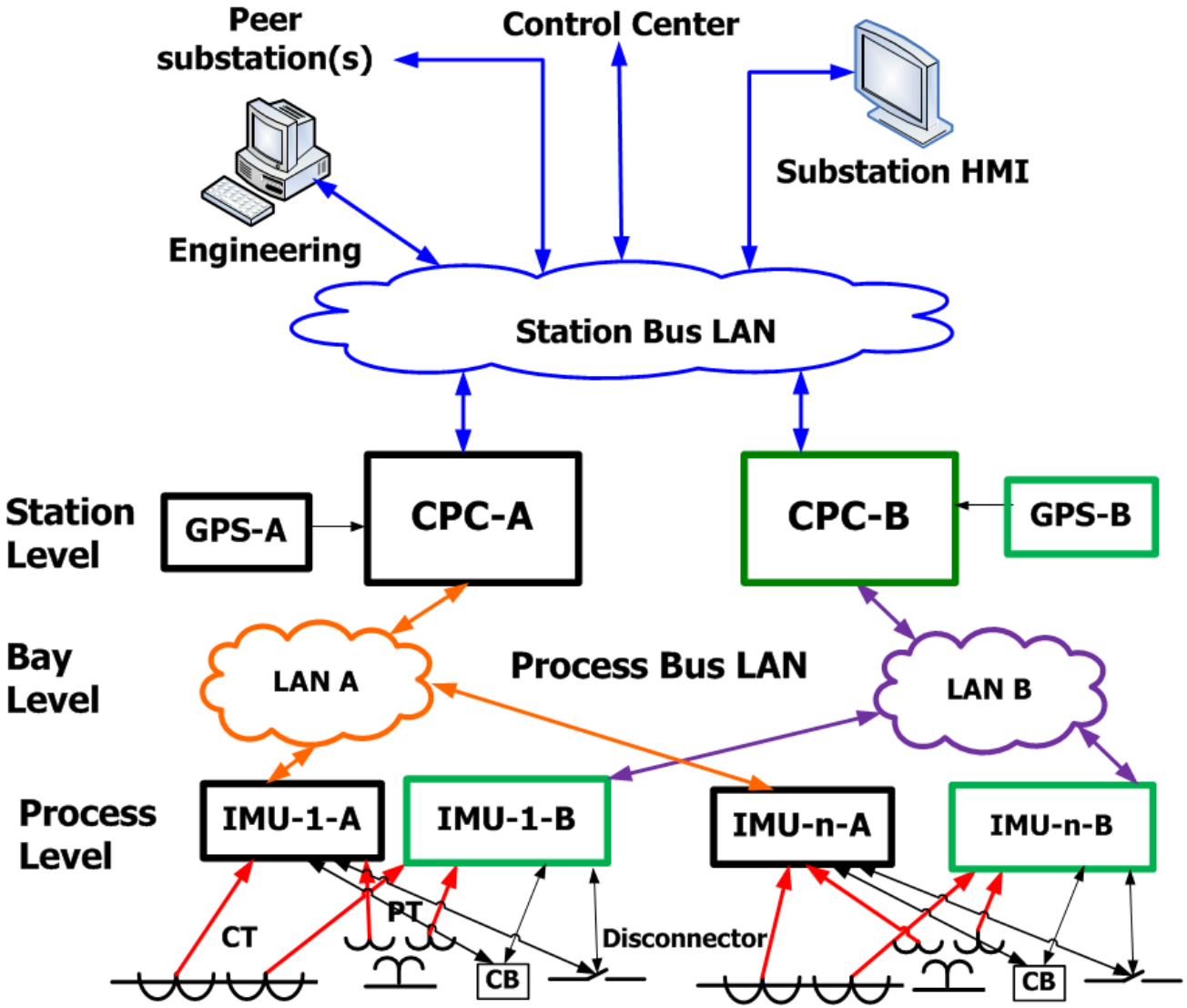
CPC Architecture 3



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

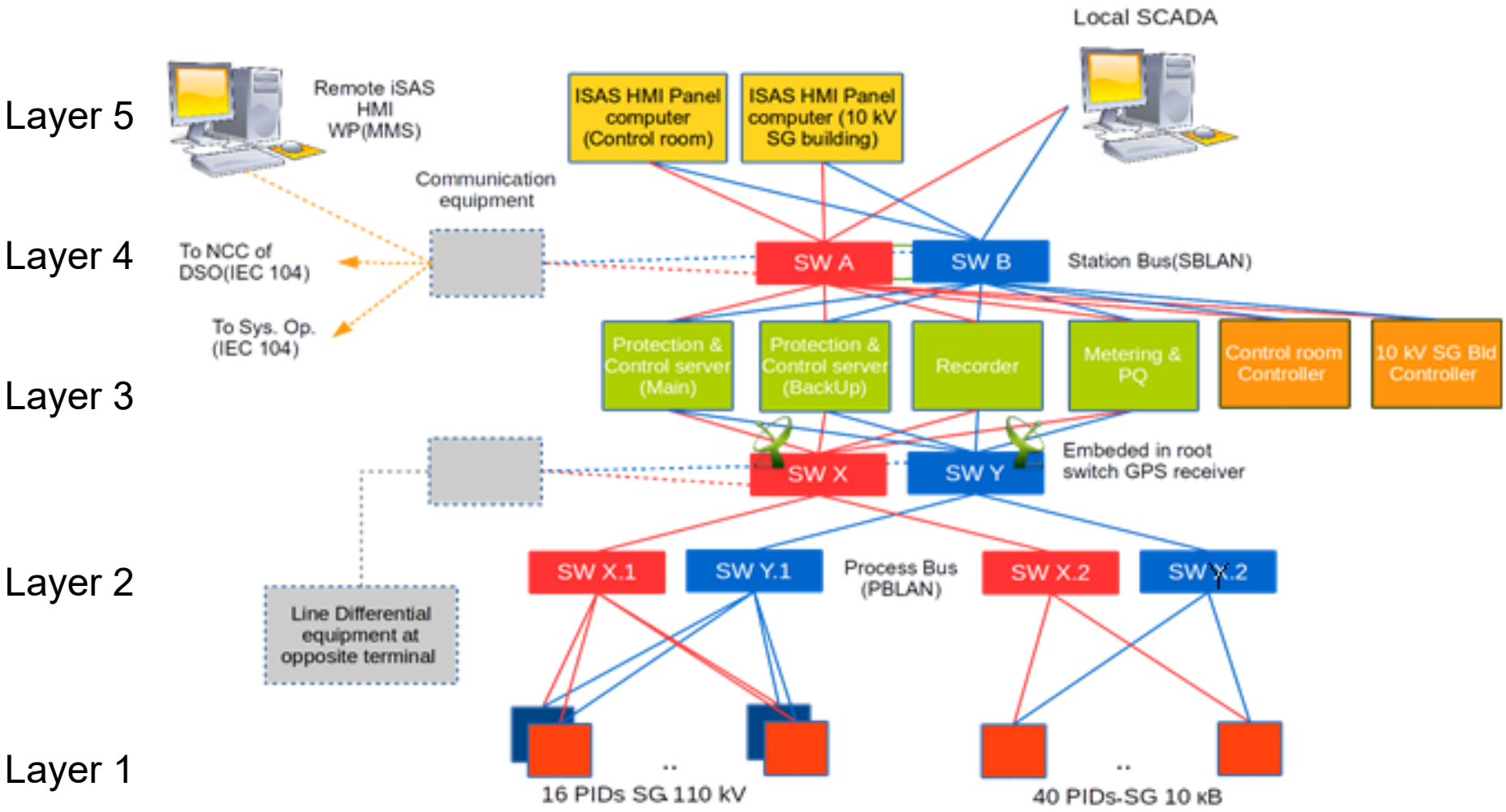
Feature	Traditional Approach	CPC Approach
Asset Mgmt	Many relays/devices	Limited number of devices
Device Mgmt	Many configuration tools	Less configuration tools
Maintenance	• Routine maintenance can be challenging • Per bay maintenance	• Less maintenance • Per bay maintenance is an avoidable challenge
Security	Multitude access points	Very limited number of access points
Interoperability	• 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



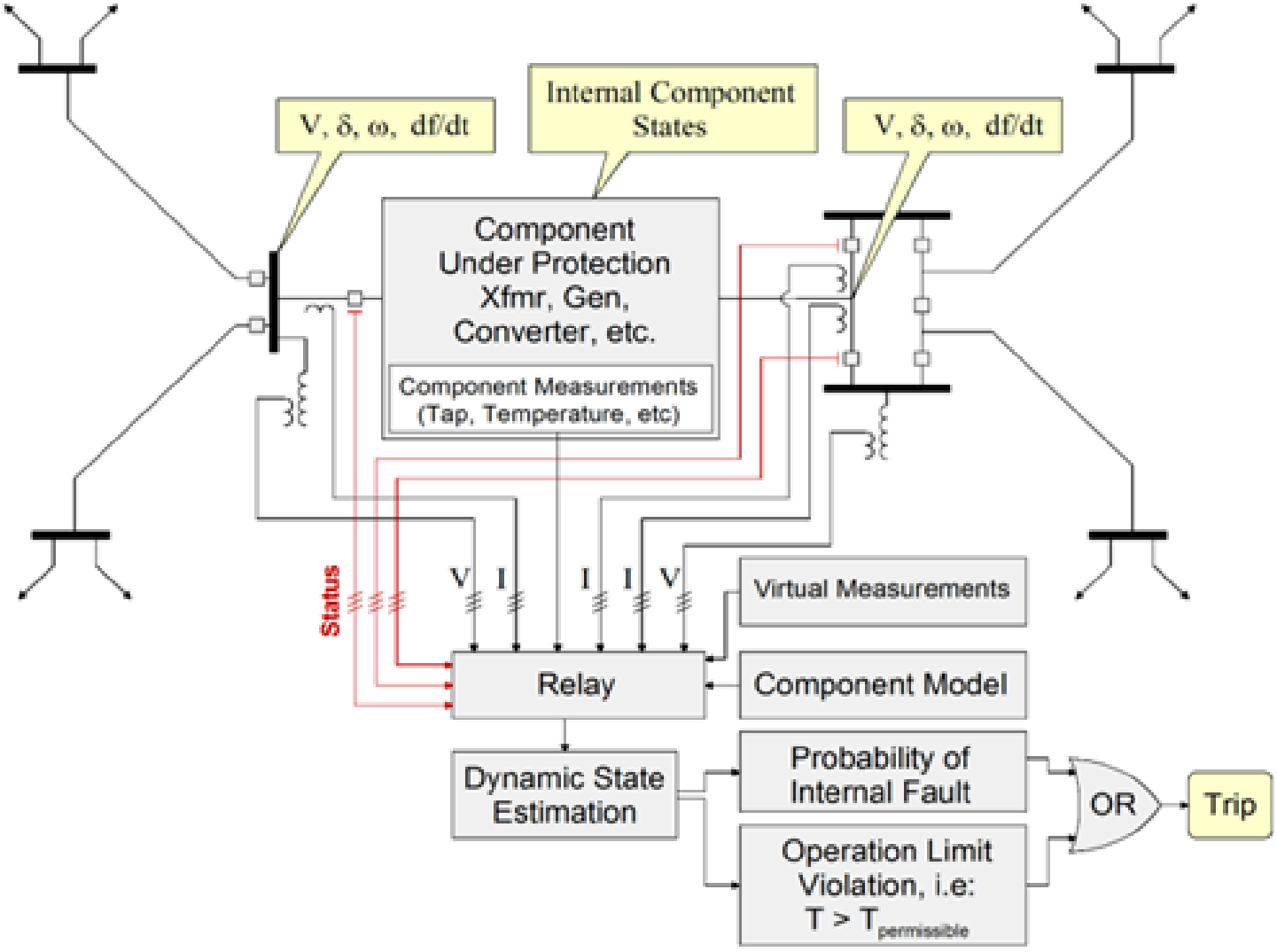
Advanced Applications

- 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

Ratan Das, Chair

Mital Kanabar, Vice Chair

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Mark Adamiak	Jack Jester	Yuri Luskind	Joshua Park
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Mohammad DadashZadeh	Raluca Lascu	Paul Myrda	Ilia Voloh
Rich Hunt	Yuan Liao	Anderson Oliveira	Joe Xavier

Further Reading

- Working Group on Centralized Substation Protection and Control, IEEE Power System Relaying Committee, “Advancements in Centralized Protection and Control within a Substation”, in Proc. IEEE Trans. on Power Delivery, Vol. 31, No. 4, pp. 1945-1952, August 2016.
- Working Group K15 on Centralized Substation Protection and Control, IEEE Power System Relaying Committee, “Looking into the Future Protection, Automation and Control Systems”, in Proc. 70th Annual Georgia Tech Protective Relaying Conference, April 20-22, 2016.
- “Centralized Substation Protection and Control,” IEEE Power System Relaying Committee WG K15 Report, Dec. 2015. [Online]. Available: http://www.pes-psrc.org/Reports/IEEE_PES_PSRC_WG%20K15_Report_CPC_Dec_2015.pdf