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Implementation of a Security-Dependability Adaptive Voting Scheme

Ryan Quint - quintr@vt.edu
Noah Badayos - nbadayos@vt.edu
David Mazur - dmazur@vt.edu

ciee California Institute for Energy and Environment

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

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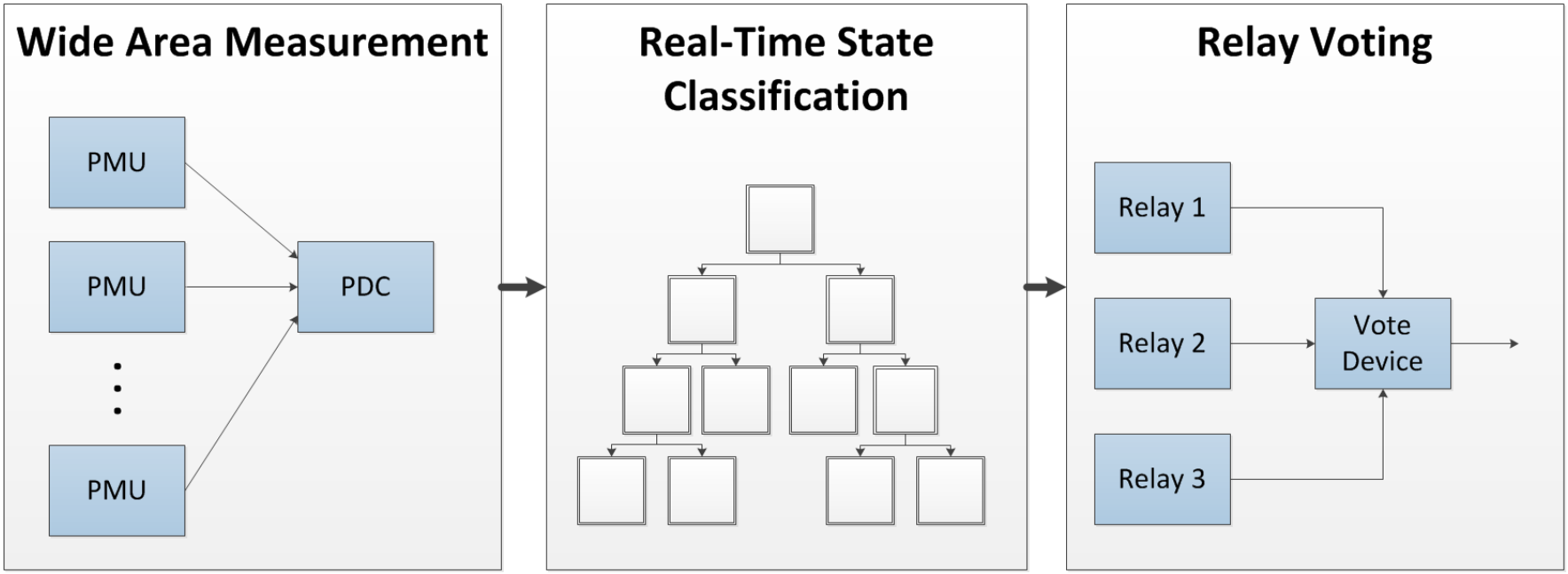
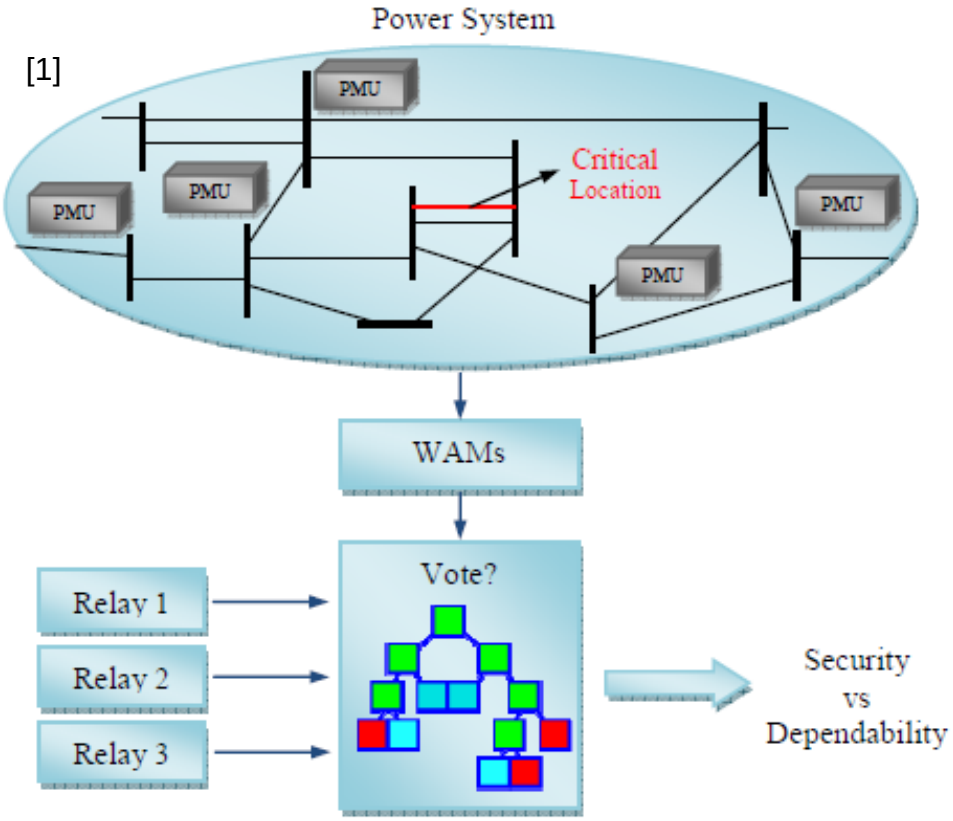
Data Mining Theory to Application



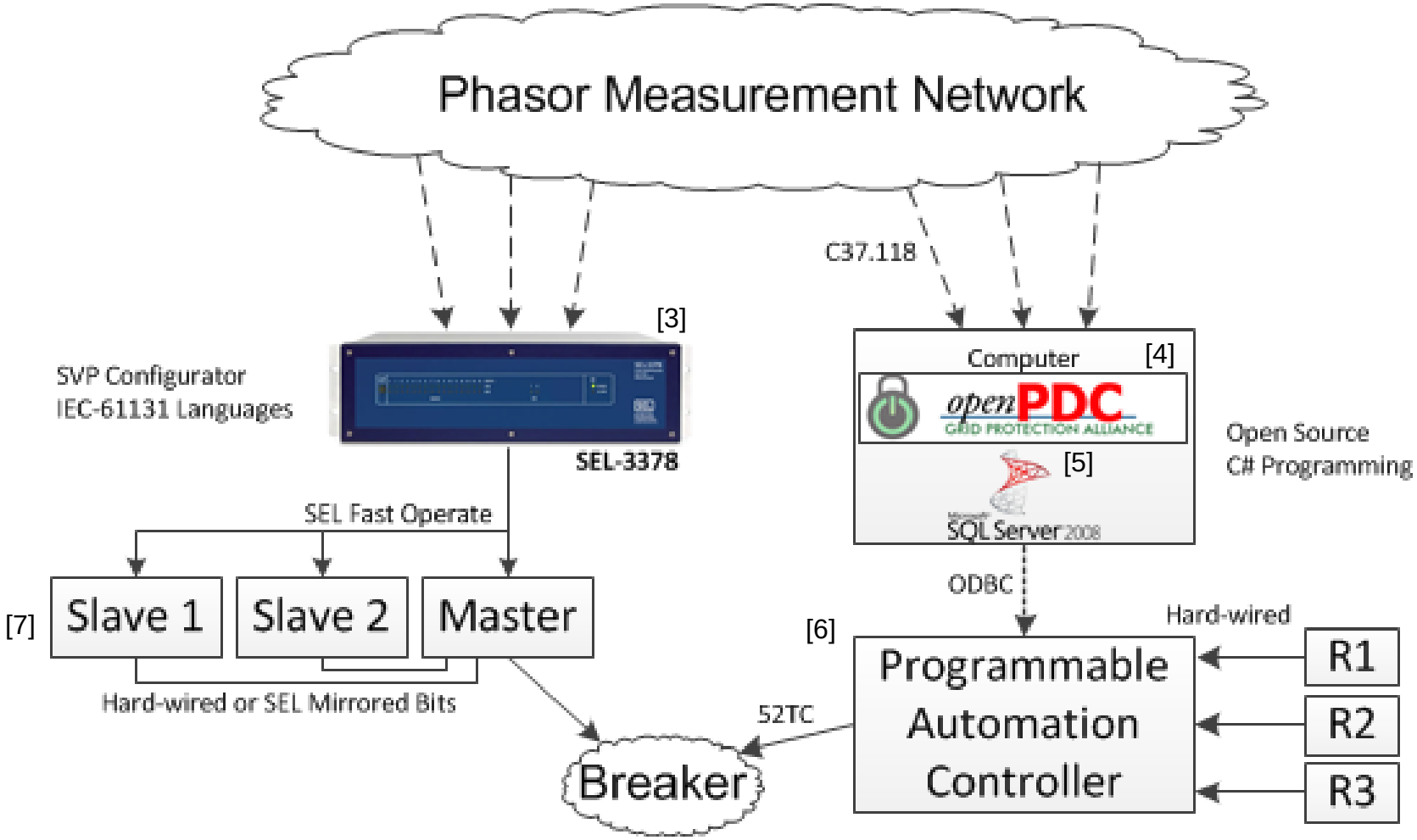
Adaptive Relaying: *The ability to modify, update, or change the settings of a protection scheme.*

Application of Voting Scheme

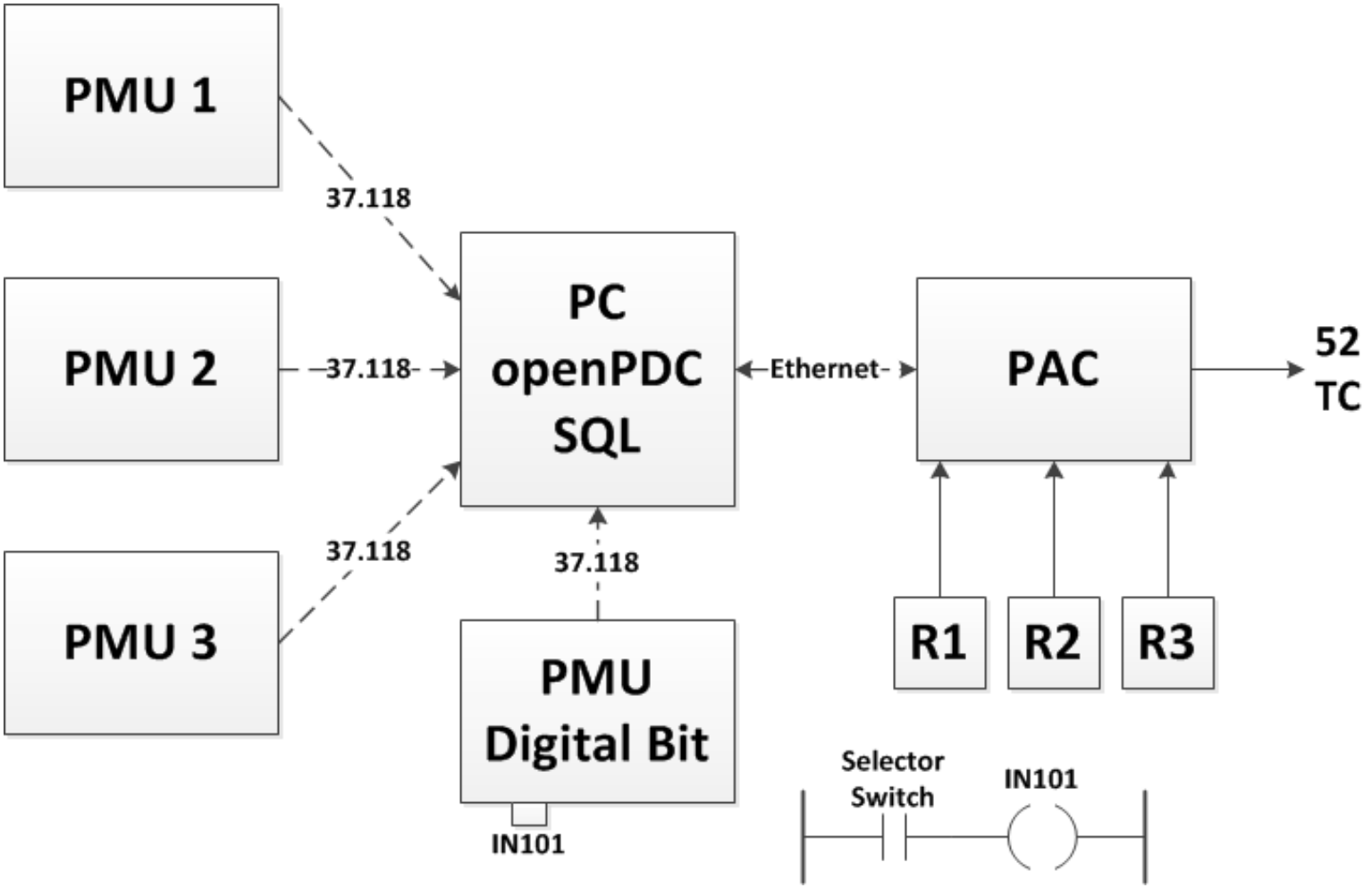


- What is system state?
  - Safe
  - Stressed
- "Stressed"?
  - Increase Security
  - Relays Vote
- "Safe"?
  - Increase Dependability
  - Normal tripping of CB

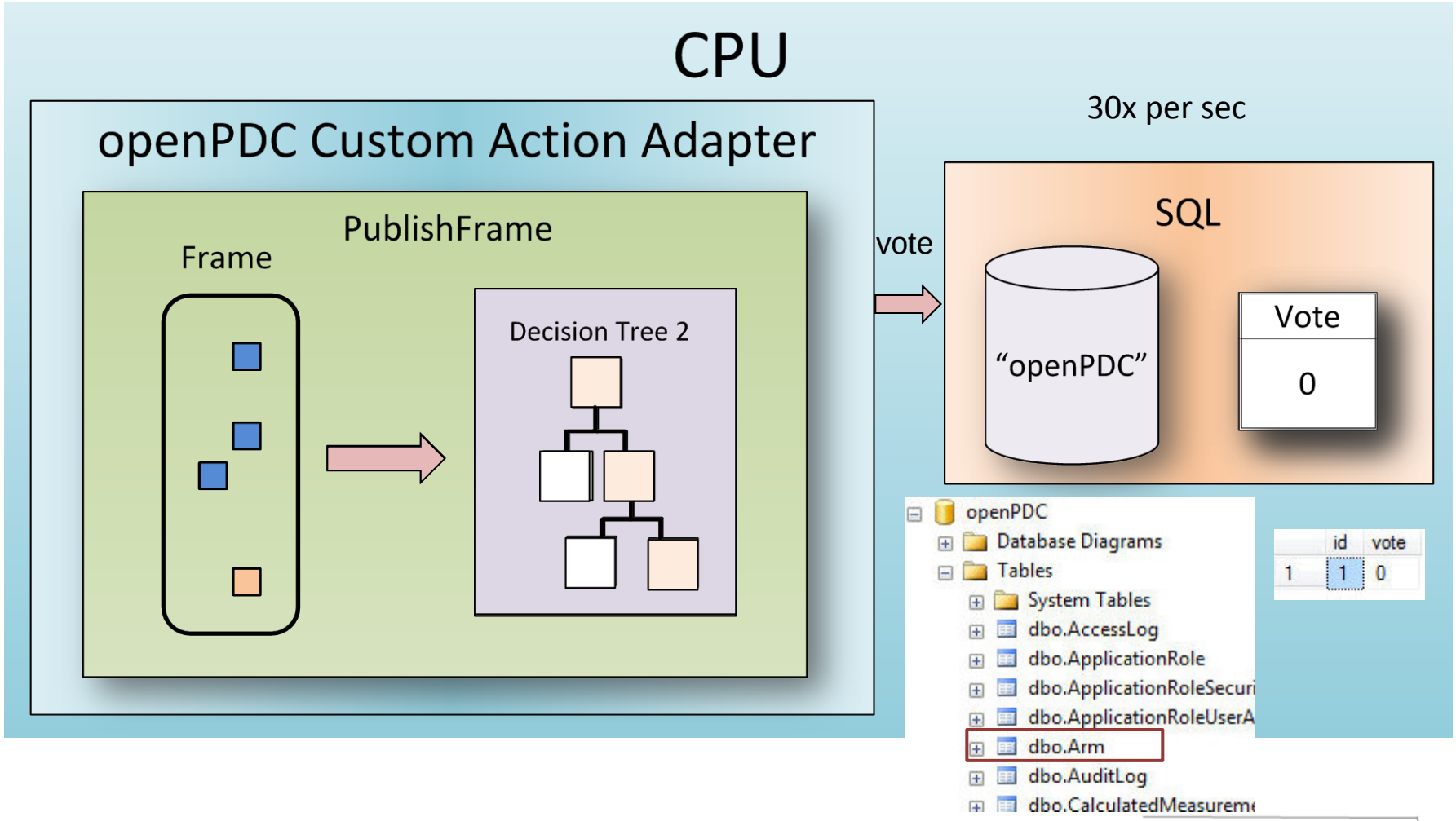
Implementations Explored



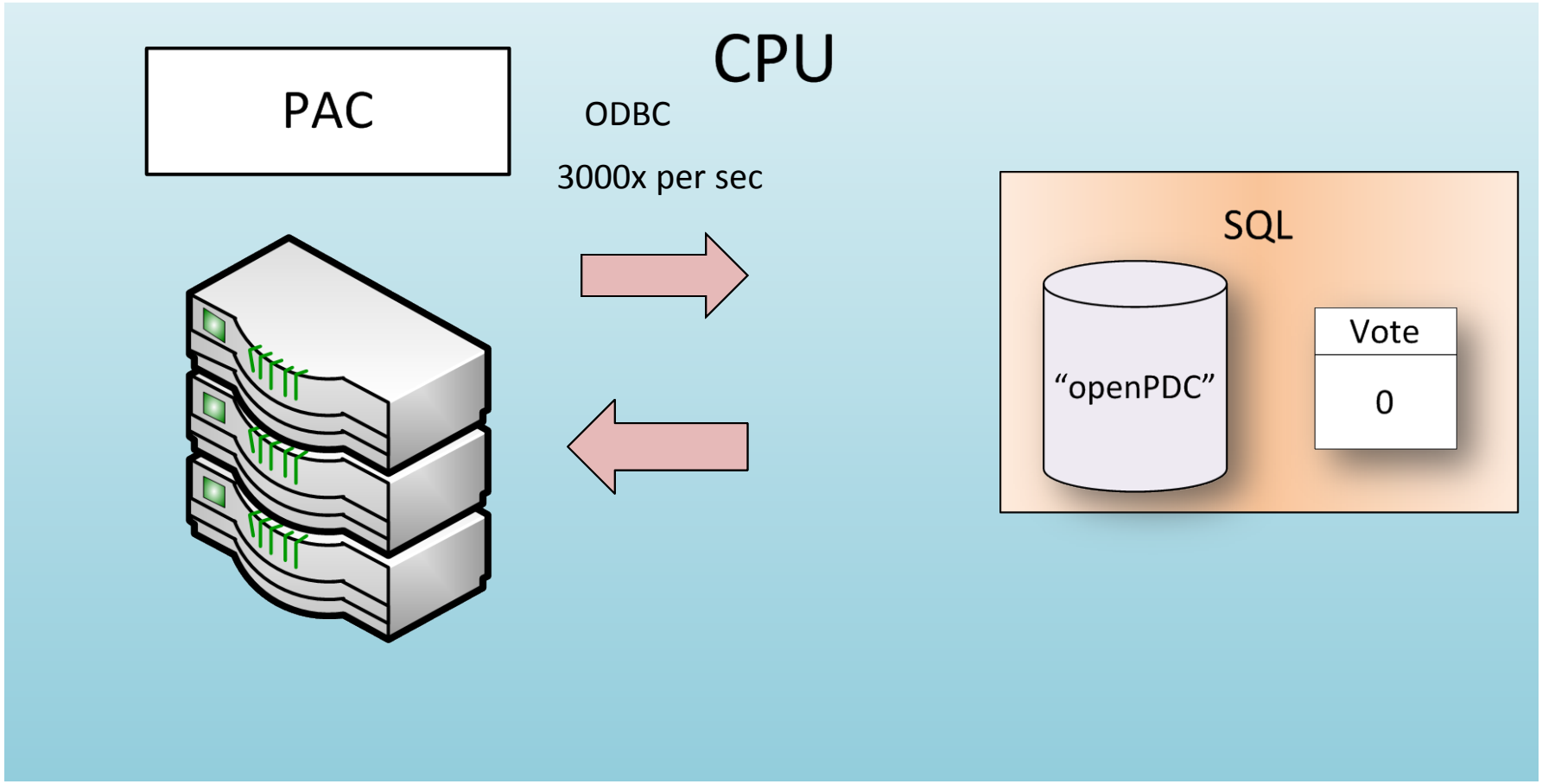
openPDC Configuration



Connection of openPDC and SQL

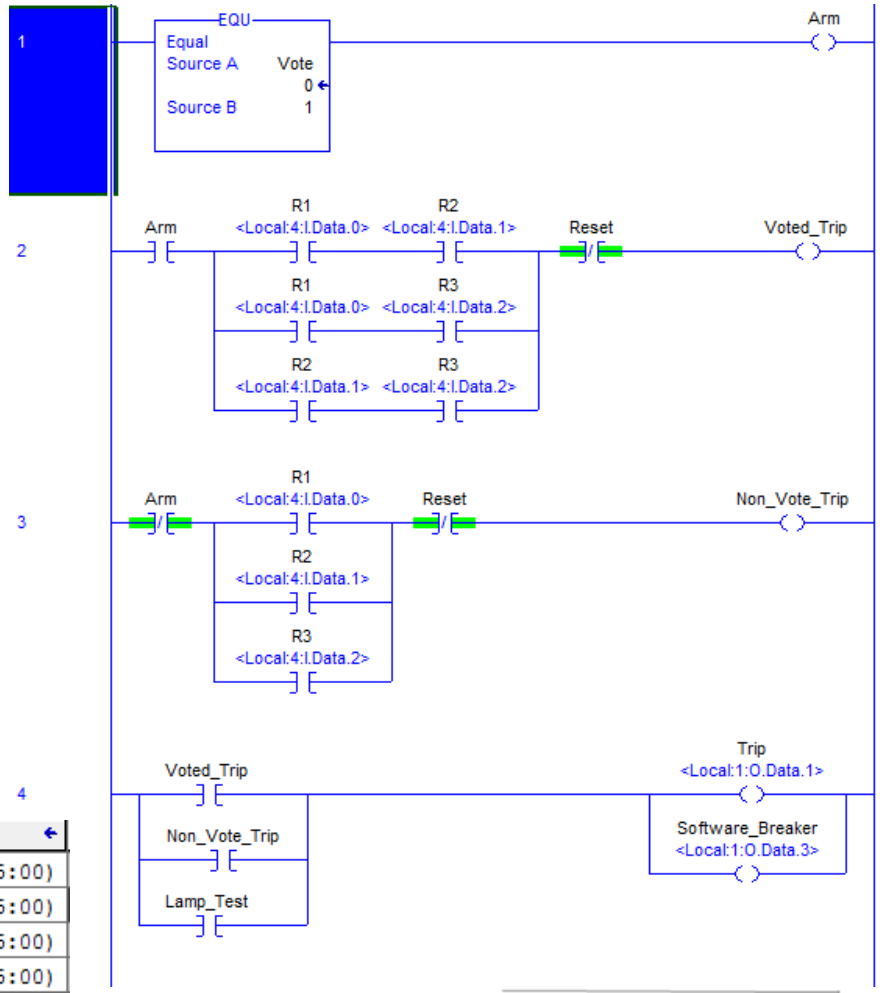


Connection of SQL and PAC



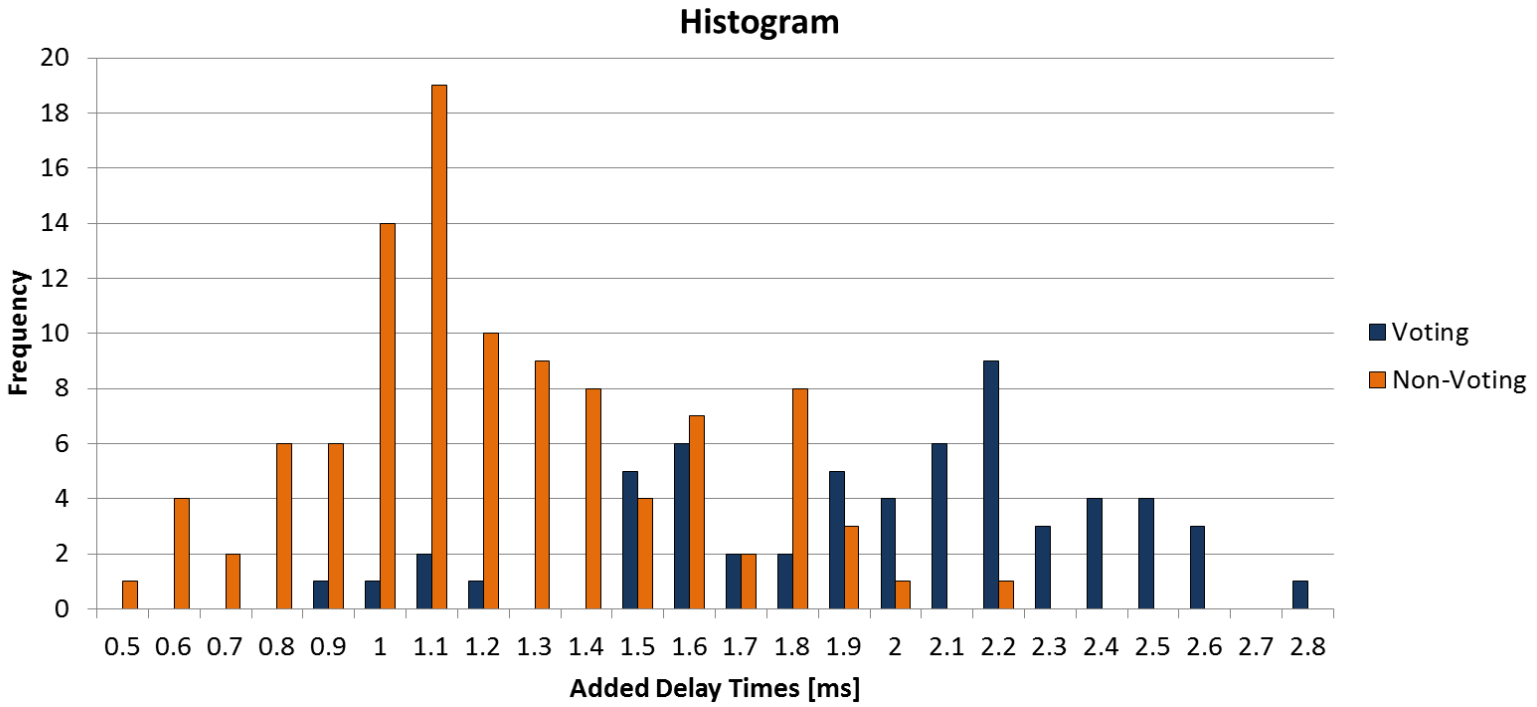
Automation Controller Voting

- Asynchronous
- Ladder Logic programming
- Software updates to relay logic, i.e. voting
- Centralized stamping of data
  - Relay trips
  - Output



Name	Value
Breaker_Full_UTC	DT#1969-12-31-19:00:00.000000(GMT-05:00)
R1_Full_UTC	DT#1969-12-31-19:00:00.000000(GMT-05:00)
R2_Full_UTC	DT#1969-12-31-19:00:00.000000(GMT-05:00)
R3_Full_UTC	DT#1969-12-31-19:00:00.000000(GMT-05:00)

PAC Performance



PAC Delay Non-Voting [ms]	
Mean	1.187324
Median	1.101
Mode	1
Standard Deviation	0.358331
Minimum	0.32
Maximum	2.199

PAC Delay Voting [ms]	
Mean	1.9561
Median	2.01925
Mode	2.2
Standard Deviation	0.457734
Minimum	0.875
Maximum	3.1755

Conclusions

- Decision Trees implemented in PDC
  - Hardware: SEL-3378
  - Software: openPDC/SQL Server
- Voting Logic implemented
  - Master-Slave relay configuration
    - No added delay, relay config changed
  - Automation controller voting device
    - ≤ 3.18 ms PAC delay, no relay changes

References

[1] Bernabeu, E., *Methodology for a Security-Dependability Adaptive Protection Scheme based on Data Mining*, in ECE, 2009, Virginia Polytechnic Institute and State University: Blacksburg.

[2] Horowitz, S.H., and A.G. Phadke, Power System Relaying, 3rd ed., Chichester, England: Wiley/Research Studies , 2008.

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[4] openPDC, http://openpdc.codeplex.com/.

[5] Microsoft Corporation, Microsoft SQL Server, 2011, http://www.microsoft.com/sqlserver/en/us/default.aspx.

[6] Rockwell Automation, ControlLogix 1756 System, http://www.ab.com/en/epub/catalogs/12762/2181376/2416247/360807/360809/.

[7] Thomas, M.K., Implementation of the Security-Dependability Adaptive Voting Scheme, in ECE, 2011, Virginia Polytechnic Institute and State University: Blacksburg