In-field testing and Validation of Synchrophasor based Remedial Action Scheme (RAS)

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Outline

1. Remedial Action Scheme
2. Need for in field RAS testing
3. Erkios
4. Cyber Physical Testbed to Test RAS
5. Erkios Test Simulation Result
6. Summary

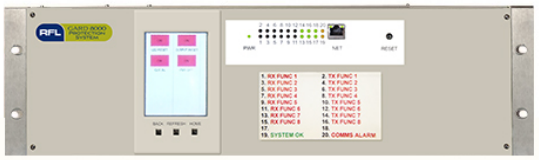
Remedial Action Schemes (RAS)

- Definition of Remedial Action Schemes (RAS)

  strong control action
  minimize the impact of contingencies
  prime objective is operational reliability

- List of control actions which can be called as RAS

  line tripping, load shedding, generator tripping, capacitor or reactor switching, system separation, tap changer control, turbine valve control, dynamic braking



Remedial Action Schemes (RAS)

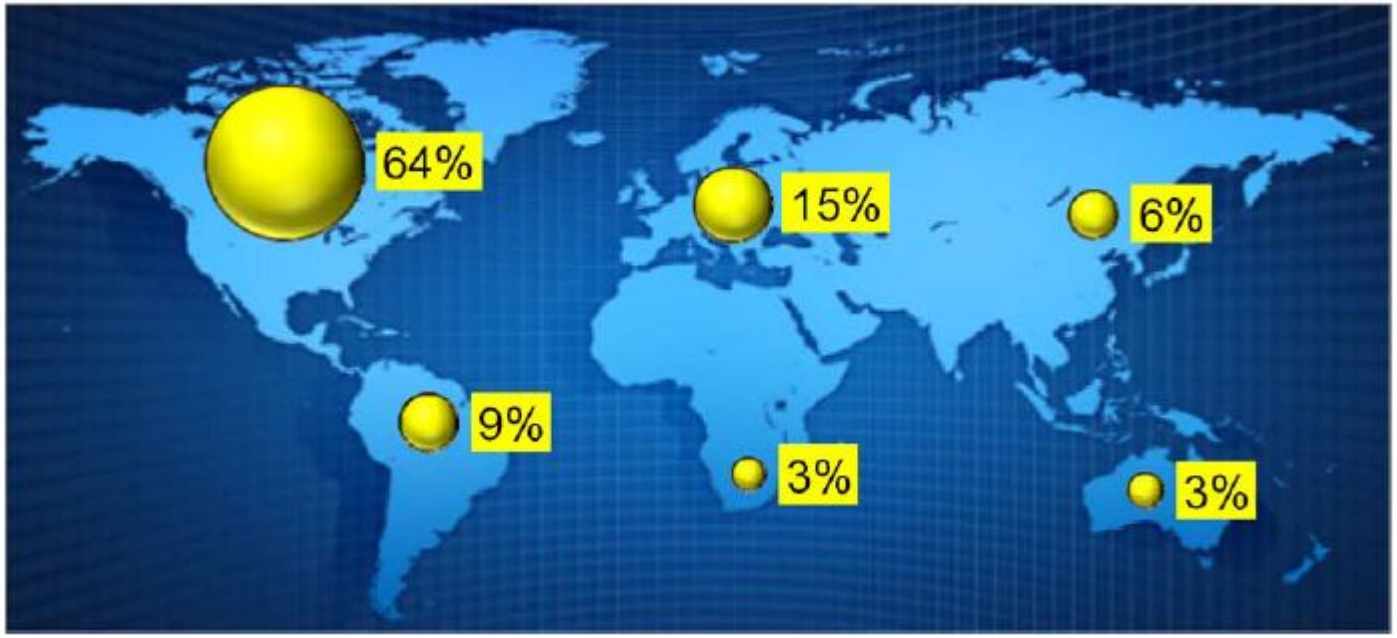
- Classification of RAS

  a) Event based
  b) Parameter based
  c) Response based

- Features of a RAS Testbed

  a) Maximum Allowable Time
  b) Communication Channels
  c) Cyber Security
  d) Redundancy

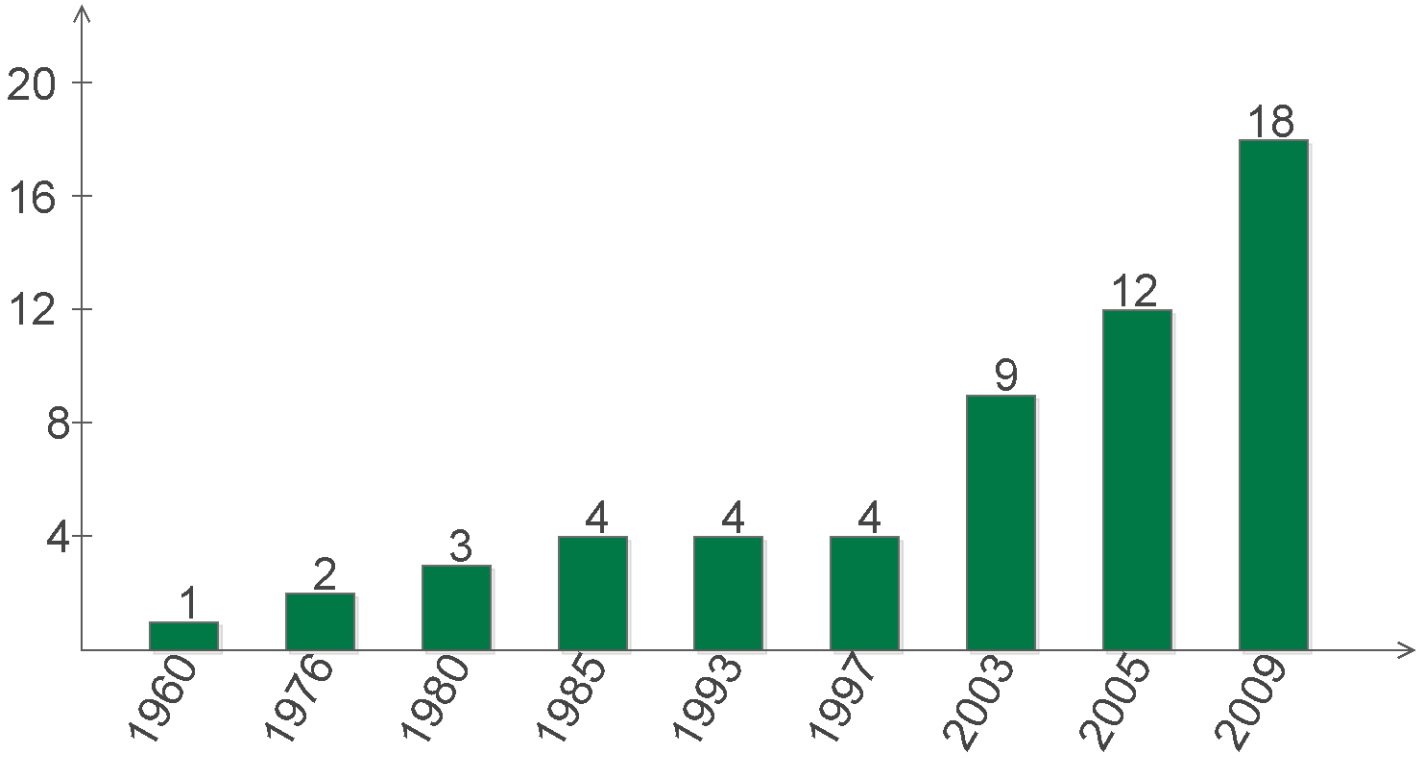
Remedial Action Schemes (RAS)



Installed RAS schemes continent wise

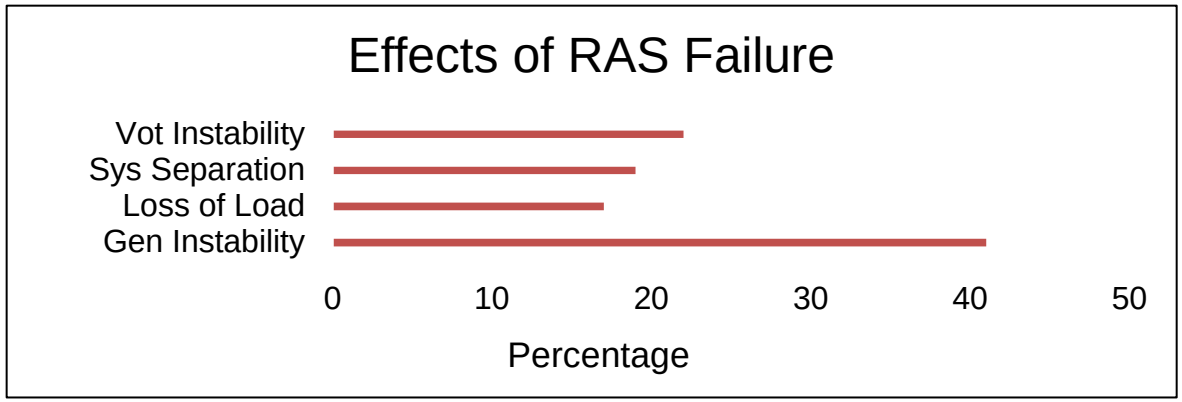
Courtesy: Madani, V.; Novosel, D.; Horowitz, S.; Adamiak, M.; Amantegui, J.; Karlsson, D.; Imai, S.; Apostolov, A., "IEEE PSRC Report on Global Industry Experiences With System Integrity Protection Schemes (SIPS)," *Power Delivery, IEEE Transactions on* , vol.25, no.4, pp.2143,2155, Oct. 2010

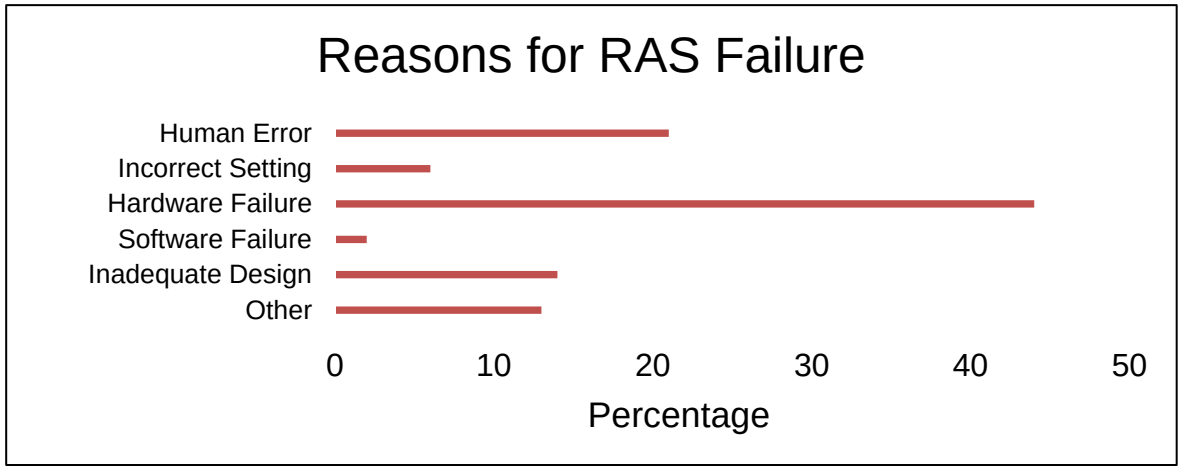
RAS Deployed in WECC



Courtesy: M. Vaiman, P. Hines, J. Jiang, S. Norris, M. Papic, A. Pitto, Y. Wang, and G. Zweigle. Mitigation and prevention of cascading outages: Methodologies and practical applications. In Power and Energy Society General Meeting (PES), 2013

Need for RAS Testing

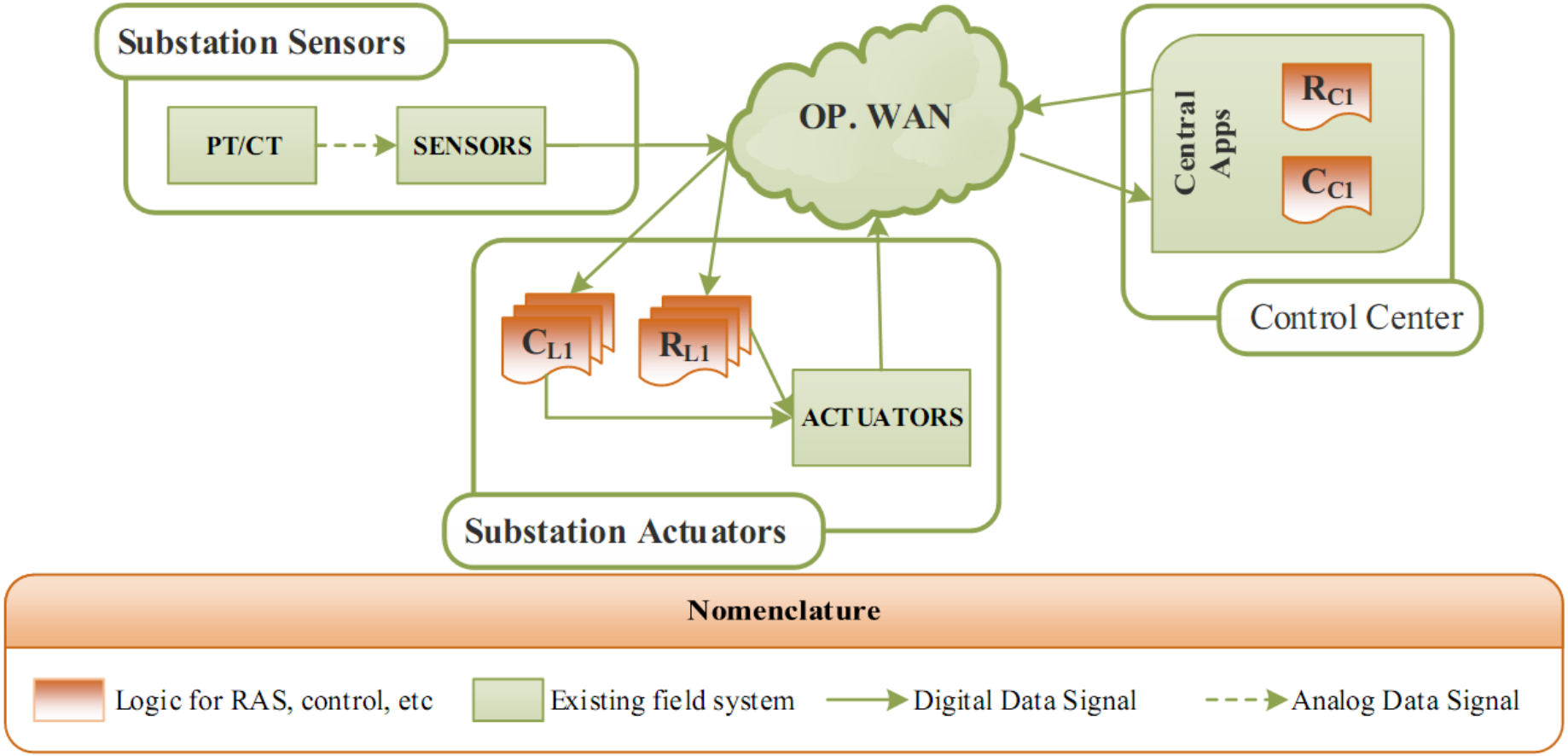




Courtesy: Anderson, P.M.; LeReverend, B.K., "Industry experience with special protection schemes, " *Power Systems, IEEE Transactions on* , vol.11, no.3, pp.1166,1179, Aug 1996

RAS STRUCTURE

The operation and flow of control in RAS is shown in the structure below,



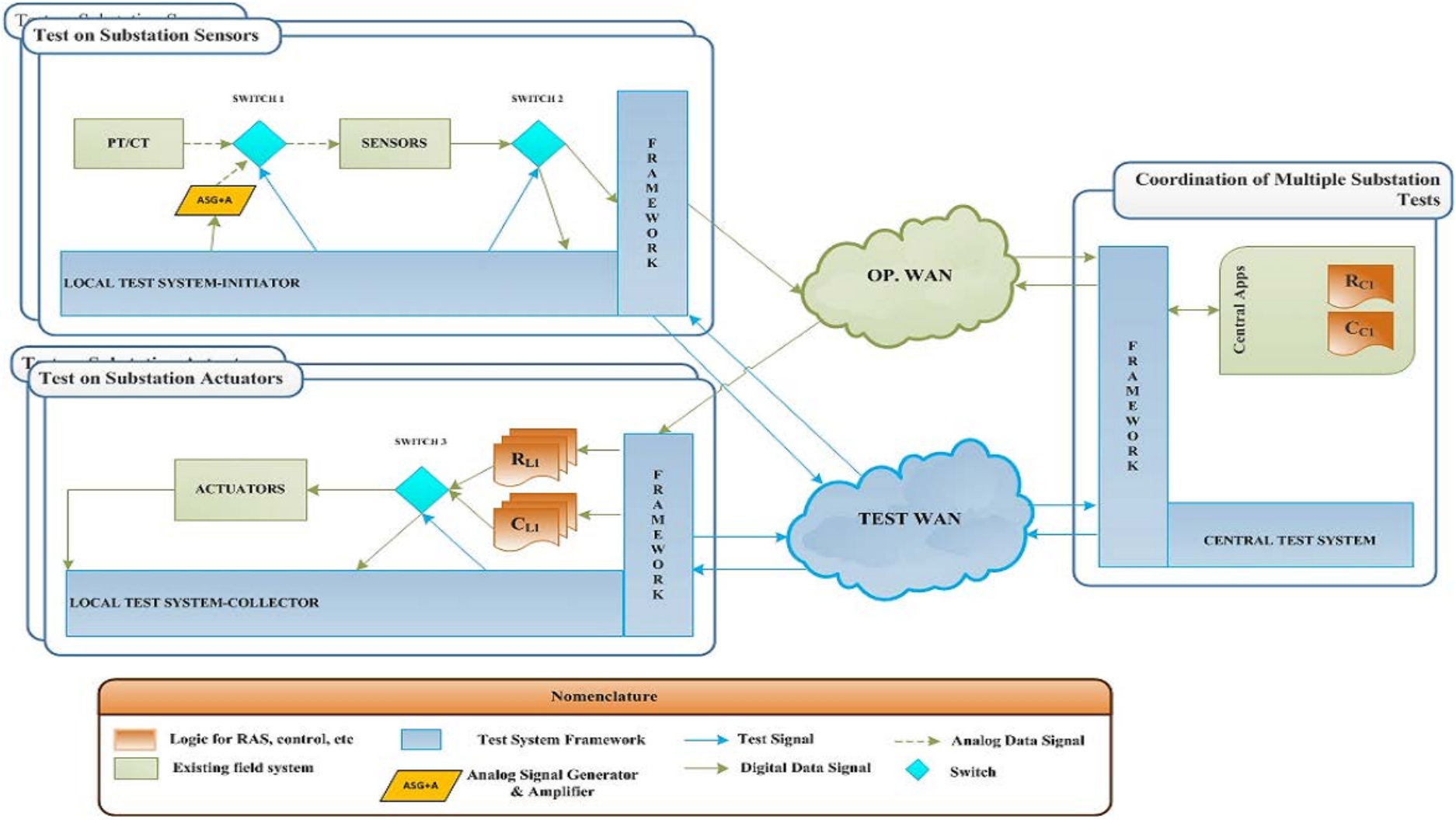
Erkios

- A fault tolerant middleware framework that facilitates in-field or remote testing of RAS.
- Erkios is designed to test and validate RAS that are already commissioned in the field.
- The fault tolerant features are implemented in Erkios using:

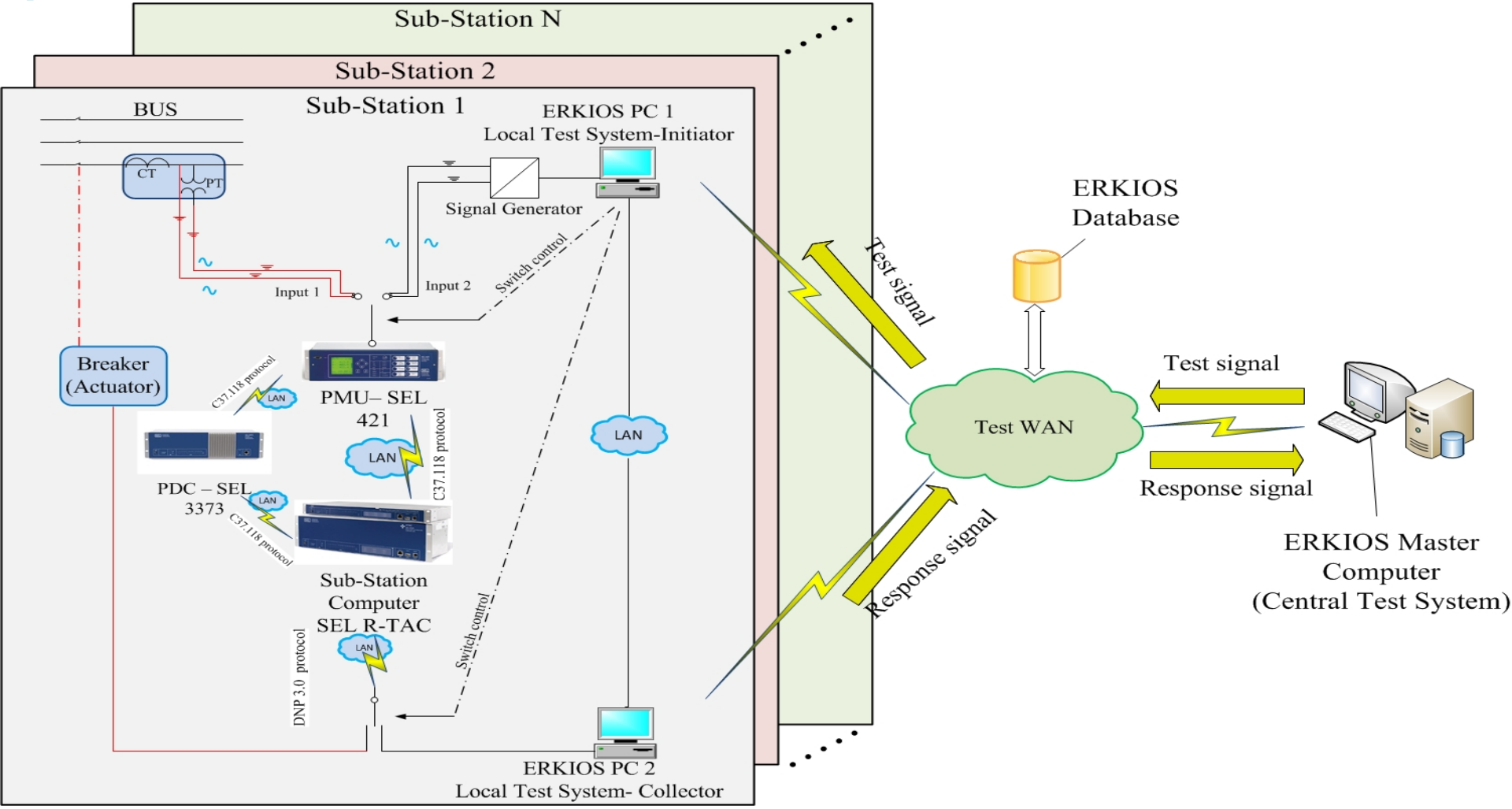
  1. Timeout
  2. Heartbeat
  3. Self-Testing

Erkios

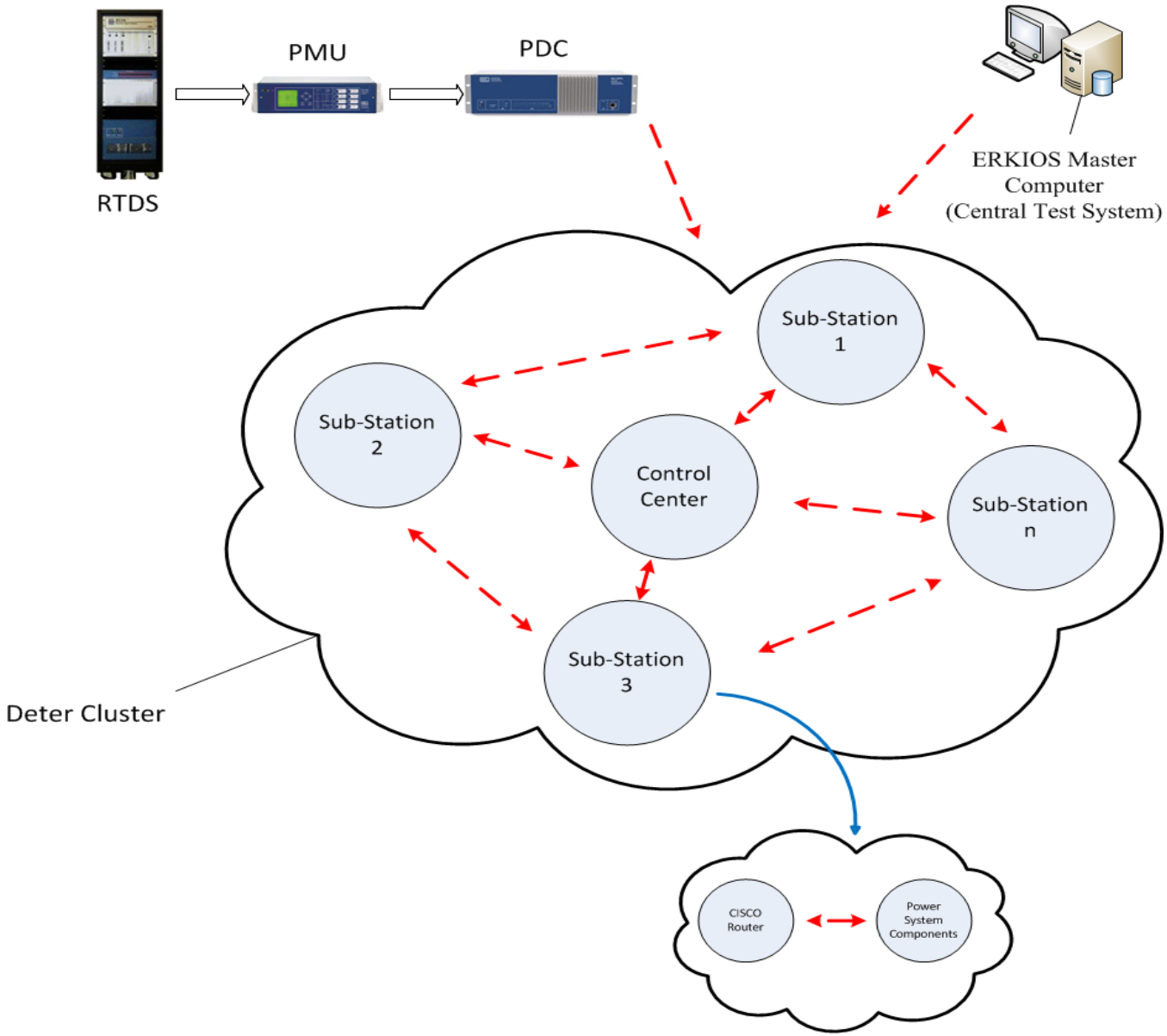
Implementing Erkios to perform End-to-End RAS testing.



Cyber Physical Testbed to Test RAS

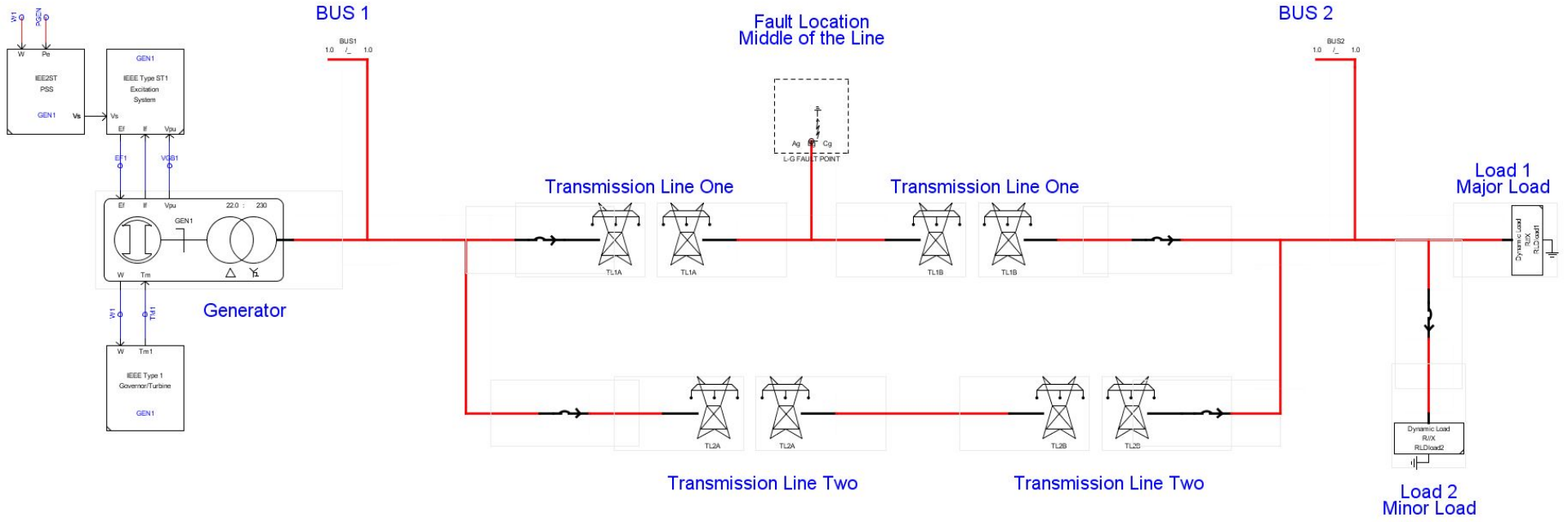


Cyber Physical Testbed to Test RAS

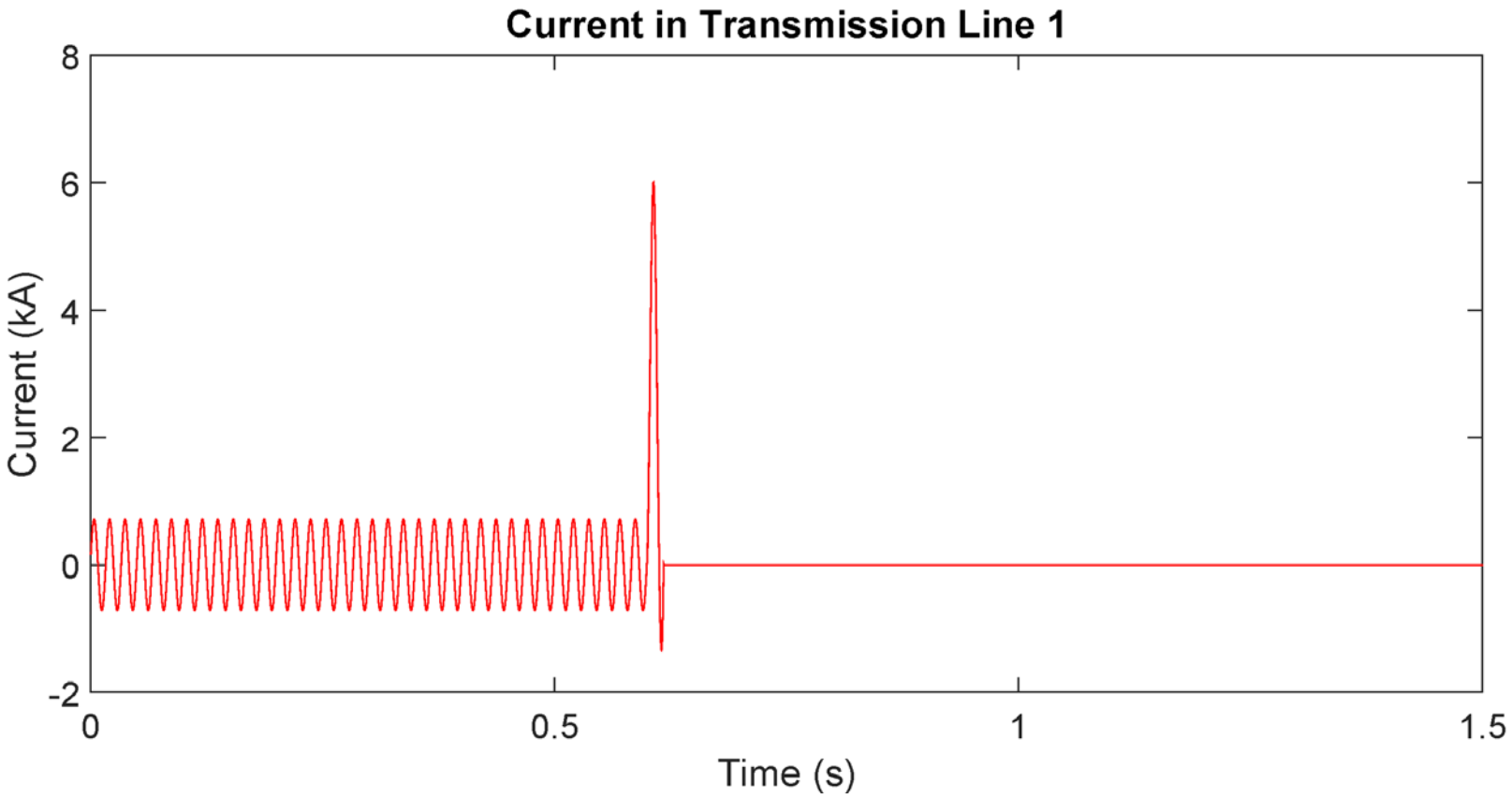


Simulation to Test Integrated Testbed

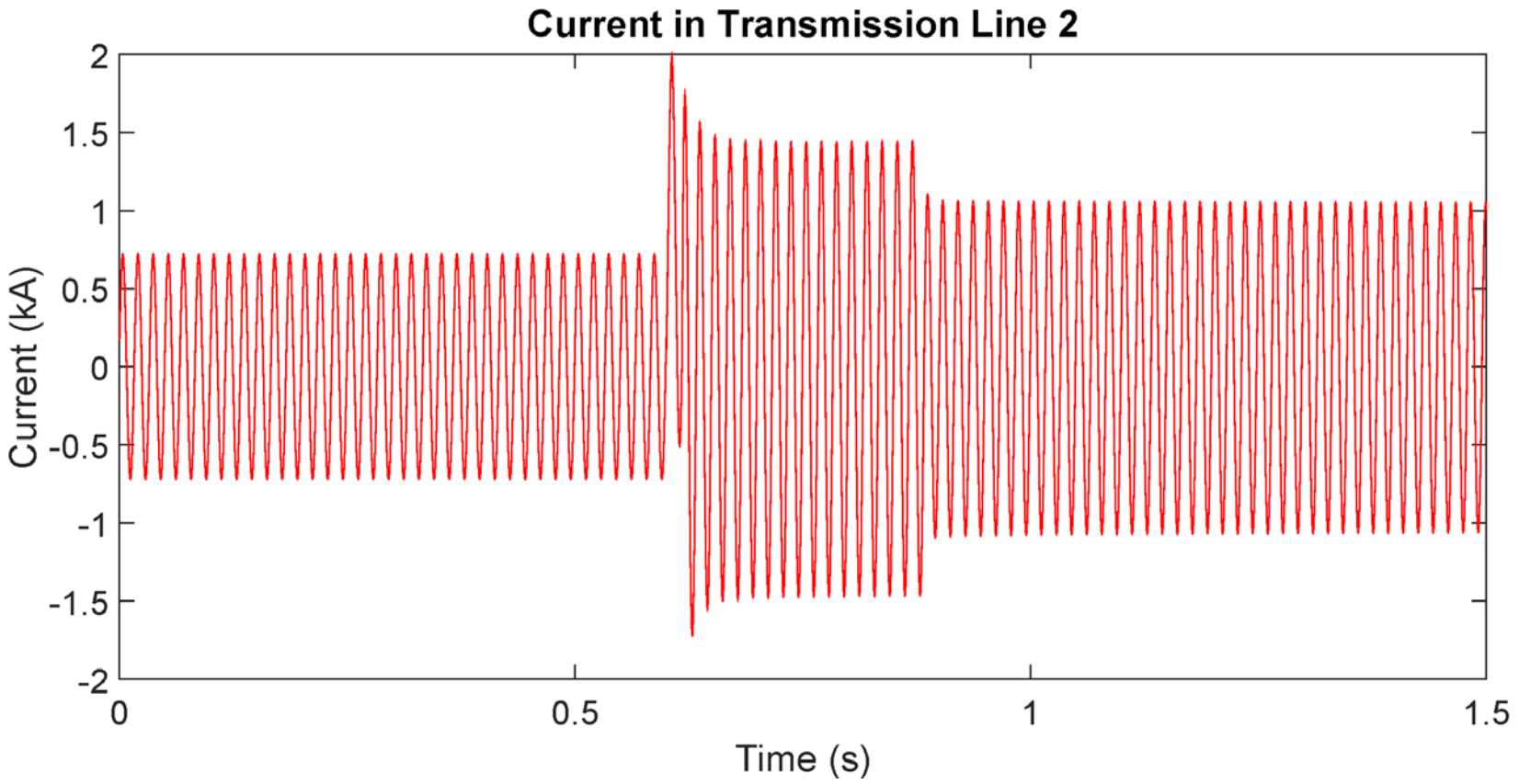
- A simple two bus system to emulate RAS testing using Erkios.



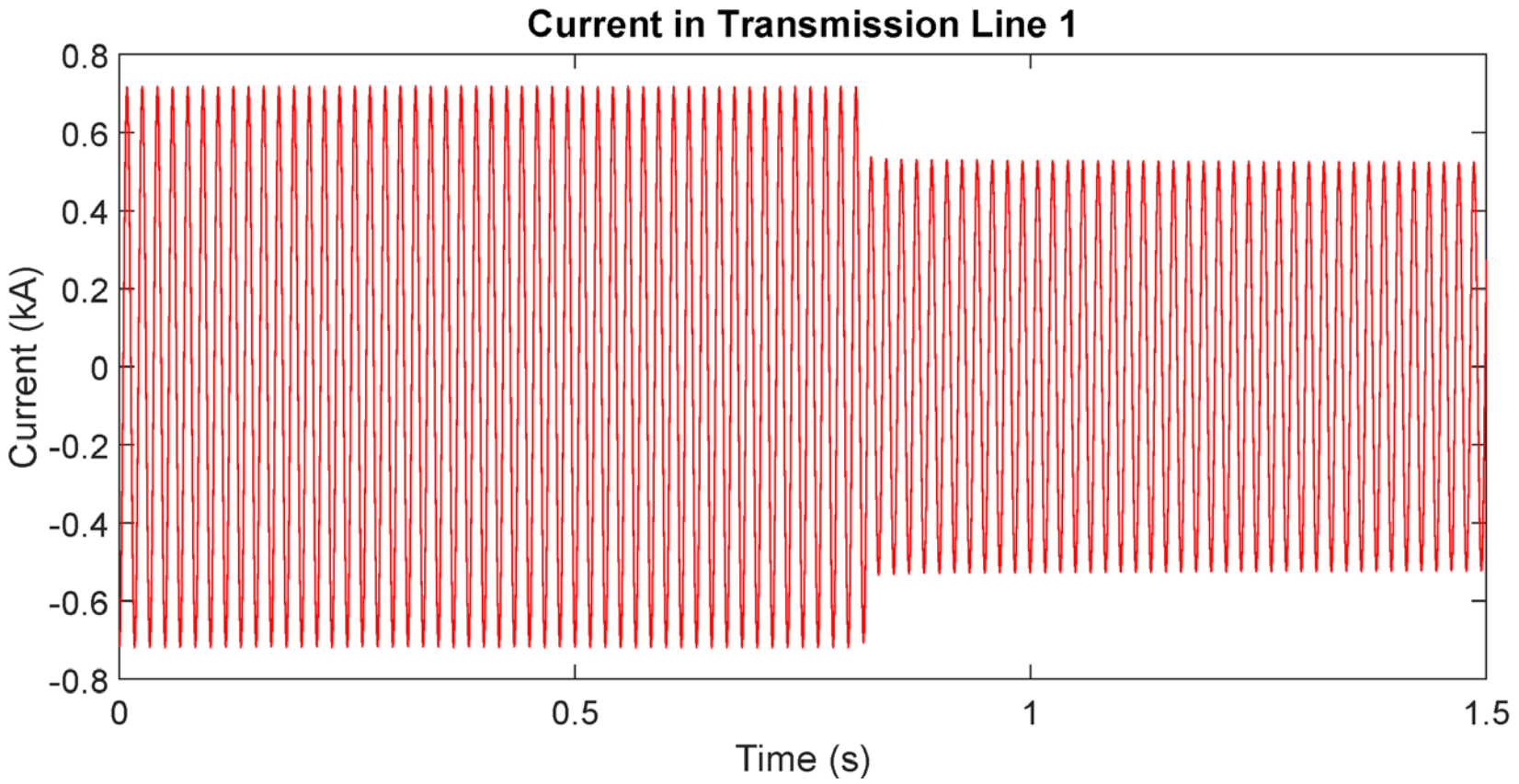
Erkios Test Simulation Result



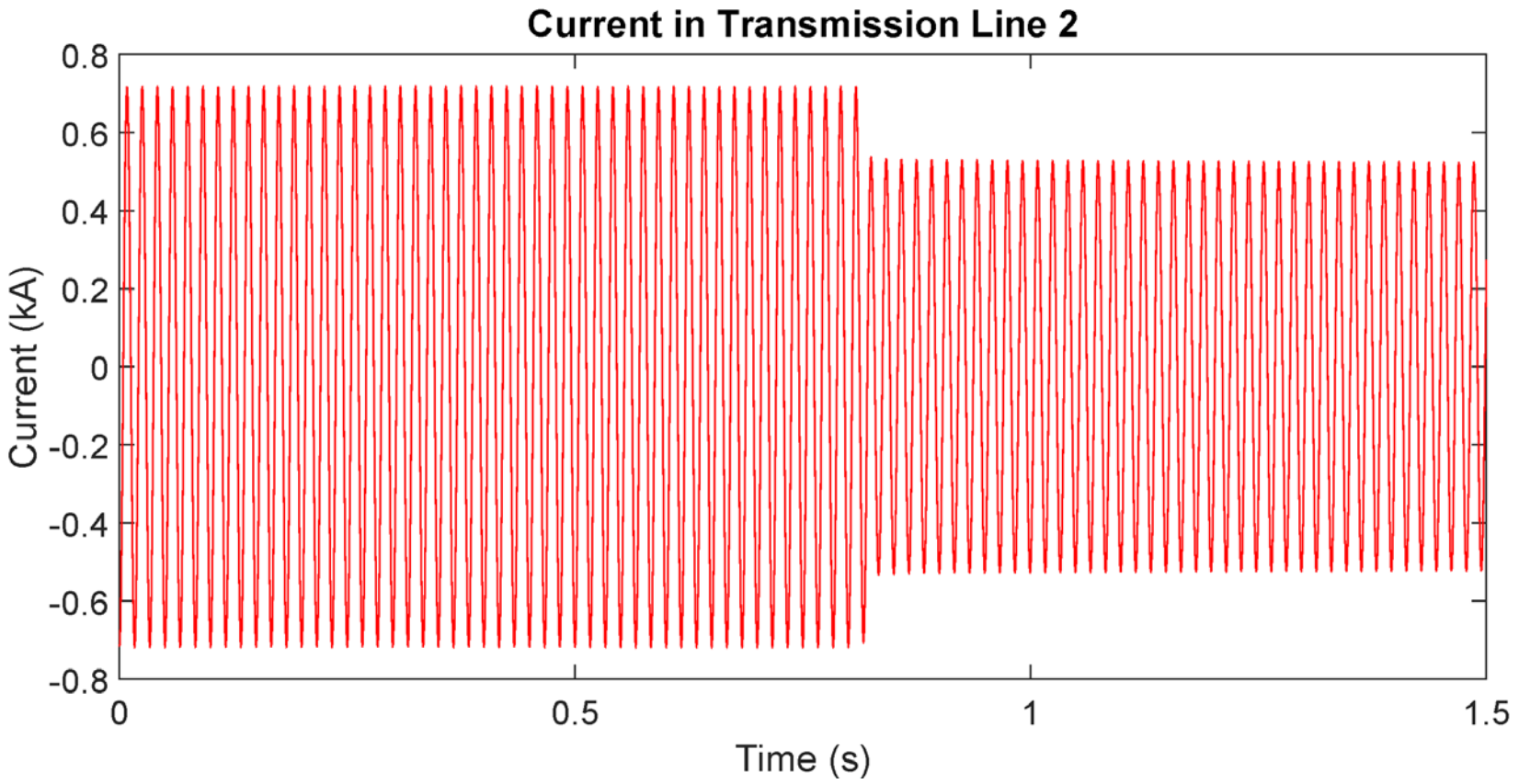
Erkios Test Simulation Result



Erkios Test Simulation Result



Erkios Test Simulation Result



Summary

- Integrating Erkios for testing Remidial Action Schemes.
- Requisite infrastructures and data management for implementation of the testbed.
- Enrich Erkios by helping to build functionality and libraries to test different RAS (Future work).
- A simple simulation is shown to verify the operation of remote RAS testing.
- Implementing other in-field testing applications like PMU and relay testing.

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- A. Mallikeswaran, “Development and Testing of Synchrophasor Based Dynamic Remedial Action Schemes”, M.S. Thesis, Washington State University, August 2015.

Acknowledgement

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