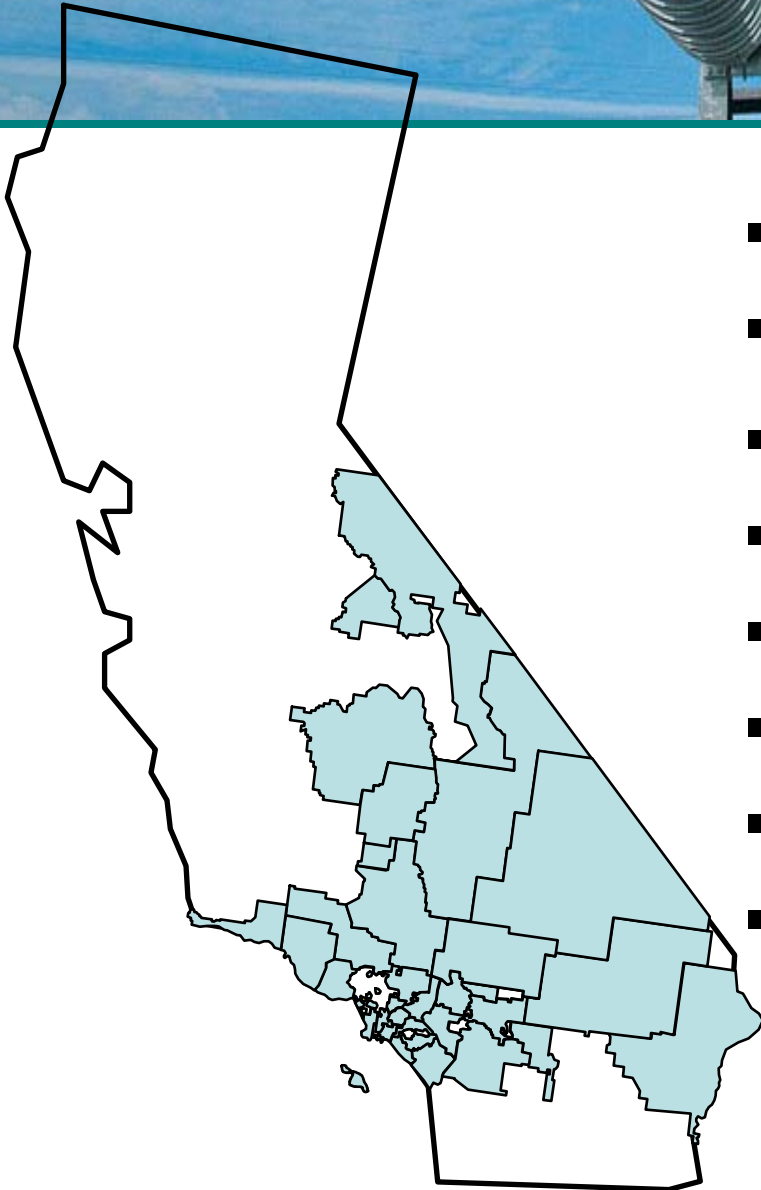




SCE's Distribution Circuit of the Future

Bob Yinger
Southern California Edison
May 23, 2006



- 50,000 square miles
- 4.7 million customers
- 22,000 MW peak demand
- 4100 distribution circuits
- 48,000 switches
- 12,000 capacitor banks
- 680,000 distribution xformers
- Started in 1897, has over a century of experience serving its communities



- *Rising customer expectations and the needs of a technology driven economy demand superior safety and reliability from electrical distribution circuits....at no increase in cost*
- *Advanced technology will make this possible*
- *The Circuit of the Future is a research initiative to explore technological advancements for future distribution circuits*

» *4 Regional Distribution Engineering Teams*

» *SCE Subject Experts*

- T&D automation
- Distributed generation
- Communications

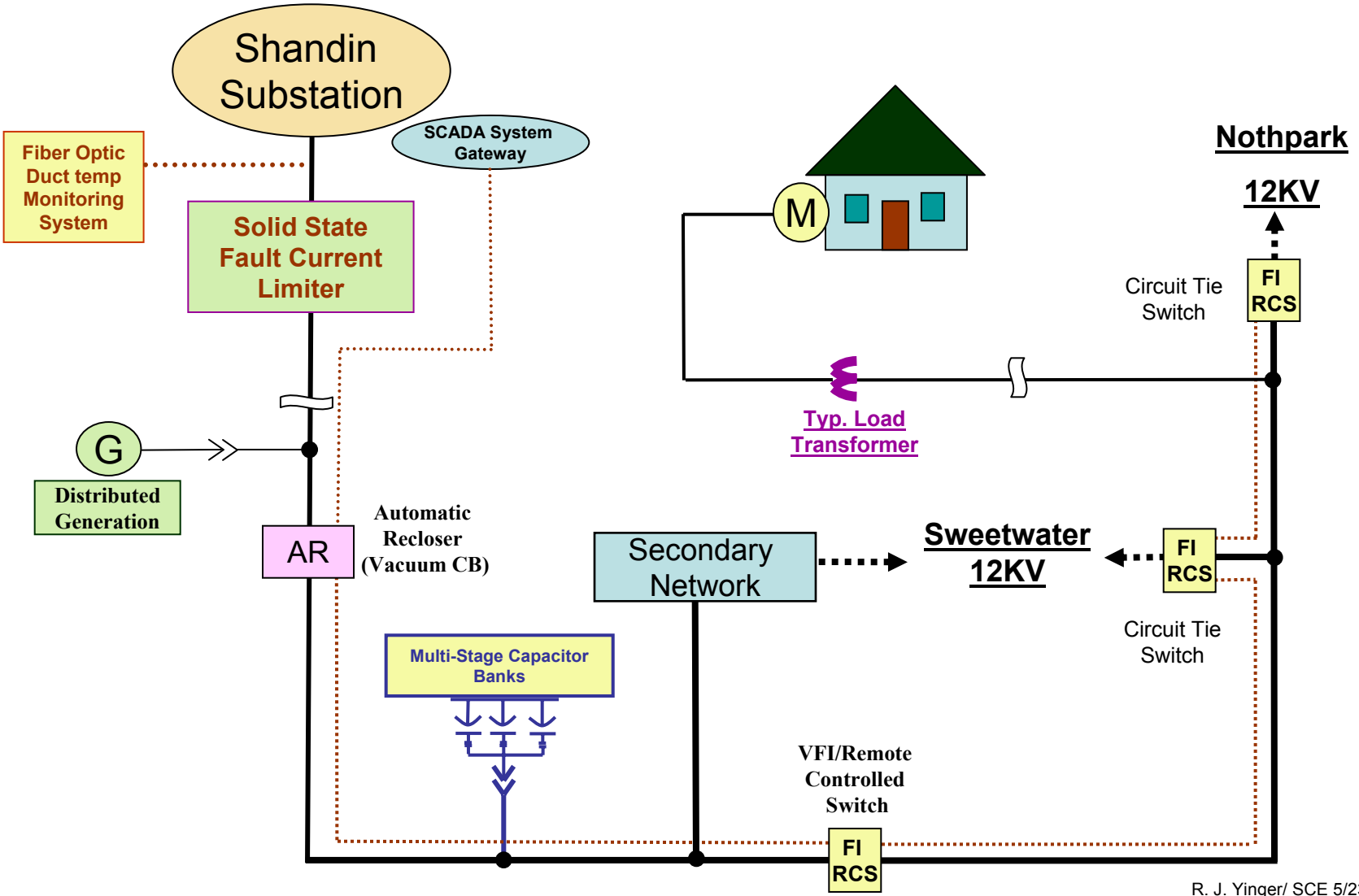
» *Outside Parties*

- DOE
- Oak Ridge National Labs
- EPRI
- CEIDS/ IntelliGrid
- Calif. Energy Commission
- KEMA Consulting



- » *New 12 kV circuit*
- » *Approximately 33,000 amps fault duty*
- » *Will serve approximately 2,000 customers*
- » *Overhead / Underground facilities*







- » *Modular poles w/ molded cross arms*
- » *Vacuum fault interrupters (VFIs) / automatic recloser (AR) / remote controlled switches (RCS)*
- » *Duct bank temperature sensor*
- » *Distributed generation/ VAR resource connect point*
- » *Multi-stage capacitor/ transient-less switch*
- » *Fault current limiter*
- » *RFID tags with data*
- » *Active harmonic filter*

- » *Replace some existing poles*
- » *Benefits:*
 - Resistant to rot and insect intrusion
 - Engineered product so there are no variations in strength
 - Cross arms can be pre-assembled for fast installation and repair
 - Created in segments facilitating transportation and installation



- » *Installed in place of selected switches*
- » *Able to interrupt fault current*
- » *Benefits:*
 - Isolates fault to minimize area affected
 - Deliver line loading and fault indication info
 - Facilitate self-healing circuits
 - Plug-in bus design





» *Fiber optic strands will be placed in duct banks to measure temperature*

» *Benefits:*

- Provides real time temperature for dynamic ratings
- Increased asset utilization



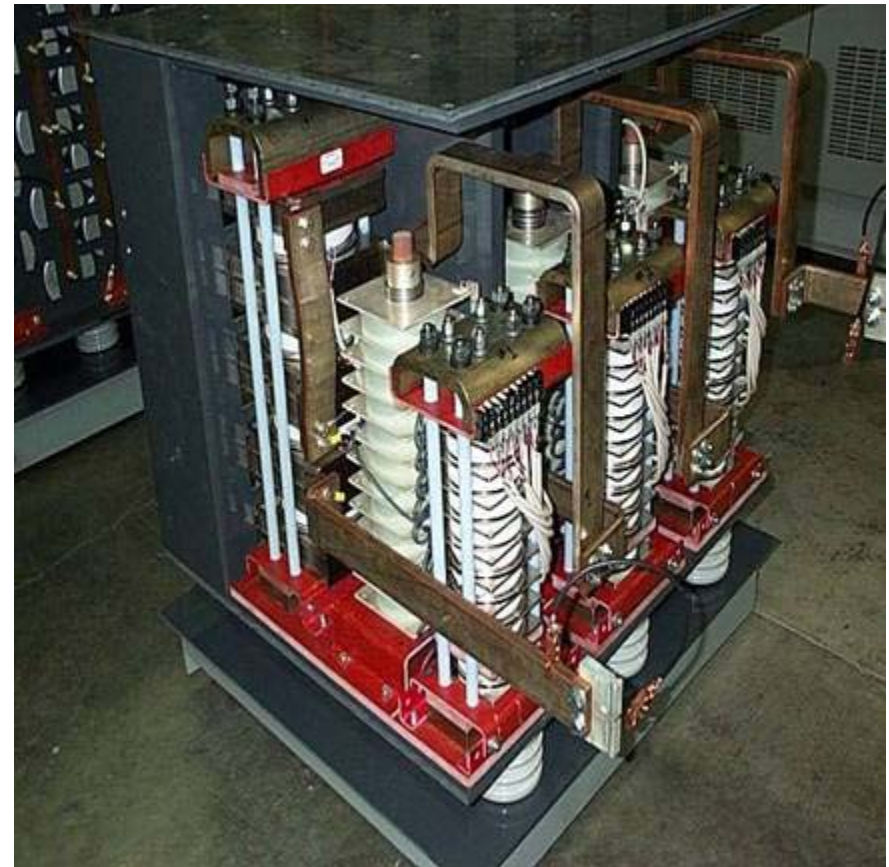
- » *Interconnection point for distributed generation equipment*
- » *Generate watts and VARs*
- » *Benefits:*
 - Supplement the feeder during high load conditions
 - Use generation for variable VAR support



- » *Install one multi-step bank to replace several normally installed on the circuit*
- » *Can be either pole mounted or pad mounted*
- » *Benefits:*
 - Reduce switching transients
 - Less capacitor banks on circuit

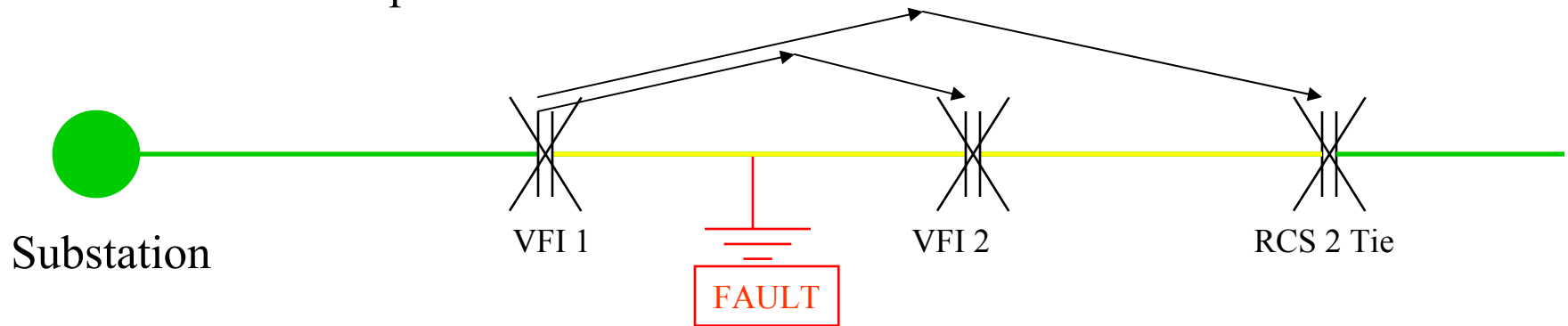


- » *Install at head of feeder to limit fault current*
- » *Various technologies being explored*
- » *Benefits:*
 - Allow devices further along on the circuit to have a lower fault current rating
 - Lower stress/ costs for equipment downstream
 - Greater safety due to less violent failures



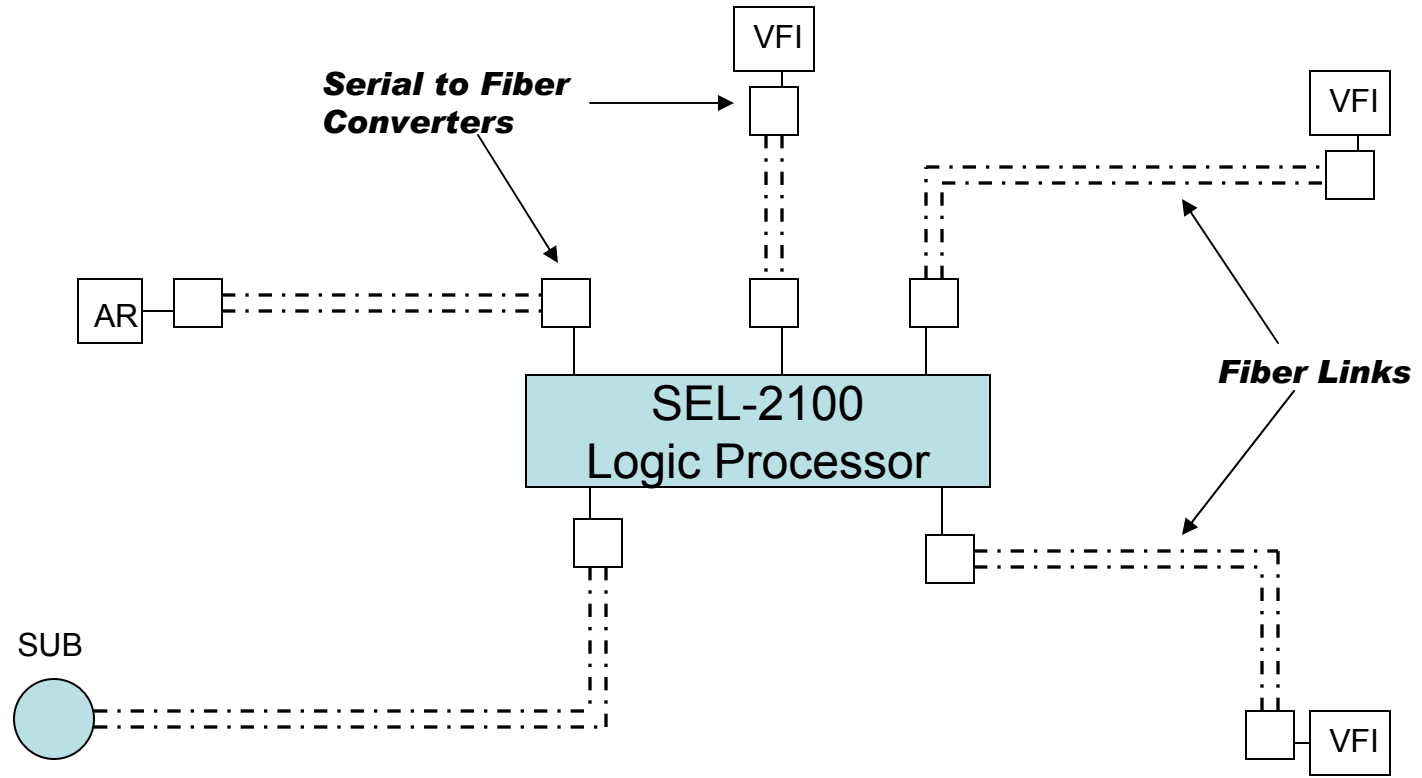
- » *Utilinet 900 MHz radio for critical switching operations*
- » *Fiber to critical nodes to allow high-speed fault isolation and monitoring*
- » *May test Broadband Over Powerlines for transport of utility data*
- » *Test bed for AMI/ demand response equipment*

SCENARIO: Fault After Interrupter

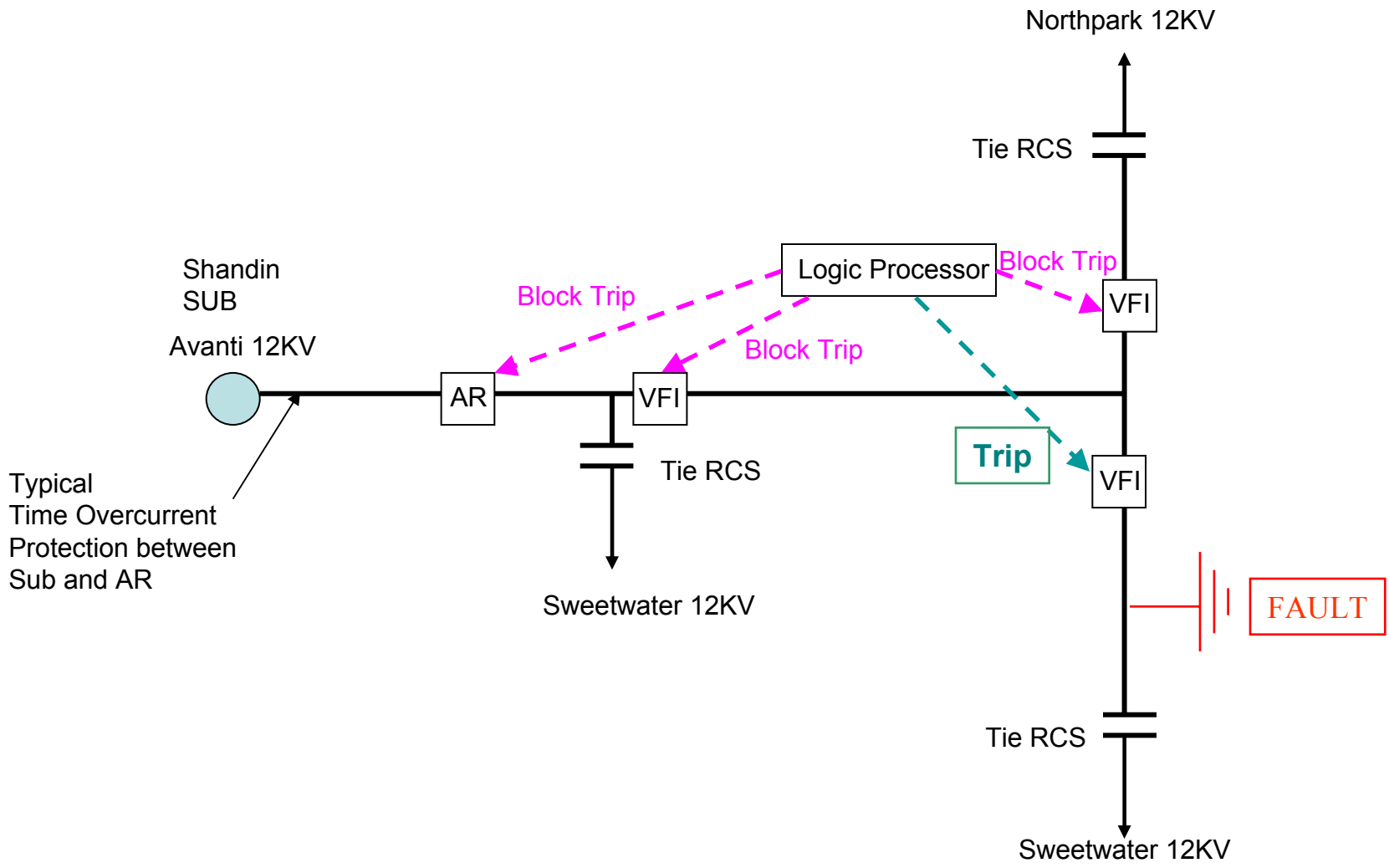


Step	Time (sec)	OPERATION
1	0000	VFI 1 Trips Opens (Fault)
2	0015	VFI 1 Requests VFI 2 to Open
3	0030	VFI 2 Opens
4	0045	VFI 1 Retests and Trips Open (Fault)
4	0060	VFI 1 Requests Load Transfer to RCS2 Tie
4	0070	RCS 2 Tie Evaluates Load Request and Closes If Acceptable Crew Begins patrol.


Use of SEL Mirrored Bits



Trip Blocking Scheme



Typical Time Overcurrent Protection between Sub and AR

- 
- » *VFIs will have directional sensing, will go solid if fed from reverse direction*
 - » *History data server will store load data*
 - » *After faulted section is isolated:*
 - Computer system will analyze peak loading for previous week
 - Suggest to operator the appropriate tie switch(s) to close
 - Operator restore the unfaulted line section(s)
 - Move to automated restoration later



» Purpose

- To better detect and isolate faults on the distribution system so that customer interruptions will be minimized in both frequency and duration


» Product

- *Design and testing of new protection methods with and without a fault current limiter. In addition, new fault sensing and prediction techniques will be studied and tested*

» Benefits

- *Reductions in number and duration of fault interruptions will save customers money in lost production and increase electrical system safety*

- » *Advanced protection Methods on the Circuit of the Future (CoF)*
- » *Three tasks over 3 years:*
 1. Evaluation of new protection scheme on CoF
 2. Design and evaluation of protection scheme with fault current limiter on CoF
 3. Develop and test advanced fault sensing and prediction methods on CoF
- » *Team: SCE, KEMA, Virginia Tech*
- » *\$1.6 M project with \$0.6 M cost share*

- 
- » *Continue work on protection scheme*
 - Vacuum fault interrupters and smart relays
 - » *Working to get fault current limiter*
 - EPRI solid state FCL or superconducting FCL
 - » *Investigate use of circuit as test bed for advanced metering and load control*
 - Potential SCE AMI test location in 2007
 - » *Potential BPL test site in 2007*
 - Follow up to tests done in Rosemead in 2005 - 2006



- » *Design & work order preparation in progress*
- » *Construction starts in January 2007*
- » *Initial operation June 2007*
- » *Initial cost will be higher than other circuits, but should reduce in cost in future years*
- » *Soliciting research funding/ partners to build and test the circuit*