



U.S. Department of Energy  
Office of Electricity Delivery & Energy Reliability

**Electric Distribution**



FY06 Annual Program and Peer Review Meeting

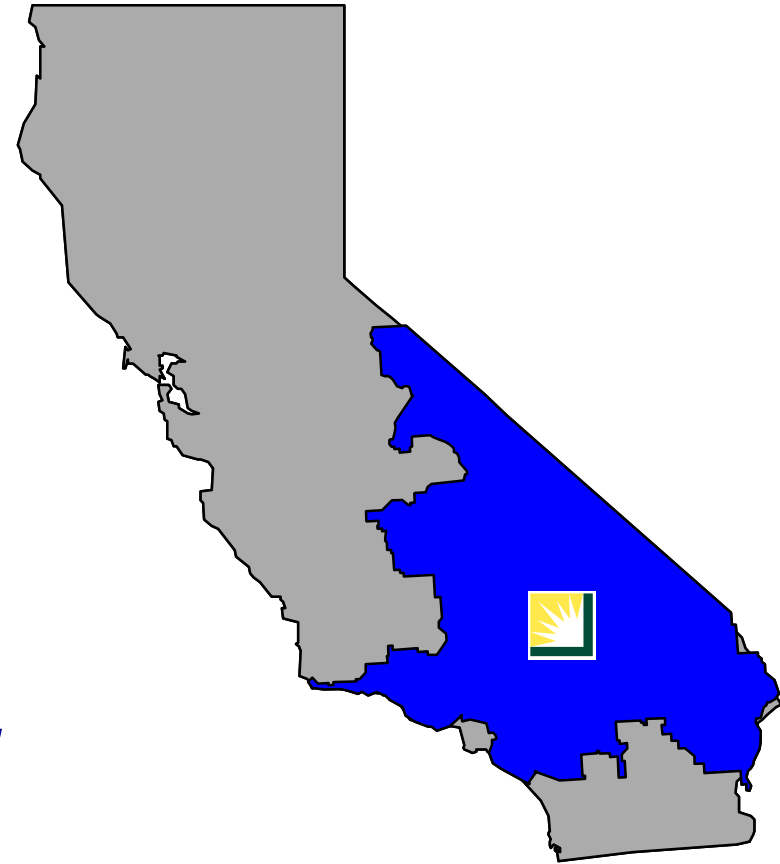
San Ramon, California  
May 25-26, 2006

# Advanced Protection Methods on SCE's Distribution Circuit of the Future

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## *Southern California Edison*

- *Southern California Edison is one of the largest electrical utilities with 4.67 million customers in its 50,000 square mile territory serving 430 cities and communities.*
- *Nearly 14,000 Employees*
- *SCE adds 70,000 New Customers each year.*
- *5396 Transmission(1,196) and Distribution circuits(4,200).*
- *857 Total Substations*



# **Commitment to Technological Advancement**

- 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 Avanti Circuit is a research initiative to explore technological advancements for future distribution circuits.

# *DOE Advanced Protection Project*

## Advanced Protection Methods on Edison's Circuit of the Future (CoF)

### Objective:

*Improve the Detection and Isolation of circuit faults on the Distribution system to minimize customer interruptions in both frequency and duration.*

*Design and test new protection methods with and without a fault current limiter.*

*In addition, new fault sensing and prediction techniques will be studied and tested on the SCE Distribution Circuit of the Future*

Team: SCE, KEMA, Virginia Tech

## *DOE Advanced Protection Project*

- Three Major Tasks over 3 years:
  1. Evaluation of new protection schemes 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
- \$1.6 M project with \$0.6 M cost share



# *DOE Advanced Protection Project*

## *Status*

- Team meeting to discuss detailed scope held – 12/05
- Contract negotiations underway
- Expect contract to be signed in June 2006
- SCE will then issue Purchase Orders to subcontractors (KEMA and VA Tech)
- Detailed work will begin July 2006 (6 months behind original schedule)
- Protection work on Circuit of the Future already in progress



# *The SCE Circuit of the Future: Status*

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## *Why the Circuit of the Future?*

- SCE has identified a need to come up with new ideas to build more reliable and efficient and easier to maintain distribution circuits
  - Provide customers with better service
  - Improve safety
  - Reduce O/M costs

## *Who's Involved?*

- 4 Regional SCE Distribution Engineering Teams
- SCE Subject Experts
  - T&D automation
  - Distributed generation
  - Communications
- Outside Parties
  - DOE
  - Oak Ridge National Labs
  - EPRI
  - Intelligrid
  - Calif. Energy Commission
  - KEMA Consulting

## *Location: San Bernadino, CA*

- New circuit: 12kV Avanti Circuit
- Approximately 23,000 amps fault duty
- Will serve approximately 2,000 customers
- Overhead / Underground facilities
- New hardware and protection schemes
- High speed communications with fiber



## *Hardware*

- Modular poles w/ molded cross arms
- Vacuum fault interrupter (VFI) / automatic recloser (AR) / remote controlled switch (RCS)
- Duct bank /equipment sensors
- Distributed generation/ VAR resource connect point
- Multi-stage capacitor/ transient-less switch
- Fault current limiter
- RFID tags with data
- Active harmonic filter

# Communication Technologies

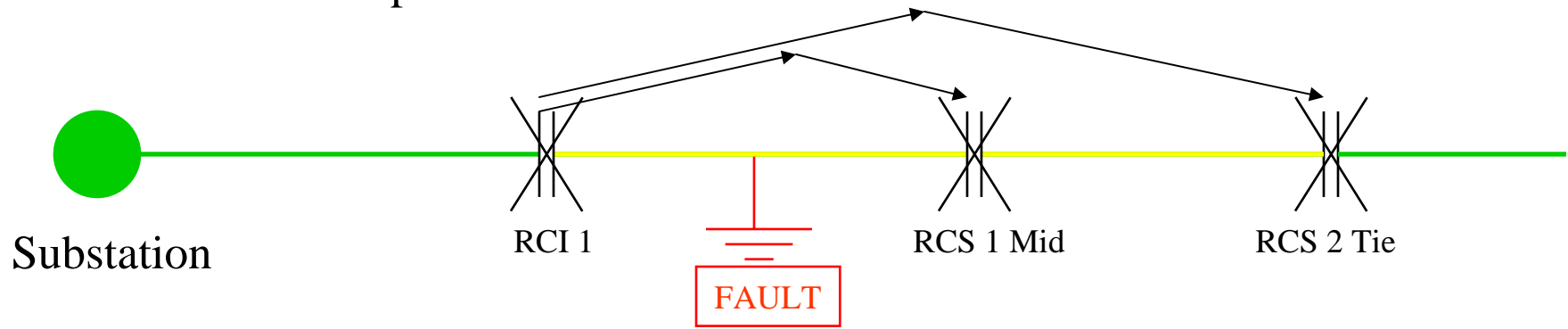
- *NetComm 900 MHz radio for critical switching operations*
- *Fiber-optic cabling to critical nodes for fast communications and high-speed data transportation*
- *May test Broadband Over Power lines (BPL) for transport of data and AMI/ demand response*
- *Advanced metering*

## **Benefits of an Automation Scheme with Fiber communications:**

- The automation scheme will limit the number of customers affected by a fault. Fiber ckts used for fast communications can determine fault location and send signals to automatically open the proper sectionalizing switches, limiting outage time and increase reliability for customers

# Automation Schemes

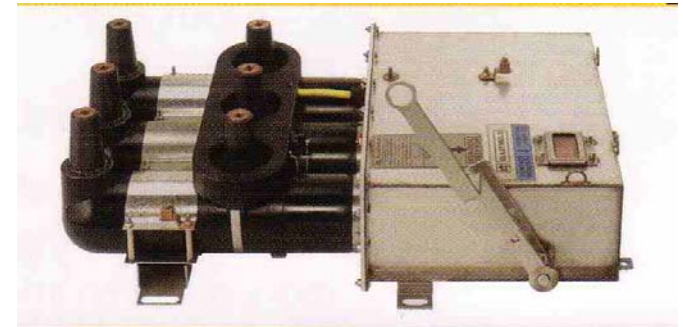
SCENARIO:  
Fault After Interrupter



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

# Remote Controlled Vacuum Fault Interrupter

- Combined effort between
  - Elastimold
    - VFI hardware
  - SEL
    - VFI trip control 351
    - SEL-2100 Logic Processor
  - CPI
    - Control cabinet, switch operator & Integrator
- Next generation automated midpoint switch
  - Configure to sectionalize on loss of voltage or Fault
  - Potentially reduces customers affected by circuit fault
  - Data: currents, settings, detailed fault information

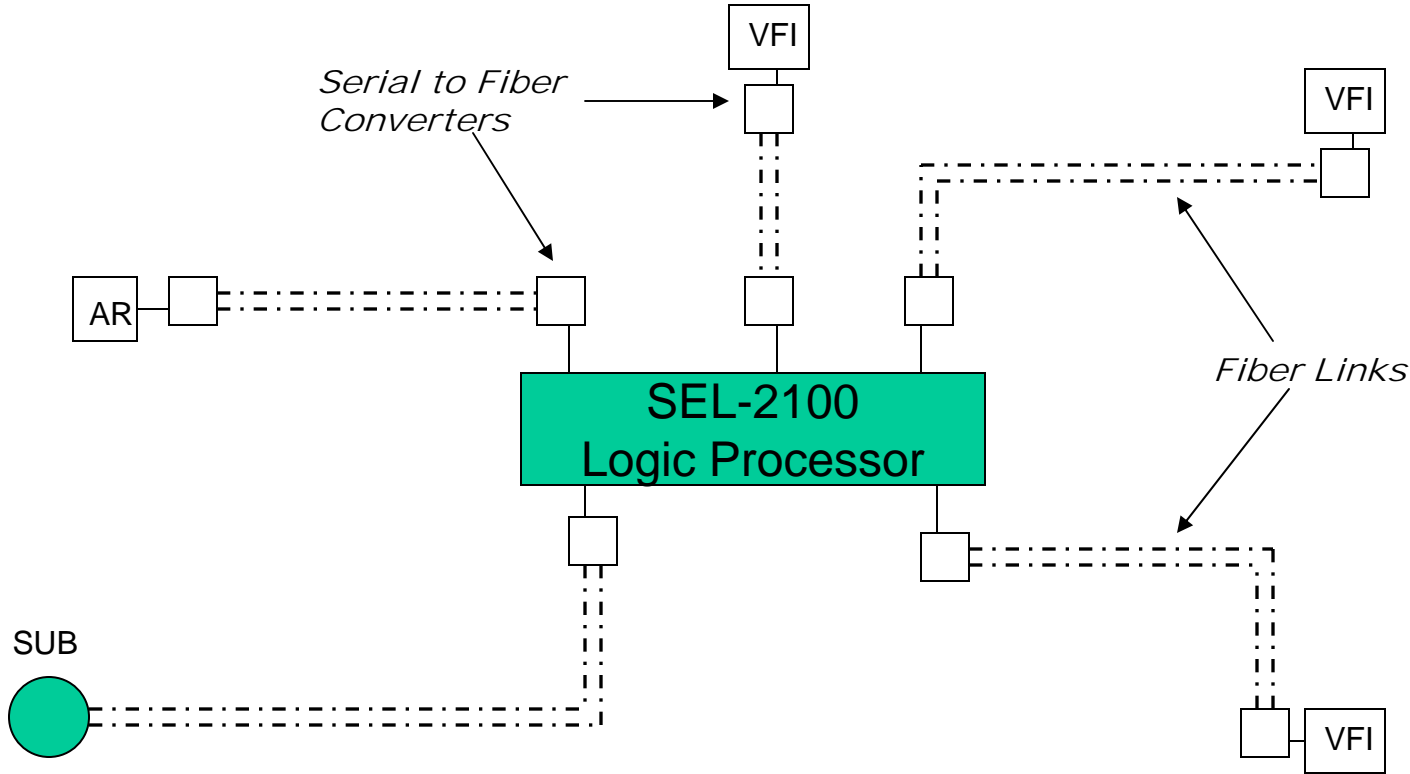


# *Sectionalizing Scheme*

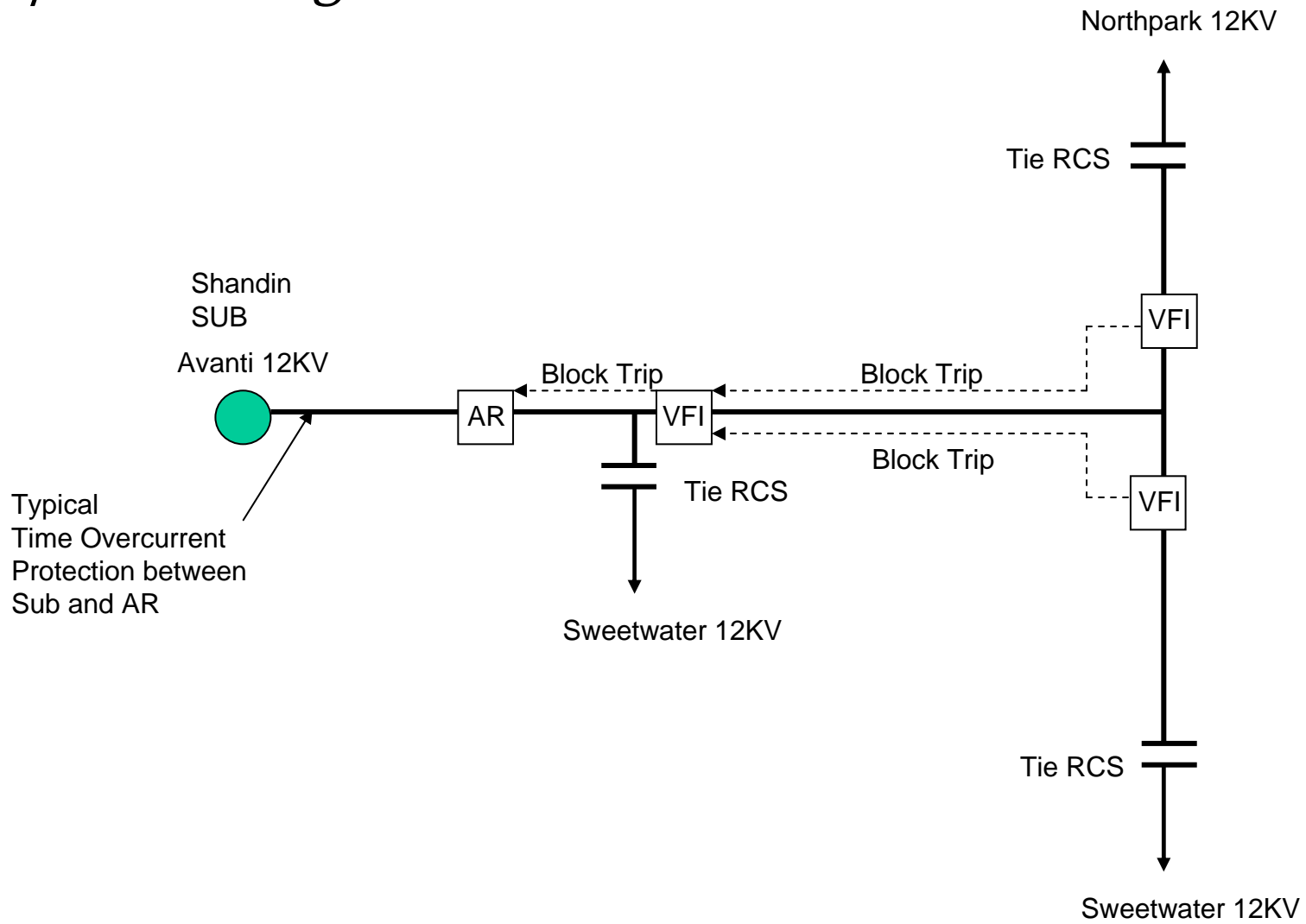
## **Communications Assisted Sectionalizing Scheme**

- AR will utilize SEL 351 R
- VFIs will utilize SEL 351 S
- AR and VFIs communicate with SEL-2100 Logic Processor via SELogic Mirrored Bits.
- AR and VFIs will have same MT settings i.e. 600 amp phase / 180 ground
- SEL-2100 will trip closest device upstream of fault and block tripping of other devices
- Ground relays will coordinate with 80E fuse.
- Phase relays will coordinate with 200E fuse

# Use of SEL Mirrored Bits



# *Trip Blocking Scheme*



## *Restoration after Fault*

- VFIs will have directional sensing, will go solid if fed from reverse direction
- History data server will store load data from AR and VFIs
- After faulted section is isolated, computer system will analyze peak loading for previous week and recommend to operator the appropriate tie switch(s) to close to restore the unfaulted line section(s)

## *Circuit of the Future Project Update*

- 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 in Rosemead in 2005 - 2006

## *Schedule*

- Design & work order preparation in progress
- Construction starts in mid 2006
- Initial operation December 2006
- Soliciting research funding/ partners to build and test the circuit and to conduct demos



# *Questions & Answers*

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