DOE/OE Transmission Reliability Program

Powerline Conductor Accelerated Testing (PCAT)

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Topics to Address

- What is PCAT and why is it here?
- Current Capabilities & Challenges
- Current Plans

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History: Powerline Conductor Accelerated Testing Facility

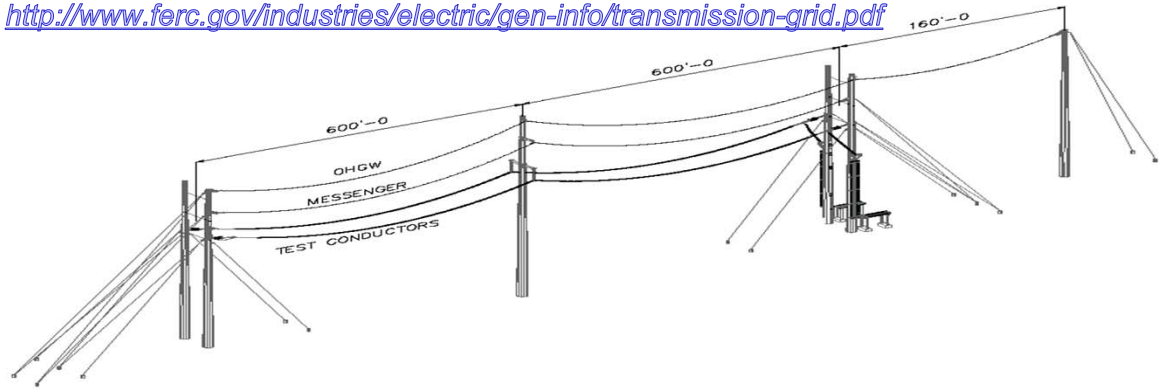
National Transmission Grid Study

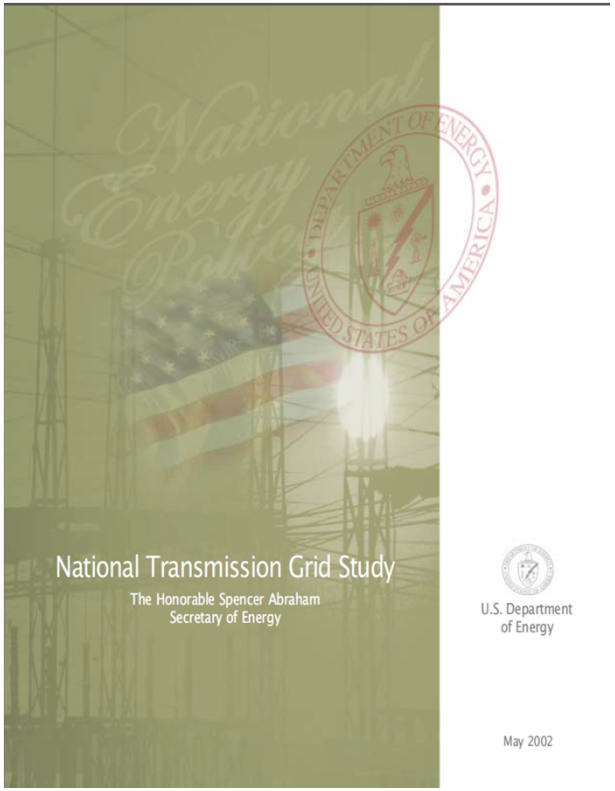
- One of the 51 Recommendations -

"DOE will develop national transmission-technology testing facilities that encourage partnering with industry to demonstrate advanced technologies in controlled environments.

Working with TVA, DOE will create an industry cost-shared transmission line testing center at DOE 's Oak Ridge National Laboratory (with at least a 50 percent industry cost share)."

http://www.ferc.gov/industries/electric/gen-info/transmission-grid.pdf





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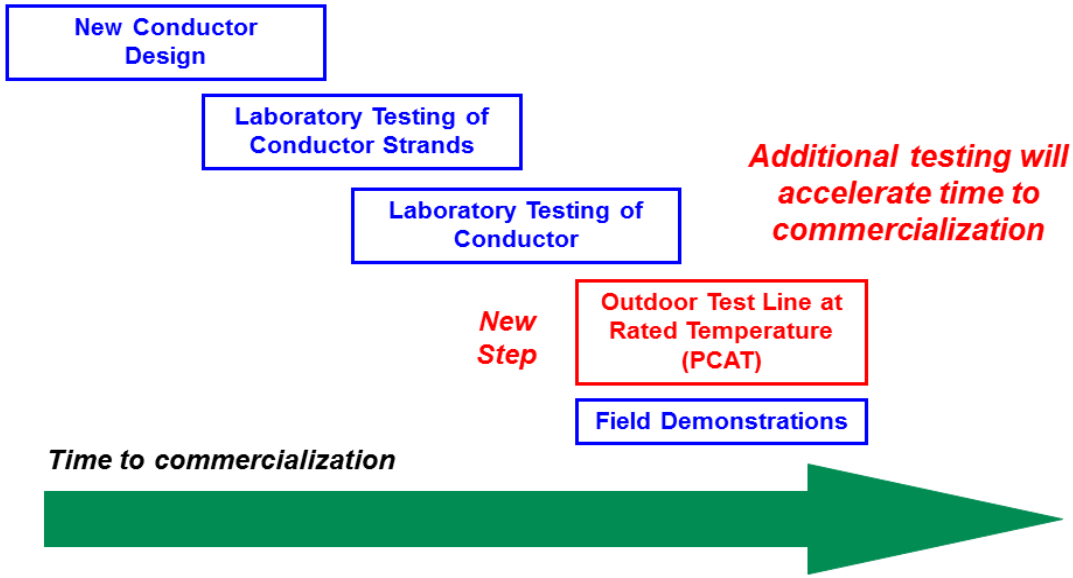
Why PCAT?

- PCAT provides a unique transmission conductor testing facility to augment utility field tests and demonstrations
- Each conductor test undertaken in collaboration with industrial partner



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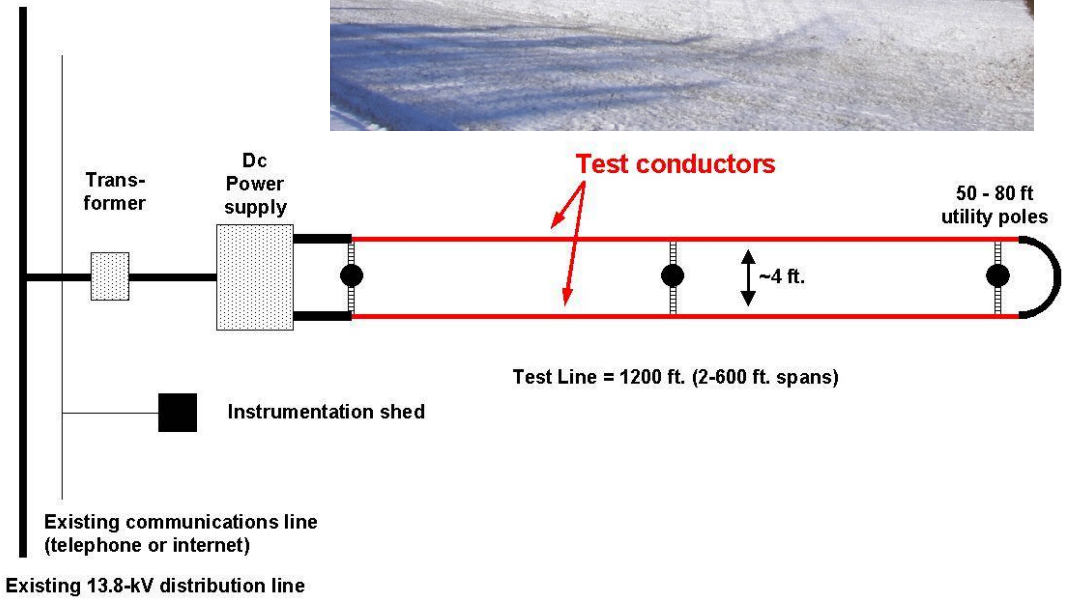
Capabilities: Powerline Conductor Accelerated Testing Facility

- Testing Capabilities
  - Thermal / Mechanical Cycling
  - Current / Temperature Ramp
  - Current / Temperature Steps and Hold
  - Controlled current testing
  - Controlled temperature testing
- Facility
  - 2400 feet of conductor
    - two 600 foot spans
    - 3 towers
  - 0 to 400 Vdc
  - 0 to 5,000 Adc
  - Conductor and accessories
  - Tested up to 300°C
    - can go higher if needed



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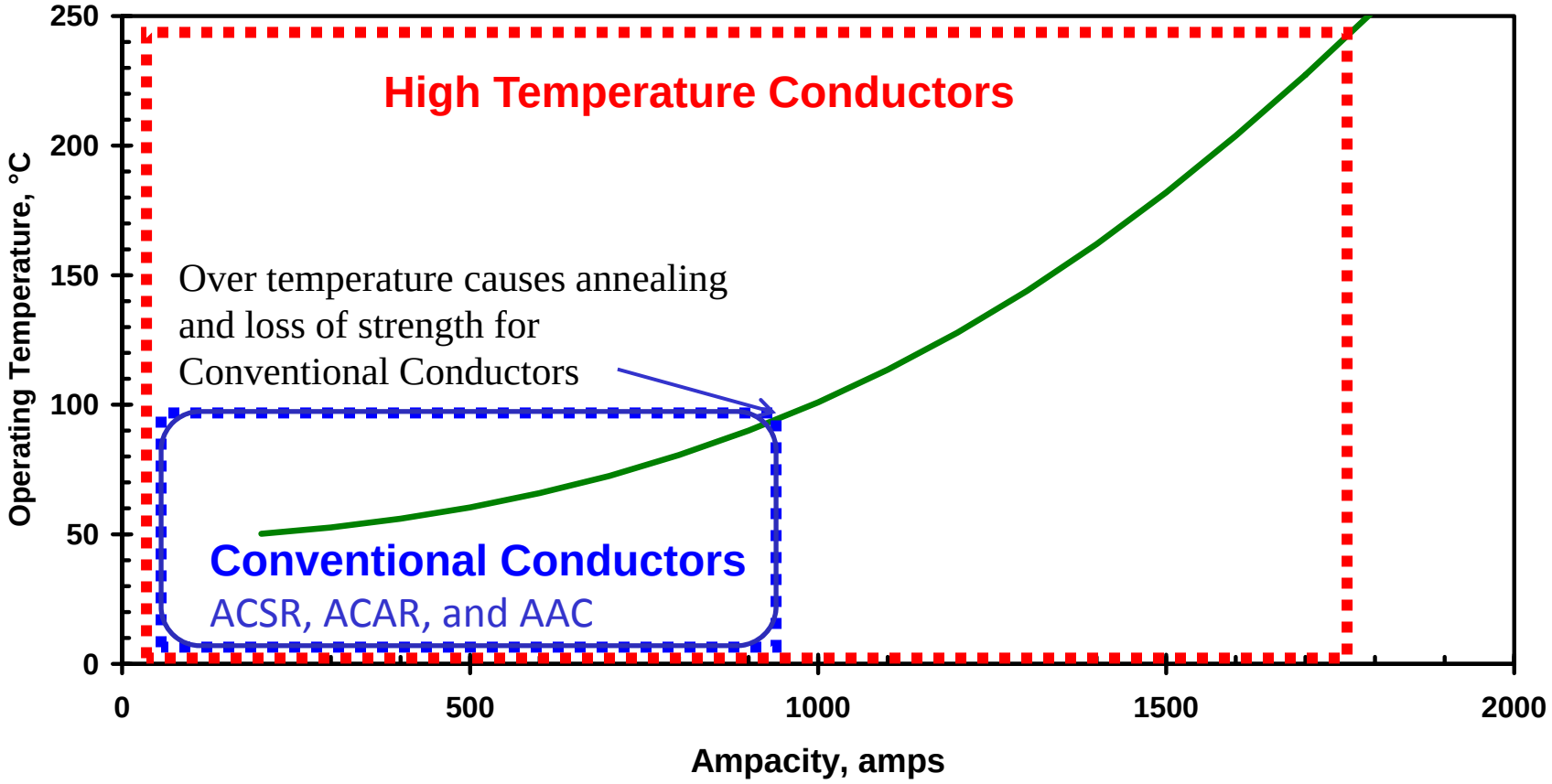
Driver of higher operating temperatures is higher current ratings



Need to test / verify new conductors over entire operating range

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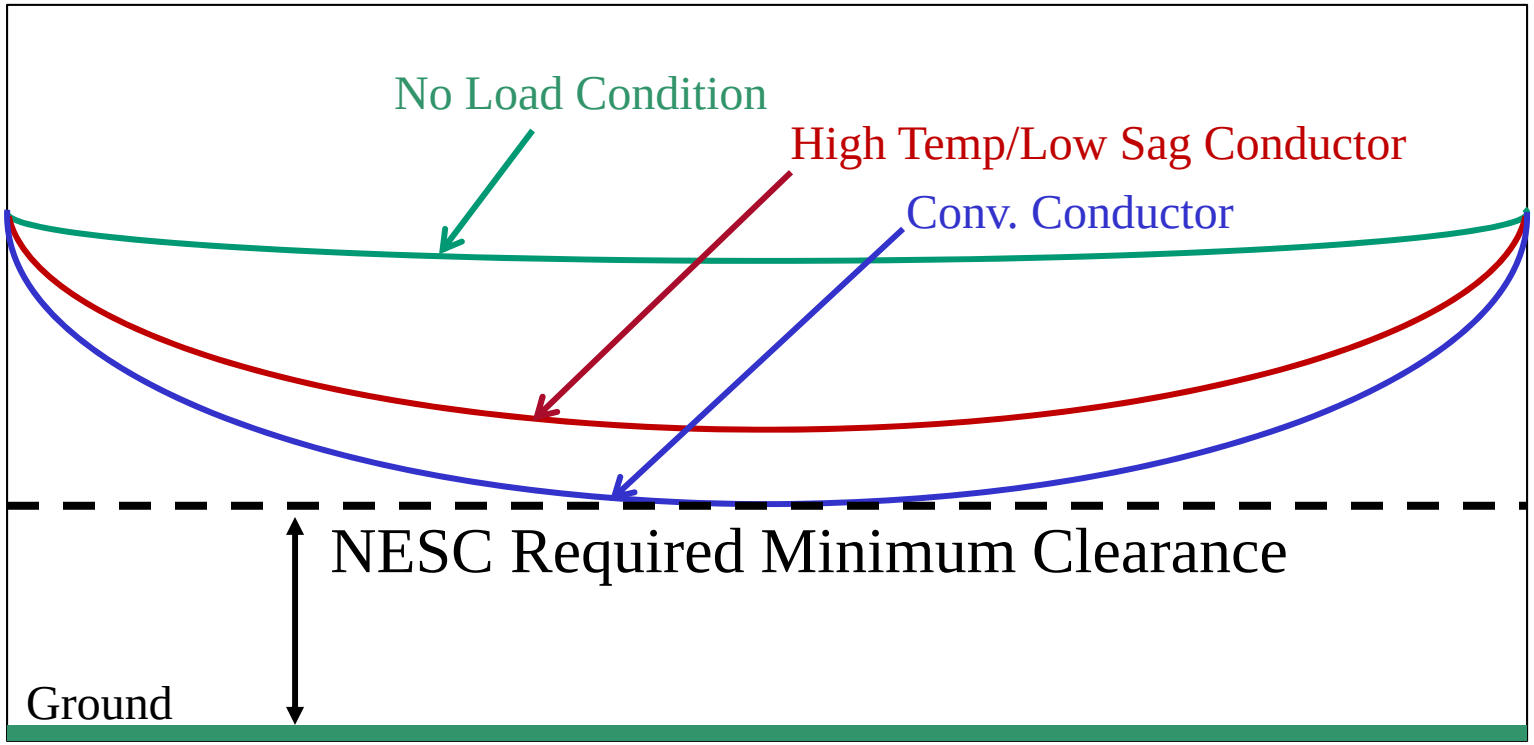
Benefit of a high temp/low sag conductor



More ampacity while still meeting the National Electric Safety Code (NESC) required minimum clearance

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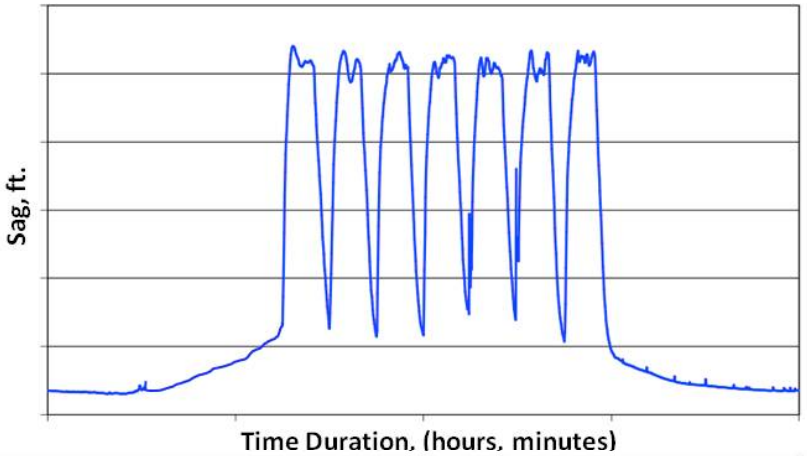
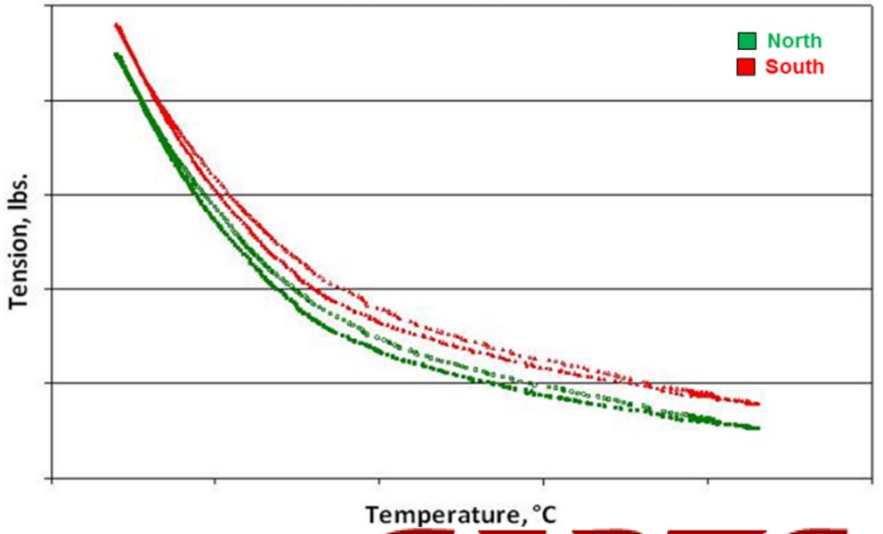
Past Accomplishments

- PCAT has been in operation for over 10 years
- The PCAT facility has been used to test manufacturer conductors and sensors including:
  - 3M 477 kcmil ACCR
  - 3M 675 kcmil ACCR
  - Southwire 1113 kcmil ACSR FO
  - Power Donut2
  - 3M 1272 kcmil ACCR
  - 3M 795 kcmil ACCR
  - Others





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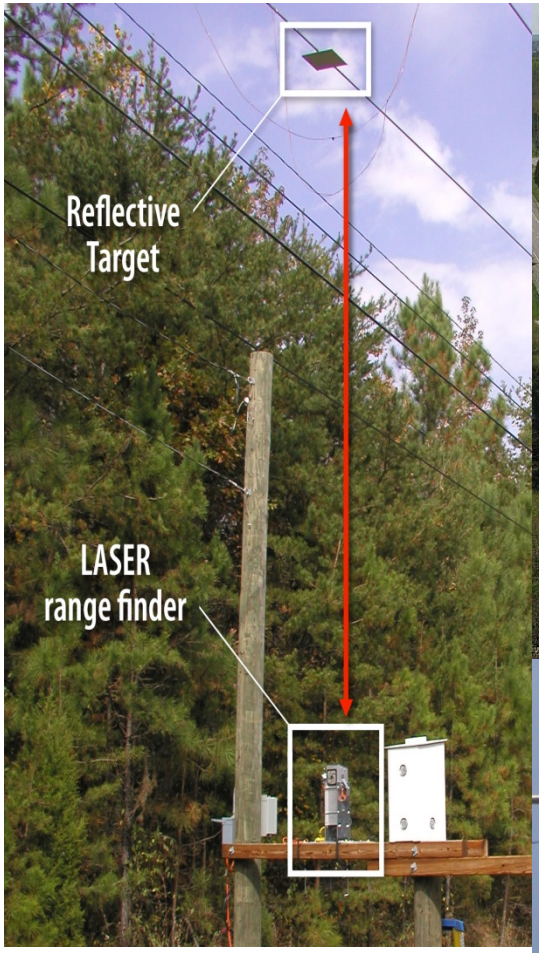
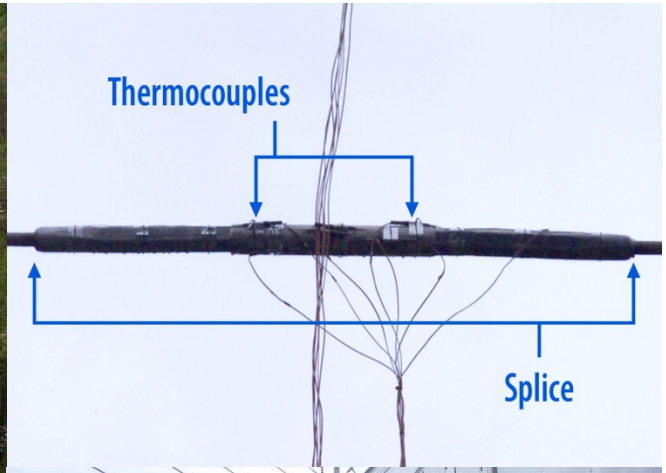
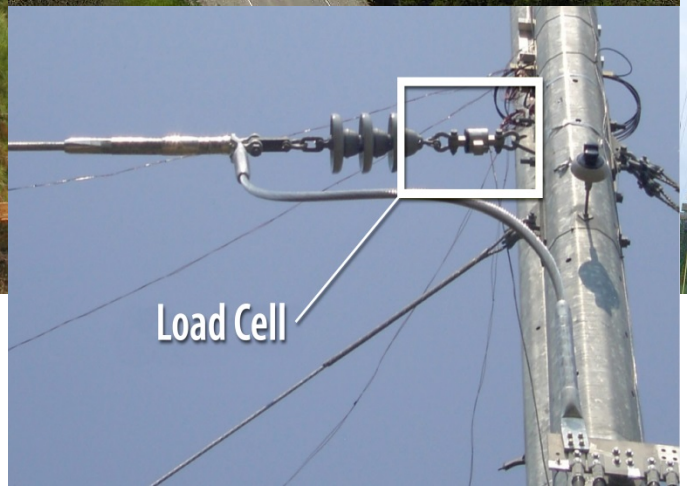
Existing Infrastructure







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Conductors are installed by TVA using conventional industry practices

Typical installation is ~ 3-4 days

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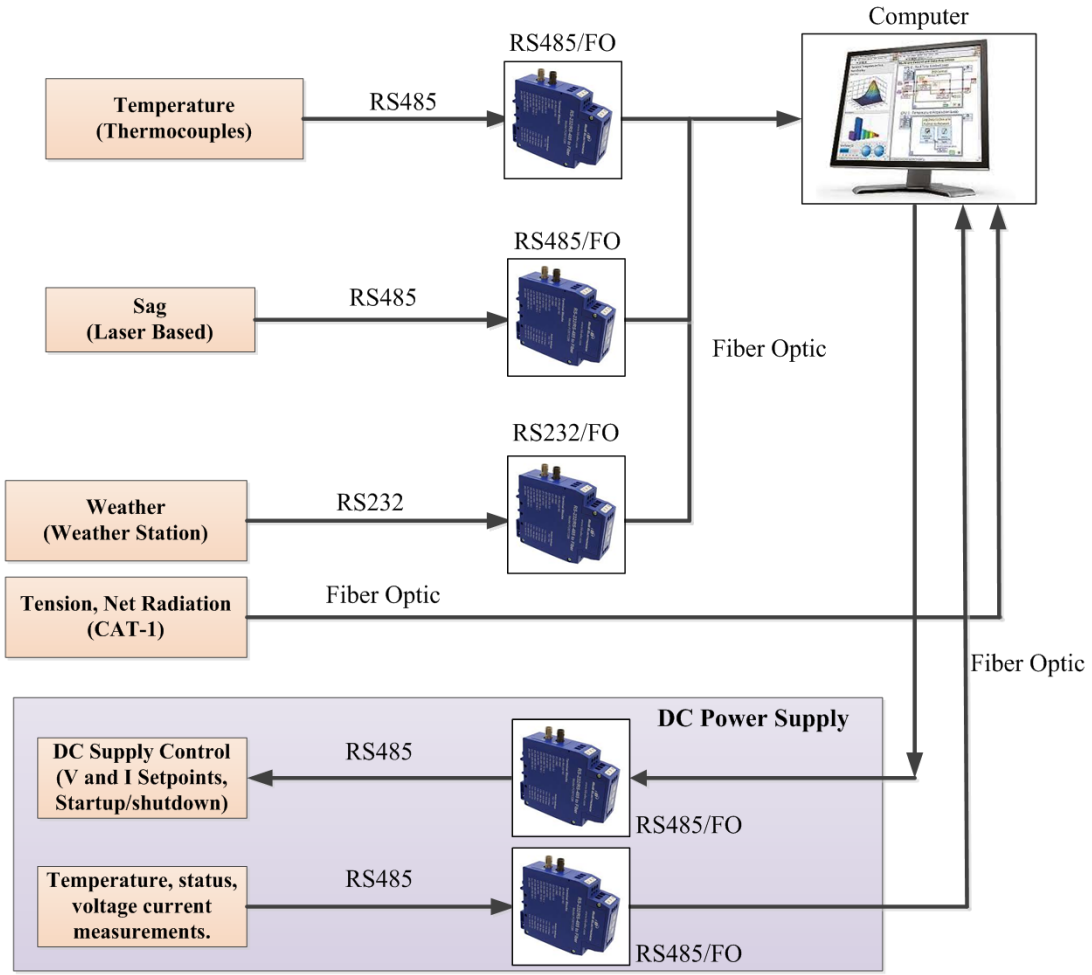
Existing Data Collection

- Conductor/accessory temperature
  - Surface contact or conductor core
  - 128 thermocouples
- Applied current and voltage
  - Measured by power supply
- Conductor sag
  - Laser at mid-span
- Conductor tension
  - Load cells on both circuits
- Weather
  - Ambient temperature, wind speed, wind direction
  - Conductor net radiation sensor
- PC-based data acquisition system
  - 10 second polling, 1 minute data archive



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Challenges to Testing

- Lightning strikes have damaged many sensors
- System lacks flexibility to adapt test plans and analysis to meet specific vendor needs:
  - Legacy software in Visual Basic
- Measurement resolution
  - Ability to investigate short duration phenomena
- Inability to detect bad data
  - Unable to validate measurements using multiple sources (diverse measurement technologies)

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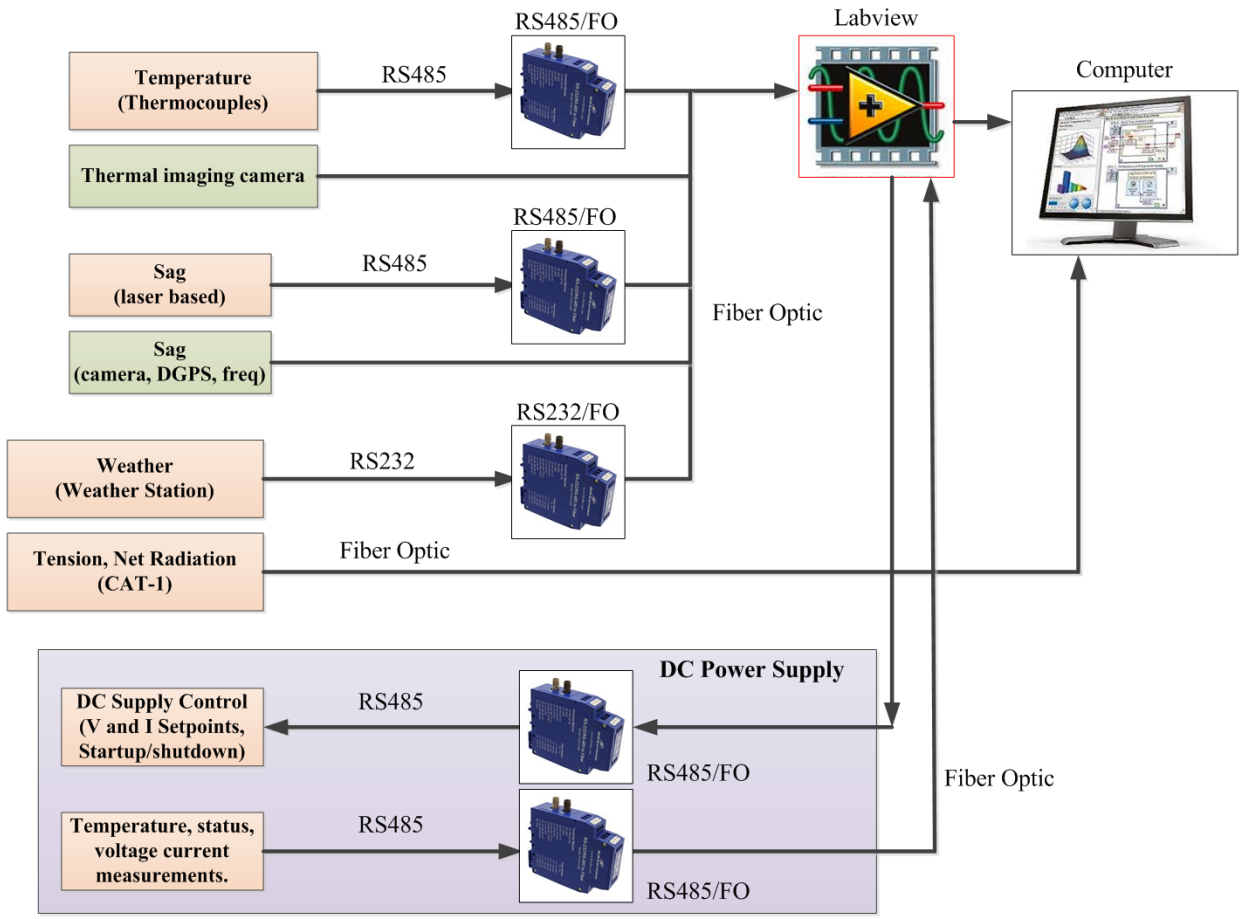
Current Activities

- Rehabilitate PCAT Data Acquisition, Controls, and Visualization:
  - Replace broken, obsolete and inflexible parts
  - Transition control from Visual Basic to LabVIEW.
  - Integrate new sensors including thermal imaging of conductor
  - Implement real-time remote monitoring and warning system
- Continue testing



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Milestones and Deliverables

- Complete testing of Southwire conductor (July 2014)
  - Date slipped from Mar 2014 due to failure of instrumentation transformer (long lead time item)
- Install new conductor for testing (Aug 2014)
- Upgrade control system and interface to existing sensors (Sep 2014)
- Install new sensors (Dec 2014)

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Risk Factors

- Continued failure of obsolete equipment.
- Glitches during cutover to new control system.
- Unfavorable weather conditions
  - Because sustained bad weather is not predicted, this is only a minor risk to the schedule.

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Proposed FY15 Activities

- Continue conductor testing
- Complete rehabilitation
  - Interface new sensors to control system
  - Complete final commissioning of new test system
- Expand PCAT test capability to include alternating current
  - Add a DC to AC inverter stage to the current infrastructure
  - Conduct additional testing including:
    - Perform conductor testing of steady state and transient conditions at grid frequency accounting for all the effects of the AC EM field
    - Test and experiment with measurement devices and auxiliary equipment including:
      - PMUs
      - CTs
      - VTs & Capacitive Coupled Voltage Transformers (CCVTs)
      - Other devices intended for ac powerline applications
    - Test and experiment with different power flow control devices
      - Smart Wire
      - Power Donut
      - ORNL's Continuously Variable Series Reactor (CVSR)
      - Others
    - Investigate the impact of AC EM field on different devices/objects along the right-of-way

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Q&A

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