Technology Readiness for the Smart Grid

Presented by

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Outline

- What is Technology Readiness?
- Why the original NASA model does not work for power
- A version for power
- SGL 5 through 9 discussion
- Concluding remarks
WHY INNOVATE?

OK, so let’s try something new!

Resistance to change

How can I do more with less?
Review of some “new technology” on the power system

- Transistor circuits: reliable -- late 1960s
- Transistor equivalents of electromechanical relays
- Not a happy experience
- Many failures
- Failures caused by electromagnetic compatibility problems
- Transistors were susceptible to line transients
How do we overcome?

A logical methodology to evaluate when a new technology is ready for the Smart Grid

NASA Technology Readiness Levels (TRL) ?
This side is a status statement. It summarizes how far the system has got.

This side is process description. It shows how you would get from one level to the next.

NASA TRL Model

TRL 1
- Principles reported
- Concept formulated

TRL 2
- Proof of Concept

TRL 3
- Lab Validated

TRL 4
- Breadboard Validated

TRL 5
- Prototype Validated

TRL 6
- Demonstration in Space Environment

TRL 7
- TRL 8
- System Development

TRL 9
- System test, flight
NASA TRL process

TRL method: three purposes:

• estimating development cost
• recording progress
• check-listing project outputs

Work *expands* as you move up the scale (team gets bigger!)

Useful attributes for NASA

But it does not work for the smart grid
Combination not appropriate for smart grid, because:

- estimating development times ............manufacturer problem
- estimating costs.............................manufacturer problem
- recording & verifying progress...............developer problem
- Check-Listing..................only thing that matters to utility/customer

What is needed is something to convince the ultimate user
Mission Assurance

Maintenance needs drive design

When maintenance is difficult & expensive, it’s worth spending considerable time & energy to insure a long life, that’s MA

Mission Assurance is principle behind the SGL numbers
Introducing Smart Grid Levels (SGL)

5 Design Validation
- Design Testing
  - EMI/EMC tests
  - HV tests

6 Power System Safe
- Reliability tests
- Cyber-security tests
- Safe for Public & Workers

7 Functional

8 Interoperable
- Interoperability standards
  - Large-scale demonstration

9 Proven
- Systems installed
- Disposal plans

- Performance standards
  - Pilot-scale demonstration
SGL scheme from Utility point-of-view

1. Issue RFQ
2. Select vendor
3. Assign SGL

- Certification done by?
- Process depends on SGL number

In RFP or RFQ specify standards

- Process depends on SGL number

Laboratory tests
Pilot test
Small-scale deployment
Full-scale installation
Smart Grid Levels

**SGL 1-4:** Manufacture’s R&D effort
  - Design tests complete

**SGL 5:** Design Validation
  - Reliability testing
  - Demonstrate hardware & software works
  - Safe for people

**SGL 6:** Power System Safe
• Demonstrate pilot project in real world
• Works properly with external systems
• Respects security requirements

SGL 7: Functional
• Scalable – large pilot works
• Meets interoperability standards

SGL 8: Interoperable

There can be no technical objection to full scale deployment
• Going beyond what goes into an RFP
• Continued software development
• Warranty and maintenance
• Disposal plans for end of life

**SGL 9: Proven Product**

*Documented along the way*
Conclusion

Requirement for each SGL can be realistically tailored for each type of product.

Complying with a full set of requirements is not relevant at all points in the program.

New systems are only allowed if they are safe for the power system (SGL 6).

Functional (SGL 7) requires a real world pilot.

Interoperability, large scale demonstrations, disposal plans are required for Proven Products (SGL 9).
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