Integrating Synchrophasor Technology into Power System Protection Applications

Task Force on Synchrophasor Protection Applications
NASPI Engineering Analysis Task Team

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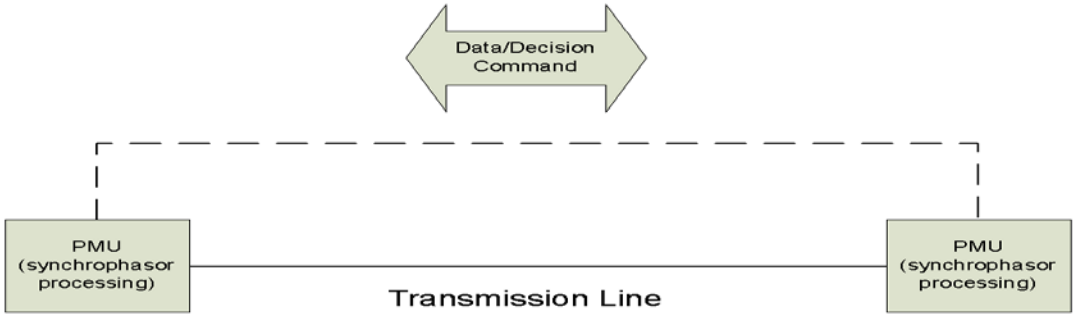
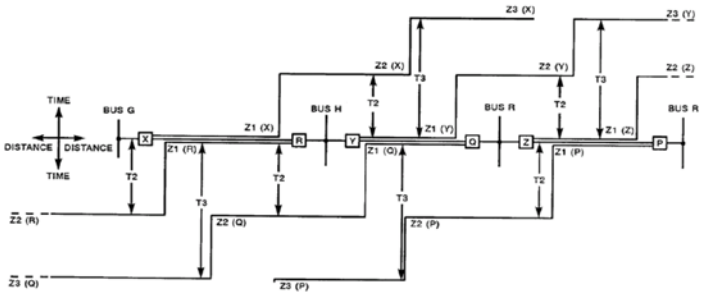
10/19/2016

Report Topics

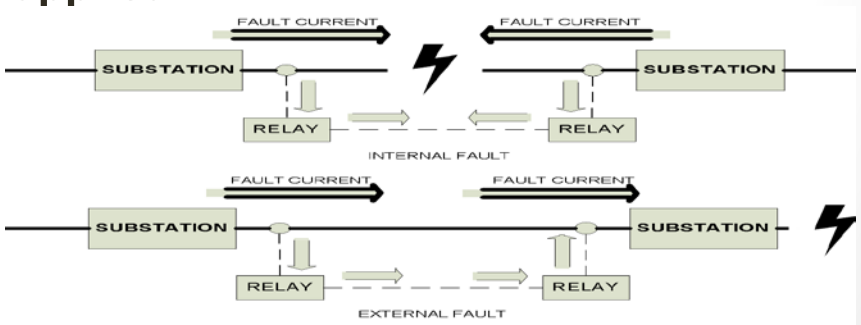
- **State of PMU data collection and transmission vs data collection standards of protective relay systems**



- **Review of protection system applications and how PMUs can be applied**



Step Distance



Differential

Report Topics

- **Synchrophasor data obstacles**

LATENCY

- **Industry survey results on current uses and what is desired in the future**

TWO PRIME QUESTIONS

1. **"Do PMU-collected data offer an advantage in terms of the types, measurement speed and accuracy of grid information collected, relative to current relay data used in existing protection systems?"**

2. **"Do current synchrophasor data networks move PMU data quickly enough to meet local or system protection timing requirements, or can dedicated PMU data transfer measures be established (much as there are dedicated data lines for many relay-based system protection schemes today)?"**

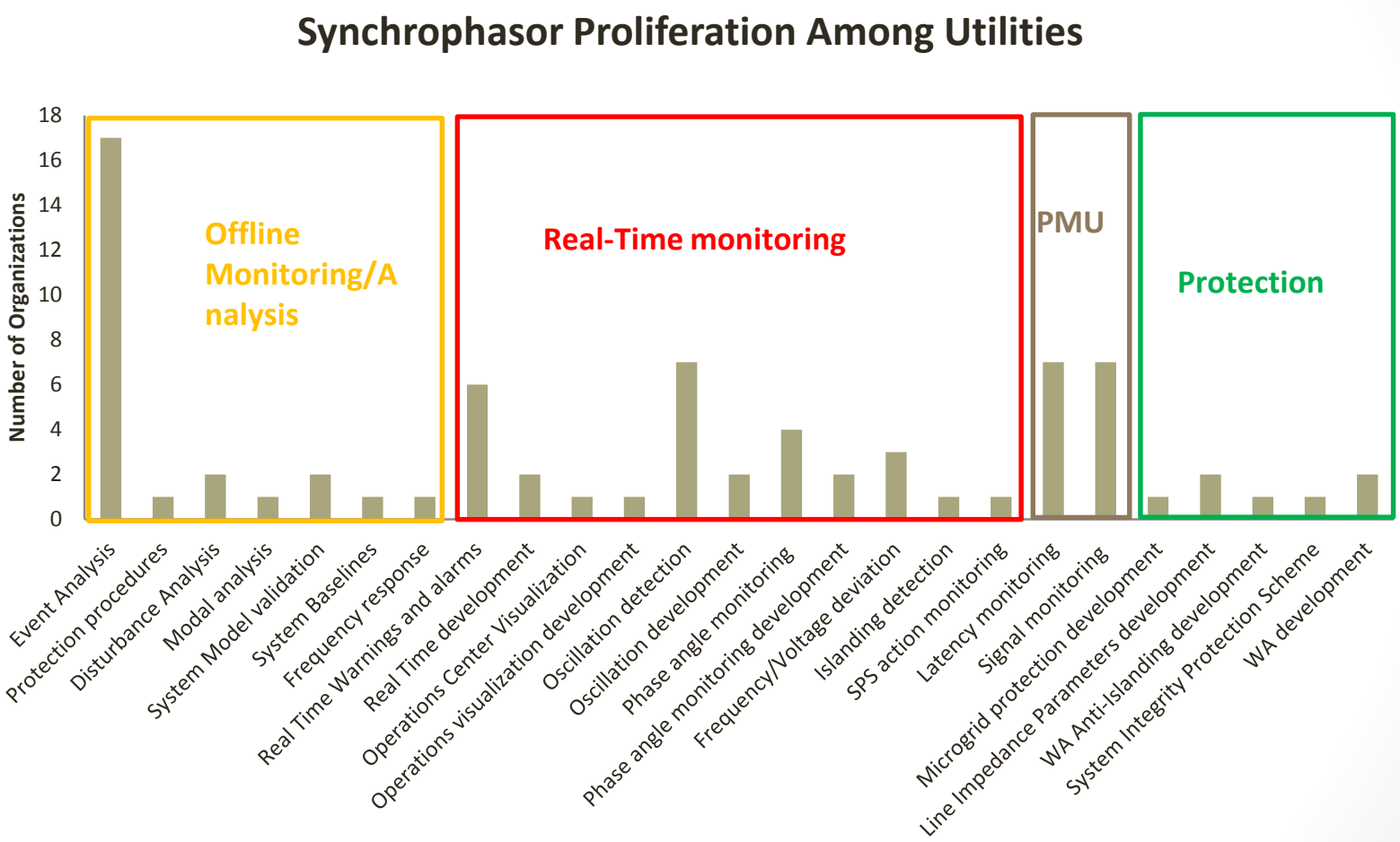
SYNCHROPHASORS IN PROTECTION SYSTEMS

- Asset Protection
  - **Distance protection** - Wide Area Multi-zone pilot operated schemes Zone 3 delayed backup protection
  - **Differential protection** - Wide area differential
  - **Transfer Trip schemes** - PMUs can collect and send digital bits for enhanced TT
- System Protection Schemes
  - **Out of Step Protection** – Already developed
  - **Transmission Line Impedance Estimation** – Several industry applications in service.
  - **Subsynchronous Resonance** – Potential with higher PMU report rates to eliminate anti-aliasing of SSR frequencies
  - **Oscillatory Stability Protection** – PMUs already detect oscillations
  - **Microgrid** – PMUs for islanding detection

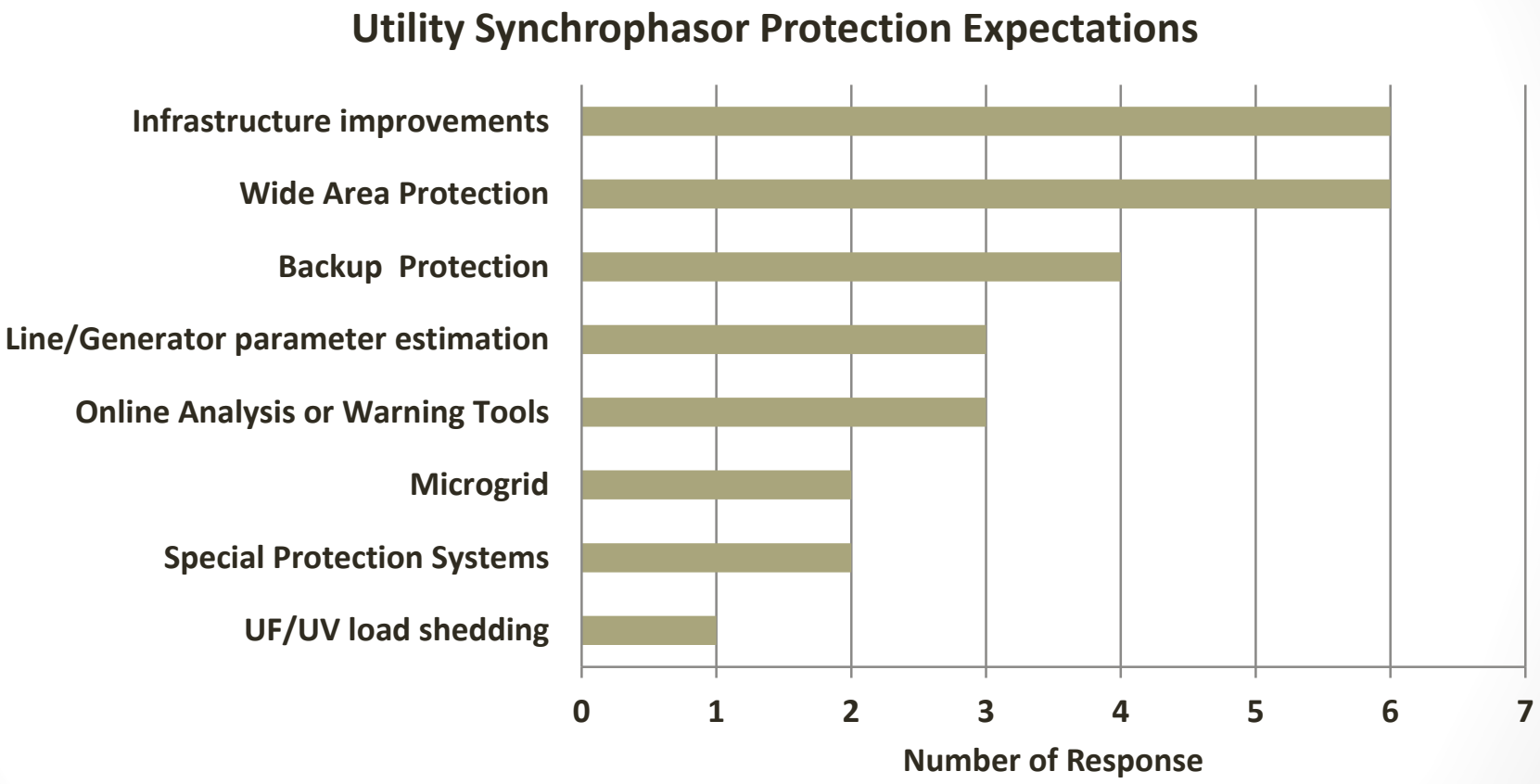
OBSTACLES FOR APPLICATION OF PMU DATA

- **Signal Quality**
  - Before PMU signals are input to applications, data quality needs to be quantified and addressed. NASPI PMU Application Requirements Task Force (PARTF) report forthcoming on this effort.
- **Signal Delay (Latency)**
  - Different network mediums introduce varying types of signal latency – algorithms under research to determine best signal paths to reduce latency through non-uniform signal channels.
- **Signal Security (Loss of GPS time synchronization)**
  - Loss of GPS clock causes wrong time stamp, angle drift and frequency deviation. Accurate, redundant sources required.

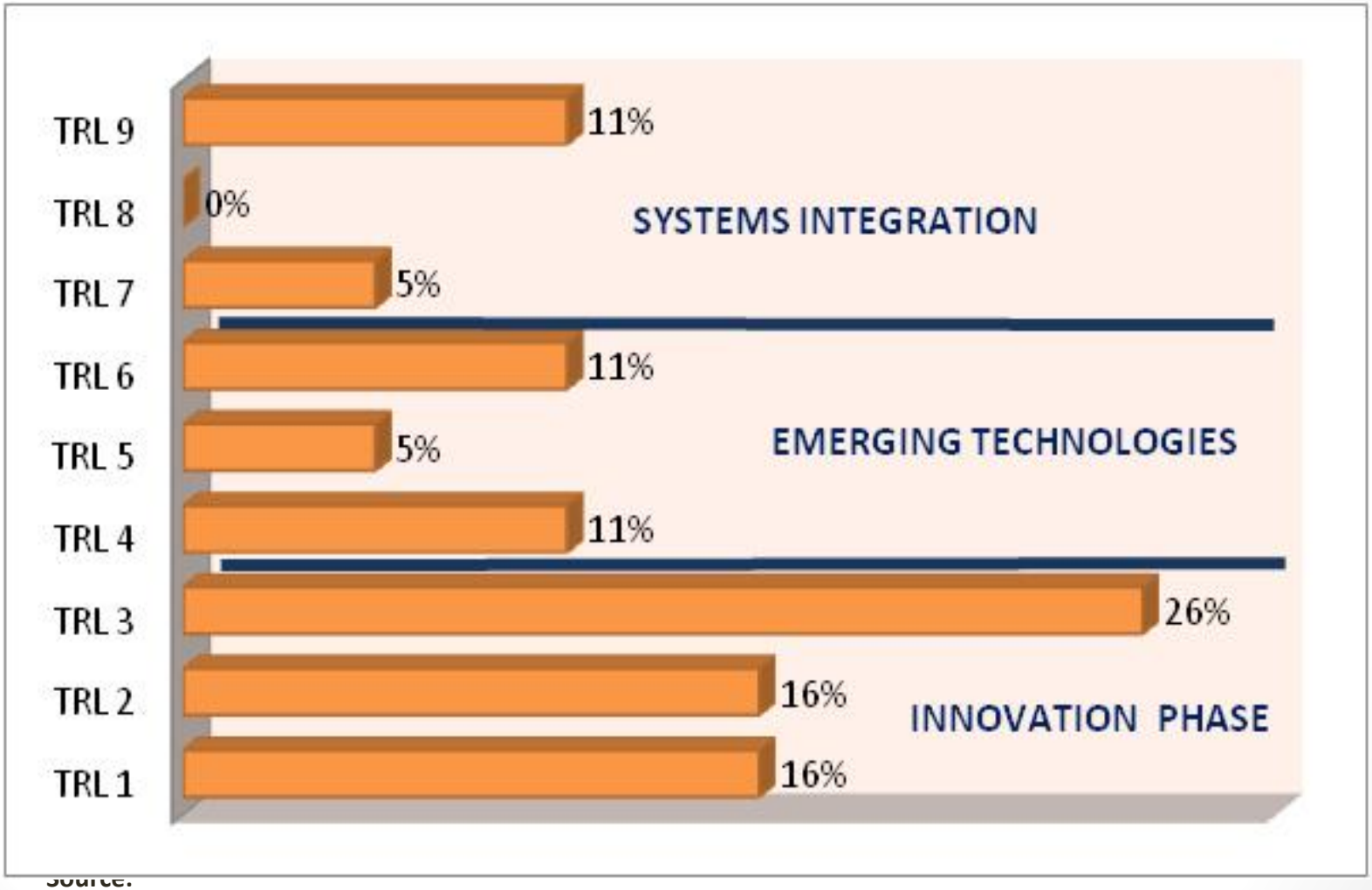
UTILITY SURVEY RESULTS



UTILITY SURVEY RESULTS



R&D SURVEY



Source:
http://www.bpa.gov/Doing%20Business/TechnologyInnovation/Documents/2014/Collaborative-Transmission-Technology-Roadmap-March-2014.pdf

VENDOR SURVEY

Vendor current product capability:
"PMUs (most relays and meters output C37.118), PDC (software and hardware), Visualization and archiving software …. Automated Control …"

Vendor view of Synchrophasor protection application today:
"Wide area protection due to better understanding of the system. Also, islanding detection and various over/under value detectors are already very helpful right now."

Vendor view of Synchrophasor protection application in the future:
"We believe the synchrophasor technology and its base technology, synchronized measurement, coupled with guaranteed communication latency, will be applied to an expanded list of protection areas in the future…"

CONCLUSIONS

- Direction forward points to substation-level element protection schemes with synchrophasor technology
- Data quality efforts should be implemented to ensure the highest quality of signal based on application.
- Detailed studies on PMU data collection timing and relay data collection and processing to determine the true benefits synchrophasors can provide.
- At this time, though, synchrophasor technology is already proving invaluable in protection fault analysis and potentially to determine data trends that can be used to mitigate transmission system events.

QUESTIONS

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