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# FUTURE OF DISTANCE BACKUP ZONES IN A SYNCHROPHASOR-BASED WIDE-AREA BACKUP PROTECTION SYSTEM

*Question 1.5 from Special Report:*
*What are the trends of backup protection considering the development of communication? If the performance of such wide area backup protection is acceptable, will the traditional backup protection be partially or totally replaced? If so, how to construct a complete backup protection system? How to simplify the setting coordination of backup protection?*

Response from author of B5-112:
The central concept of the paper B5-112 is to present a backup protection strategy that utilizes synchrophasor current and voltage measurements collected via a wide-area communications network. The current measurements are employed in a sequenced application of surgically precise current differential fault detection and location. Voltage measurements are optionally used for controlled protection against out-of-step or islanding conditions as well as voltage instability protection; these voltage-based stability methods are treated in papers of others.

The author of B5-112 proposes that an accurate implementation of the phasor current based backup protection strategy is robust. The fault current measurements are not critically dependent on a set of system conditions as is the case for backup distance relays. The paper points out the application issues that do require attention in design, and proposes that these phenomena are manageable. A benefit of the current phasor based scheme not cited in the paper is that even as new sources of generation are connected to the system at unconventional locations and with unconventional fault current contributions – like wind farms or large photovoltaic (PV) generation sites – the new backup protection scheme can make the correct tripping decisions. It requires no elaborate calculations or coordination to do so, and offers much better sensitivity for low fault current contributions. With this and the other advantages listed in Section 6 of the paper, no other backup protection scheme is needed. If the synchrophasor current based backup protection scheme works as expected, any distance-based backup scheme left in service will detect uncleared faults more slowly and will never actually have a chance to operate. Theoretically, this distance based backup can be removed from service.

The key to success is reliable, available, secure communications as described in Section 4 of the paper. The author acknowledges that a communications-based backup protection system is unfamiliar, and raises questions of channel availability and cyber or physical security. Many potential users would need to make a major investment in communications infrastructure; the business case for doing so would be based on current-based backup protection scheme advantages along with the many other uses of the wide-area network communications. There are many utilities which already have suitable communications – these are in a position to consider a trial application of this communications-based backup strategy. Some of these also have substantial penetration of PMU deployments.

Until highly available, redundant, secure high-speed communications paths for phasor data become a familiar fixture to users, the conservative inclination of the industry (and the author) would favor keeping a safety net scheme that works without communications, as today's backup works. The nature of a safety net is that it unconditionally saves the equipment of the

system from damage, but may not be focused on achieving well-coordinated fault clearing. Familiar overreaching-zone distance elements can be set with delays longer than those of the current phasor based backup scheme (which could be the same backup delays as used today), along with longer distance reaches or lower current setting thresholds.

The marginal cost of continuing to include familiar backup zone functionality in relay-PMUs or other protective relaying installations is negligible. The effort to set them is not negligible, but is far less than is required for coordinated protection and is free of significant maintenance work if these safety net principles are applied:

- The fundamental purpose of the non-communicating safety net elements is to protect equipment from damage.
- Coordinated protection that never overtrips is *not* a required objective. So backup element zones can be set to reach greater distances.
- The time delays are set beyond those of the phasor current based backup, so that safety net relays operate only if the phasor-based backup fault protection system fails.
- Note that, since backup fault protection based on current phasors can be significantly faster than today's distance backup, the existing backup distance element time delays may *not* need to increase as they are changed to safety net service.
- Safety net relays do not require comprehensive coordination studies with application of vast arrays of trial fault cases, or periodic updates to tune settings as the system changes. In the unexpected event of all existing primary and multiple backup protection layers failing to operate, overtripping is accepted.

A potential new user of the backup system based on current phasor communications should consider the collaborative nature of its relationship to the existing distance-based backup protection. If coordination of backup zones had been kept up to date until the time of introduction of the new scheme, and if the new scheme is faster (as it is likely to be), it is then not necessary to make any changes to the existing distance backup protection as its role shifts gradually to that of safety net. The synchrophasor backup system can operate at first in an open-loop mode (records of fault location determinations and trip decisions, but no actual tripping) to demonstrate effectiveness, and to give the owner a chance to correct design or configuration errors. Once the new scheme is allowed to trip, its operating records may expose the shortcomings of the distance backup settings. As confidence builds, the owner can increase the reach or coverage of the safety net, knowing that precision of setting is no longer critical.