Industry Feedback & Followup Questions Regarding DTT & LL

Prepared by Industry for PSEGLI-IWG meeting xx March 2020.
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1. General Document Notes

a. All information and products referenced in this document presented on behalf of the PSEGLI-IWG industry only and do not represent any position or endorsement by PSEG Long Island.
b. Default black text contains general reference, acknowledgement or summary notes
c. Red text indicates specific sections to focus on during initial presentation
d. Key reference: ***PSEG Long Island's Distributed Energy Resource (DER) Direct Transfer Trip (DTT) Requirements***, Long Island Interconnection Working Group Meeting, August 22, 2019
e. Additional related JU document, that has not been included in this document to review: ***Interim JU Anti-Islanding Criteria (February 9, 2017)*** found on the ITWG website
f. The desired outcome of this document is to facilitate future discussion; it is not intended that all the content in this document be reviewed at the next meeting.
g. We recommend a separate focus group where a detailed conversation about each item can take place, using this presentation and the PPT above as reference.
h. UGR = Utility Grade Relaying

2. Baseline Review of CESIR SCADA & DTT language. Goal is clarity of what the existing reasons & requirements are. Suggest CESIR revisions and/or separate overview/terminology document.

a. Current DTT & LL language is not easily understood and information is not readily available. For reference, below is a direct excerpt of sample CESIR language for SCADA & DTT. Some key sentences are highlighted and referred to below.

20. **SCADA is required for this interconnection**. Please update drawings to reflect this. For SCADA: Developer is responsible to order the lease line. The developer will require a TLS (wired) and/or MPLS (wireless) connection for the RTU to SCADA. The output of the RTU needs to be DNP 3.0 Serial. Verizon will install Router at developer site. The RTU connects to Verizon router via RS-232 serial connection. The required RTU Points Count is as follows: There will be a total of 9 points, 1 digital and 8 analog. Digital points will be: Interconnection Breaker Status. Analog points will be: A phase amps, B phase amps, C phase amps, A phase voltage, B phase voltage, C phase voltage, WATTS and VARS. Since Direct Transfer Trip (DTT) is also required for this interconnection, the following additional digital points will be required: DTT Received, DTT Status and DTT Comm Fail. PSEGLI will provide RTU programming sheets (Function Tabs) to the Developer.

21. **Direct Transfer Trip (DTT) scheme is required for this interconnection**. Please update drawings to reflect this.

DTT needs to be provided via RFL GARD 8000 over T1 leased line and needs to be shown on relay functional. Show receipt of DTT tripping the interconnection breaker on relay functional. Also show the

lease line for DTT. Show all RFL equipment and model numbers on drawings.

The developer needs to order the DTT equipment that will be installed at the customer's facility. PSEGLI will order DTT equipment that will be installed at the LIPA substation and be paid for by developer. The RFL GARD 8000 Logic diagram must be CD65956. Depending on available dc voltage at the customer's facility one of the following RFL GARD 8000 are required:
- RF-GARD3U-1034 = GARD3UTSDTTD1250MPTP0E000ST0RI000 (125VDC)
- RF-GARD3U-1034-1 = GARD3UTSDTTD480MPTP0E000ST0RI000 (48VDC)
- RF-GARD3U-1034-2 = GARD3UTSDTTD240MPTP0E000ST0RI000 (24VDC)

T1 circuit to be ordered from Verizon: Point to Point T1 connection, B8ZS line coding with ESF and a Standard Jack. If part of T1 circuit is over metallic wires, that part of the circuit must be Class A SPO Type 4 and no repeaters. Verizon may require a positron to be installed at their facilities.

b. Confusion regarding CESIR language above
    i. It is not generally known or apparent, even by Verizon representatives, what the difference is between MPLS and a T1 connection. Following is common guidance from Verizon POC's.
        1. There are several "T1" type connections
        2. They have insisted that a traditional T1 is not available and only offered a MPLS circuit for both DTT & SCADA. Unsure if this is acceptable or not.
        3. Some providers are offering Ethernet(MPLS) with T1 capacity and calling them Digital T1. This may not offer the same performance of a traditional T1.
    ii. For example, based on the above comments, Verizon has suggested that there is no difference between the line requested for SCADA and DTT.
        1. This also makes it exceedingly difficult to plan for and quote.
    iii. Request additional clarity on each individual term in the statement Point to Point T1 connection, B8ZS line coding with ESF
        1. On several occasions the Verizon rep does not know what a B8ZS line is or ESF.
    iv. Obtaining necessary clarity from Verizon and/or PSEGLI-PAM can be a challenging process, especially if trying to facilitate discussion between all three parties
c. Requested actions
    i. A general desired outcome is a possible review/revision of the standard CESIR language below and/or
    ii. Create a summary handout for developer/designer reference. Ex. A dedicated document published by PSEG would be extremely helpful.
    iii. Provide PSEG vetted and dedicated POC's listed at Verizon who actually know what they are talking about.
d. ***NOTE: This is not intended to be reviewed in our group meeting but included for future development or reference in separate document. If we end up developing or pursuing a different technology, then this information will not be necessary. Simple and reliable resources/explanations of the technology are currently lacking.***)

Possible draft handout sections & terminology. The content below is the start of some basic review of leased line and data communication fundamentals.

i. Common Uses of LL's
    1. Note that the quality of the LL may not be required for all the cases below. That is one focus of this initiative.
    2. Utility Network Protection
        a. Direct Transfer Trip Signals
        b. SCADA
        c. "Current Differential" trip signal (used in some DER applications)
    3. Internet data centers, financial institutions, etc that need to maintain critical connections between nodes

ii. Network/Circuit Classification & Terminology
    1. A "leased line" is a generic term that refers to when a high reliability service is "leased" from the network owner such as Verizon. Wikipedia: A leased line is a private bidirectional or symmetric telecommunications circuit between two or more locations provided according to a commercial contract.
    2. TLS (wired other) vs MPLS (wired ethernet) vs T1
        a. TLS = Transport Layer Security = This is described as a protocol, and doesn't necessarily mean a wired connection. More clarity is needed.
        b. MPLS = Multiprotocol Label Switching = Routing technique in telecommunications networks that directs data from one node to the next based on short path labels. This does imply a network connection where there is shared traffic.
        c. T1 = Dedicated transmission connection between a service provider and client. Uses advanced telephone line to carry more data than a traditional analog line than a single channel of data at 64 Kbps. Developed by AT&T Bell Laboratories in 1962, traditional T1 lines use copper wire, but most new installations use optical fiber. T1 lines use pulse-code modulation, which allows coder and decoder sharing by multiple voice trunks. Channels are preconfigured to carry voice traffic or Internet data.
    3. **Deterministic Signal** = guaranteed and absolute fixed bandwidth and speed.
       Ex. Signal will ALWAYS arrive at exactly 2 ms from being sent
        a. Ex. A direct line dedicated circuit, not part of a network
        b. Network terminology: DS0, DS1, "Traditional T1", dedicated copper, "direct fiber", direct ethernet
        c. Traditional T1 is SONET based and deterministic.
    4. **Non-Deterministic Signal** = signal will arrive but will be within a range of bandwidth and speed
       Ex. Signal will arrive within 2 to 15 ms.
        a. Ex. Signal is being transmitted over a network that carries other traffic. Your traffic might be prioritized, but it is still over a network
        b. Network terminology: "T1 Equivalent" or "Digital T1"
    5. Virtual Synchronous Network (VSN) = TBD

3. Fundamental review of DTT requirement & standards

a. (slide 4) Review & basis review of current screening requirements
   i. For inverter-based generation ≥1,000 kVA regardless of penetration, or as otherwise deemed necessary
      1. Confirm if statement correct: Regardless of penetration, DTT is a requirement for inverter DER >= 1000 kVA for all feeders with <50% DER penetration. Is this happening?
      2. What is the basis for 1MW limit? Is this because the assumption that projects over 1MW can handle the extra cost?
   ii. For any DER, of any technology or size when DER penetration exceeds 50% of applicable load (Screens P8 & S1)
      1. Note that this requirement implies that DER of 51 kVA or more require DTT on >=50% DER penetrated feeders. Confirmation that this is happening?
      2. What is the basis for 50%?
      3. What is the process for performing a risk analysis to evaluate higher levels of penetration? Ex. 80%.

b. Building on Slides 3 and 7, in preparation for forthcoming discussions about timing requirements
   i. The key concern is that the DER will not have tripped offline when the recloser recloses, thus resulting in an "out of phase" reclosure
   ii. For reference, total recloser sequence of events is
   fault → recloser fault detection → recloser open contacts → recloser reclose
   iii. However, because it is assumed that the DER is not sensitive enough to detect a fault (for various reasons, discussed more below), the reference duration of concern is
   ~~fault → recloser fault detection~~ → (a) recloser open contacts → recloser reclose
   iv. Total reference "DER open" duration of concern
   ~~fault → DER fault detection → DER open contacts~~ (not sensitive enough)
   (b) recloser open contacts → DER fault detection → DER open contacts
   v. * In conclusion, if DTT is NOT installed, to prevent an out of phase reclose we would need to ensure that (a) the time for the recloser to open and close again
   recloser open contacts → recloser reclose
   is GREATER than
   (b) the time from the recloser open contacts to the DER opening its contacts
   recloser open contacts (fault) → DER fault detection → DER open contacts
   by some minimum value.
   vi. Questions below will address durations/concepts in this section.
   vii. We acknowledge, however, that the time it takes the DER to trip varies under different settings and conditions, as outlined below.

c. Reference circuit review & proximity questions
   i. Anytime a "recloser" is referenced in this discussion, it is at the same place that the DTT signal would *originate*
   ii. As such, the recloser is assumed at the substation and the DER would be at some place on the circuit
   iii. How does the requirement for DTT change based DER proximity to substation?

iv. How quickly do UGR detectable voltage and frequency conditions propagate down the circuit?
v. In other words, if DER is located within a certain distance of the substation and has sufficiently programmed UGR trip settings, could DTT not be required?

d. (slide 10) Clarification questions about not accounting for DER ability to detect fault, and statement: "Utility protection systems/recloser trips off at 10% to 20% dip"
   i. In a scenario when DTT would be required on a DER anyway, request clarification on why DER and recloser voltage trip settings cannot be made identical, thus resulting the same trip time characteristics negating need for DTT?
   ii. If the DER is being tripped off by DTT anyway, it seems the "ride through" functionality is an undesirable characteristic. In what instances, therefore, is "ride through" useful if the DER has DTT?

e. (slide 10) Questions regarding statement: "The undervoltage clearing time specified by PSEG-LI for voltages between 50% and 88% of nominal is 5.0 seconds". And review of UGR & UL trip setpoints.
   i. Please confirm if this rewrite of the statement is correct. If not, revise please - PSEG's operational requirement is that voltage to customers cannot be within a range of 50% to 88% of nominal for more than 5.0 seconds.
   ii. How does this statement make sense when considering previous statement?
   iii. What is this setupoint used for? For example, it doesn't make sense that this is a customer DER UGR setpoint.
      1. For example: Once the voltage dips to 88% of nominal the DER's UGR is programmed to trip after 5s?
   iv. What are the UGR standards for tripping? What are the UL standards for tripping? Confirming these standards seems important to properly evaluate whether or not the UL setpoints are possibly adequate.

f. Recloser vs DER time comparison, questions from presentation
   i. (slide 7) Quest re statement: "Electromechanical reclosers with no intentional delay are considered "instantaneous" which in ~200 ms. Microprocessor reclosers are set to 300 ms delay".
      1. Which total duration does the 200(300) ms represent? Does it include the time between fault, fault detection and opening of contacts?
         a. fault → recloser fault detection → reclosure open contacts → recloser reclose
            Or
         b. ~~fault →~~ recloser fault detection → reclosure open contacts → recloser reclose
            Or
         c. ~~fault → recloser fault detection~~ → recloser open contacts → recloser reclose
      2. How long does it take for the recloser to detect the fault?
      3. If settings are the same,
         how long does it take for PSEG required DER UGR to detect the fault?
      4. And compare to
         how long it takes for UL tested inverter to identify the fault?
   ii. (slide 11) Quest re statement: "Many DER AI schemes use some form of destabilization to drive voltage or frequency to trip points. Shortest trip points are 160 ms; 40 ms margin is far too little time for the destabilization to succeed."

1. Confirm that the 160ms duration represents
    a. recloser open contacts (fault) → DER fault detection → DER open contacts
    Or
    b. ~~recloser open contacts (fault)~~ → DER fault detection → DER open contacts
    Or
    c. recloser open contacts (fault) → DER fault detection → ~~DER open contacts~~
2. Slide header suggests that this is the duration for UL-1741 certified inverter. How would the 160ms value change if using appropriate PSEG specified UGR settings (ex Schweitzer Relay)?
3. Request clarity on this 160ms scenario vs the "trip at 50% to 88% of nominal in 5.0s" standard

iii. (slide 11) Quest re statement: "Research testing indicates typical AI detection times in the "hundreds of milliseconds" even with substantial generation/load imbalance"
1. So is 160ms the incorrect value to use as a reference? What reference value should we use then?
2. What actual studies/papers can we reference?
3. Can we use a circuit modeling tool given that this is already a trusted resource for many other critical protection analysis?

iv. (slide 11) Quest re statement: "Shortest trip points are 0.16 seconds; 40 ms margin is far too little time for the destabilization to succeed"
1. Why is 40ms "far too little"? At what margin is enough? How can this be "minimum margin" be accurately determined?

v. Pending clarity on the various questions above, we revisit the calculation of the new '40ms +/- SD' is the correct statistical mean & variance. Then we can evaluate what is appropriate for UGR to trip.

g. To review & next steps: Why is DTT not commonly required for other utilities? Sample actions & questions for future review:

i. Acknowledged, need to review the JU document: ***Interim JU Anti-Islanding Criteria (February 9, 2017)*** found on the ITWG website
1. Note that reclose blocking option is referenced throughout the document.

ii. Other utilities in NY have moved to reclose blocking which installs potential transformers (PTs) at the utility substation to prevent out of phase reclosing.
1. We understand historically PSEG-LI stated they predominantly use switchgear, which is costly to install. CenHud (for example) have developed cheap alternatives to PTs in switchgear which simplifies installation, it also works for any DER on the circuit once installed.

iii. Is "instantaneous reclose" the primary reason DTT is required in PSEG territory?

iv. Do the other utilities not have good SAIFI metrics?

v. What are the key reference values used for other utilities and why do they not see the same concerns as PSEG?

vi. It is our understanding that other members of the JU have required utility supplied reclosers for their customer projects, and this also has reduced or eliminated the need for DTT.

vii. What other reasons why DTT is more of a requirement in PSEG territory?

h. Discussion(s) about modifying "instantaneous trip" policy
    i. *Reference: (slide 8) Reclosing is critical to maintaining customer reliability. Majority of faults are eliminated without an "outage". Yields a substantial increase in the SAIFI metric on which utility performance is evaluated.*
    ii. What if 200(300)ms limit is raised to 400ms? As noted above, what margin is enough?
    iii. Using 160ms as a reference UGR trip time, it seems plausible that a relatively slight increase in recloser closing duration would result in sufficient margin.
    iv. To review is how an increase in recloser duration would actually impact SAIFI metric. What are the actual final resultant impacts/sensitivity of the SAIFI metric?
    v. What would be a sample cost to adjust or upgrade reclosers on a feeder by feeder basis if a proposed DER on the circuit would otherwise require DTT?
        1. This upfront costs may likely still be better than monthly LL payments over the entire lifetime of a project.

4. DTT alternative technology options & usage by other utilities (only desired to pursue if we have properly vetted DTT basis completely)

a. In the event DTT is ultimately required, seeking less expensive solutions with lower or no recurring costs.
b. Reference: ***SEL Leased Line Alternatives***, presentation by Joe Malone from RSI Reps
c. Following are industry "first impressions" of each alternative to traditional leased lines for DTT Applications and possible references for each application supplied by SEL.
d. Direct Fiber
    i. Arrangement: Using existing overhead poles to run a direct fiber cable between DER and substation
    ii. Product Presented: SEL ICON supports multiple fiber topologies for Reliability and simple point to point service of DTT, SCADA, etc
    iii. Costs: Believe that this will be a financial evaluation with utility pole owners (Verizon or other such as RCN or Lighpath). Unsure of how much would be in upfront capital costs vs. recurring pole usage or easement costs.
    iv. Risk Profile: Given direct connection, would expect same or higher reliability than any other solution presented. Additional review necessary.
    v. Questions for PSEG: Interested in PSEG-LI thoughts on this solution and whether it's done this for any other projects to date
    vi. Usage by other utilities: TBA
e. Sonet Network &
   Leased Ethernet Services
   (Not a focus because this option may already be used. Key goal is atto clarify confusion on this.)
    i. Arrangement: Using existing data network by Verizon or other network owner
    ii. Product presented: SEL ICON (Integrated Communications Optical Network)
    iii. Costs: Acknowledged that this option still has a high monthly fee given quotes received by members already (Note that DTT and SCADA can share the same hardware and point to point connection)
    iv. Risk profile: According to SEL, risk profile is as good or more favorable than traditional T1 (slide 19, 22). Additional review necessary.
    v. Questions for PSEG:

1. To confirm whether this solution is already being offered for DTT? Need clarity on whether "Point to Point T1 connection, B8ZS line coding with ESF" is allowed with a MPLS service offered by Verizon or must it be a "Traditional" T1. (see previous discussion)
2. If classic Analog T1 is currently only option for carrying DTT signal, need to review risk analysis and possible implementation plan
3. What is the minimum necessary bandwidth? Note that ICON can work as an edge device with VSN to perform DTT and SCADA with only 10MB connection.

vi. Usage by other utilities:
1. Central Lincoln PUD, Cowlitz PUD, Hawaii Electric Light Company (HELCO), Consumers Energy, SCANA Energy
2. POC's: https://docs.google.com/spreadsheets/d/1Jq0XDc3Dva6-tq8I5fGlhL-K_auwWDoZlRwudDMPk-w/edit?usp=sharing

vii. Additional reference papers:
1. *Deterministic Communications for Protection Applications Over Packet-Based Wide-Area Networks*, Kenneth Fodero, Christopher Huntley, and Paul Robertson, Schweitzer Engineering Laboratories, Inc. https://drive.google.com/file/d/1TBFqhMYIW2Z1MXO0YL4SIPcUZJrNP4vQ/view?usp=sharing
2. *Addressing Analog Leased Line Obsolescence by Preserving Protection Channel Performance Over Ethernet*, Jonathan Geurink, Consumers Energy, Kenneth Fodero and Paul Robertson, Schweitzer Engineering Laboratories, Inc. https://drive.google.com/file/d/190nbdju7tkn6IUzUMAPvG07P529Um9LE/view?usp=sharing

f. Serial Radio

i. Arrangement:
1. Point to point wireless communication
2. Acknowledged that in general DER should not be very distant from substation on Long Island
3. Possible to "network" multiple points together to travel longer distances (ex, could possibly create an secondary DTT communication network)
4. Challenge will be siting poles or small towers between DER and substation. Ex. What is minimum height to ensure proper communications.

ii. Product presented: SEL 3031 Serial Radio

iii. Risk profile: Given (a) encryption, and (b) fail-safe tripping when packets are lost, seems to be a reliable and viable solution to consider. Additional review necessary.

iv. Costs: Majority cost is upfront siting. Possible ongoing maintenance costs. These are favorable characteristics to industry.

v. Questions for PSEG: TBD as we continue this review process. What is the minimum necessary bandwidth?

vi. Usage by other utilities:
1. *Early Experience in the Application of Unlicensed Wireless for Direct Transfer Trip: A Pacific Gas & Electric Case Study on Rural*

Communications Infrastructure, Tim Kruckewitt PE, Mike Jensen PE, Eric Sagen EIT
https://drive.google.com/file/d/1j0t8wl1XVkXB7sY6wCGqqXSrQ9ejtSmY/view?usp=sharing

vii. Additional reference materials:
1. SEL Application Guide: *Using MIRRORED BITS® and SEL-3031 Serial Radio Communications for Protection Schemes*, Tom Bartman and Ariana Hargrave
https://drive.google.com/file/d/1JWzOle7ZD2g0SmIIZco5dFE2El2laKlN/view?usp=sharing

g. Cellular networks
i. Arrangement:
1. Cellular modems at DER and utility network operations center.
2. Risk profile:
3. Need to review in what cases, if any, that SCADA is used for protective action
4. Existing request is that an MPLS line be used (see previous sample CESIR language). Seems like MPLS line may be much more than is actually needed.

ii. Product Presented: SEL-3061 Cellular Router
iii. Risk profile:
iv. Costs: Recurring costs are estimated at 10x cheaper than MPLS line. Especially favorable for when only SCADA is required.
v. Questions for PSEG:
1. To review: When DTT is additionally required, Verizon has said that an additional circuit is not necessary. The suggested arrangement is to have three endpoints: DER facility, substation & utility NOC. Verizon has implied that this is what is being done already. To confirm.
2. Review of what type of data is typically transmitted over SCADA signal. In what instances is the network operations center sending a trip or other "supervisory" action?
3. What is the minimum necessary bandwidth?
4. Has PSEG-LI used this option on any projects to date? Seems like a highly favorable option from an industry standpoint.

vi. Usage by other utilities: TBA

5. General Notes & Question for PSEG

a. If LL & DTT standards change what is the process for currently operating projects shift to one of the newer, more favorable technologies?
i. Simply stated, the goal would be to shift to a less expensive technology that has lower recurring costs. (Recurring costs are among the most detrimental to long term project return.)
ii. Observe that "Material Modifications Tariff - Industry for JU review" document is on IPWG website for 19 June 2019 meeting. Soon to be officially adopted.
http://www3.dps.ny.gov/W/PSCWeb.nsf/All/0D7596DBBEF0380885257FD90048ADFA?OpenDocument
iii. What does PSEG define as "Material Modifications"?

1. Currently no document in the "Reference Documents" library https://www.psegliny.com/aboutpseglongisland/ratesandtariffs/sgip/documents

b. It has been suggested by other members of the JU that the utilization of reclosers for DER projects, supplied and programmed by the utility, eliminated the DTT requirement.
    i. Additionally, when a recloser was utilized, DER UGR was not required.
    ii. Industry will obtain more information on this scenario for future discussion