

2023-2025 WMP Joint IOU Covered Conductor Working Group

**New Technologies
Workstream**

**Topic:
EFD**



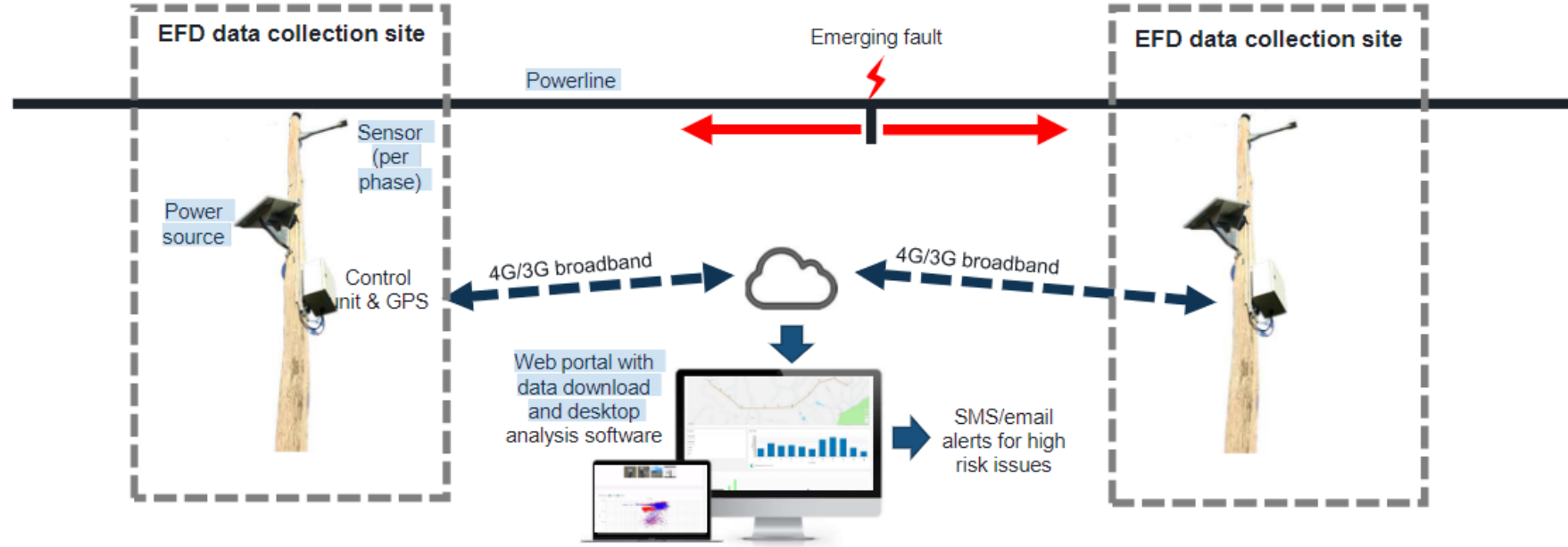
EFD – EARLY FAULT DETECTION

- Technology developed by IND.T in Australia to help prevent Bushfires
- The EFD system uses accumulated detections of partial discharge events to pinpoint equipment issues.
- Detection conditions types
 - Broken damaged conductor/splices
 - Broken damaged insulator
 - Failing service transformers
 - Vegetation encroachment
 - Fuse Cutout Malfunction

SENSOR THEORY OF OPERATION AND SPACE

Sensors installed along circuit approximately every 3 miles

Early Fault Detection (EFD) system

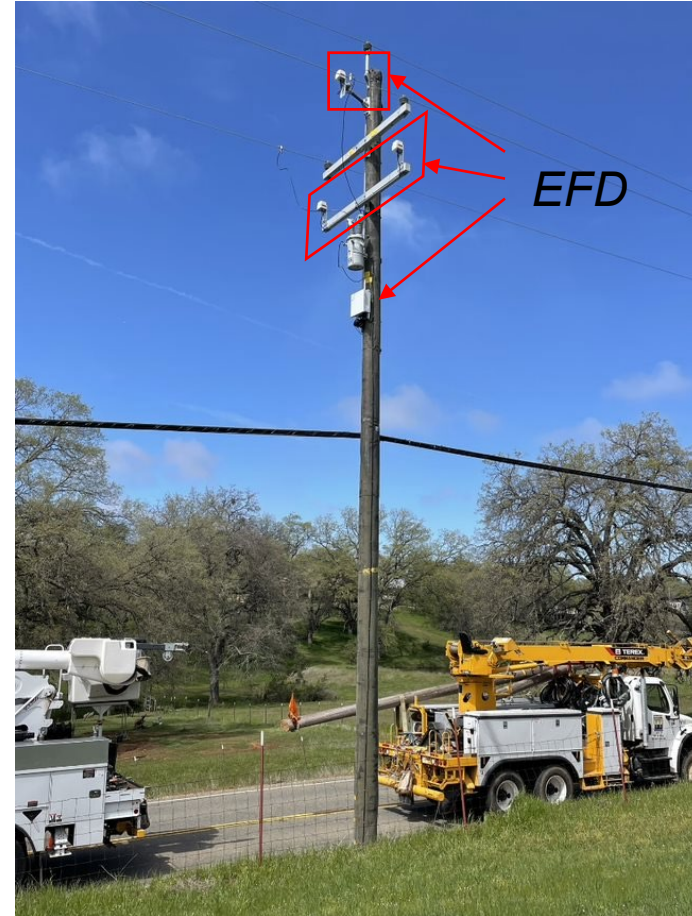


High frequency monitoring technology.

EFD delivers information you can act on before the event.

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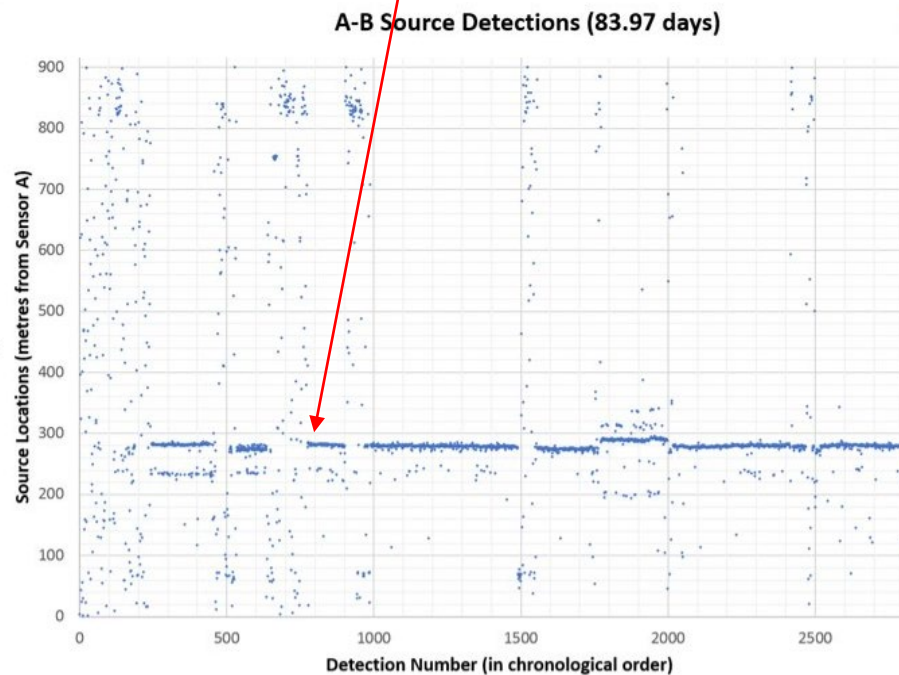
Installation



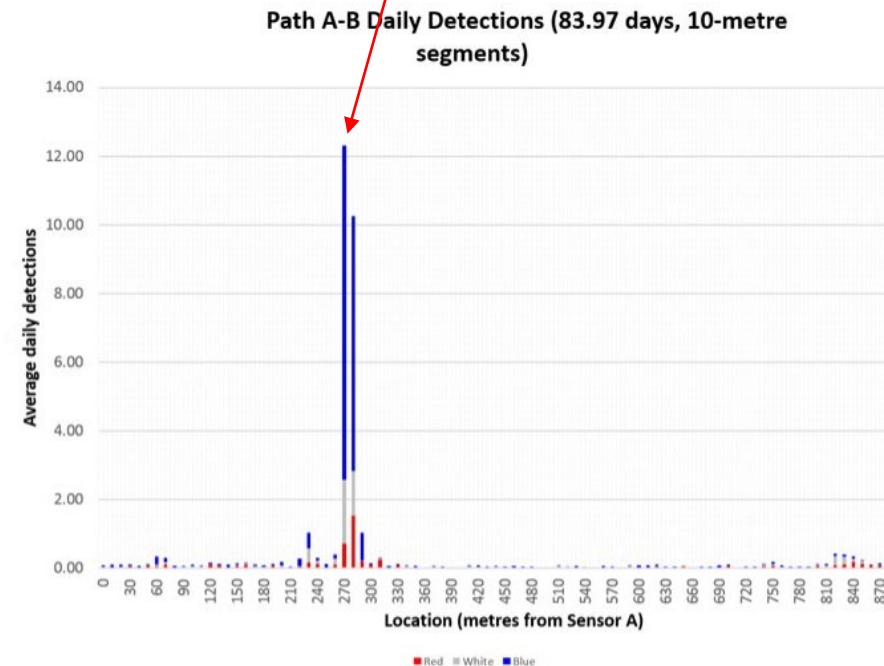
Signal Analysis Example

Signal Analysis Example

- Source Detections indicate where on a sensor path a problem is located

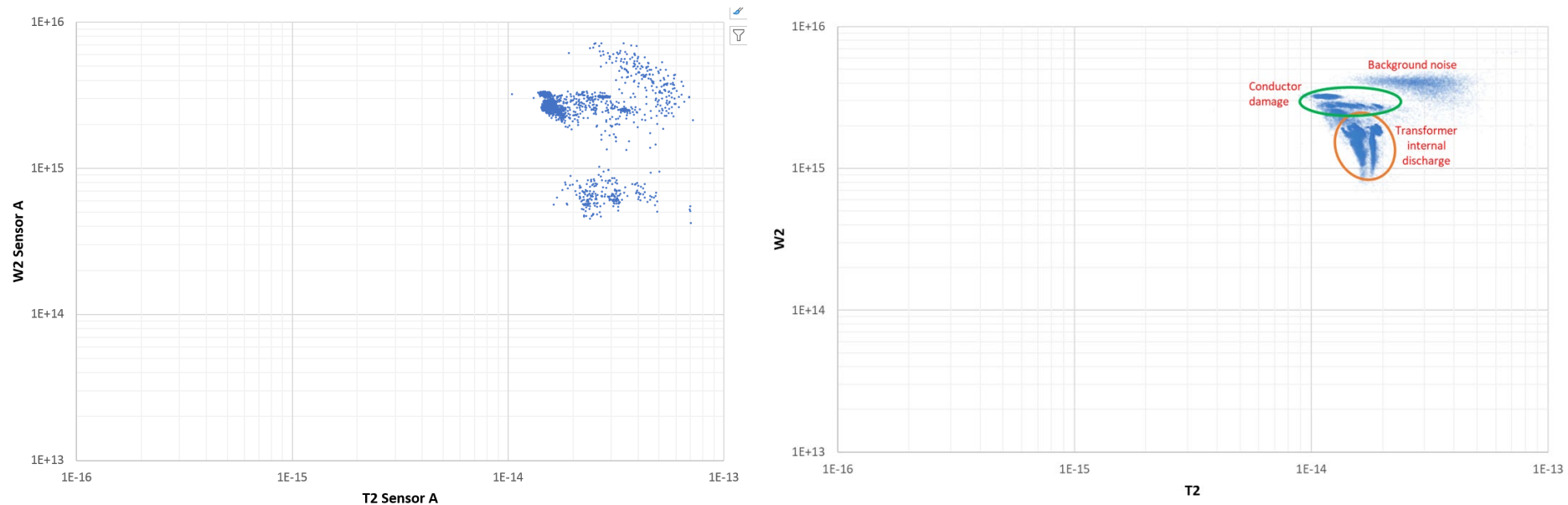


- Daily Detections indicate on which phase a problem is located



Signal Analysis Example

- Below is SCE frequency-time (FT) Chart (left) with comparison FT Chart from another utility (right)
- Patterns on FT chart indicate potential cause of issue(s)
- Consistent across different voltage classes and utilities



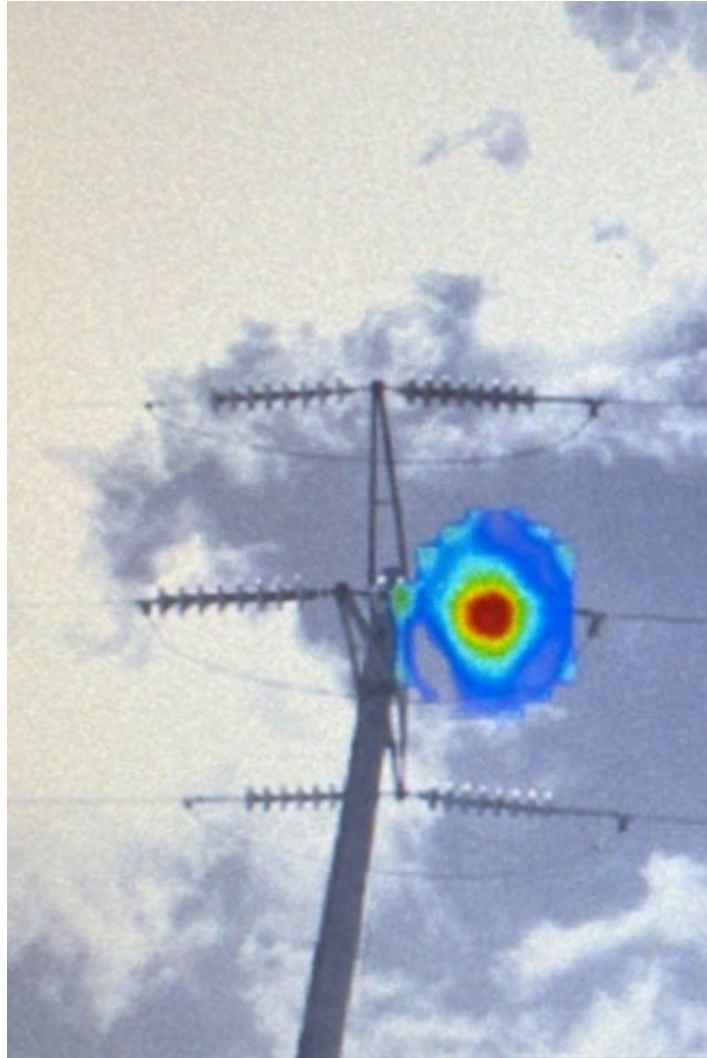
Examples of Findings - SCE



Examples of Findings - SCE



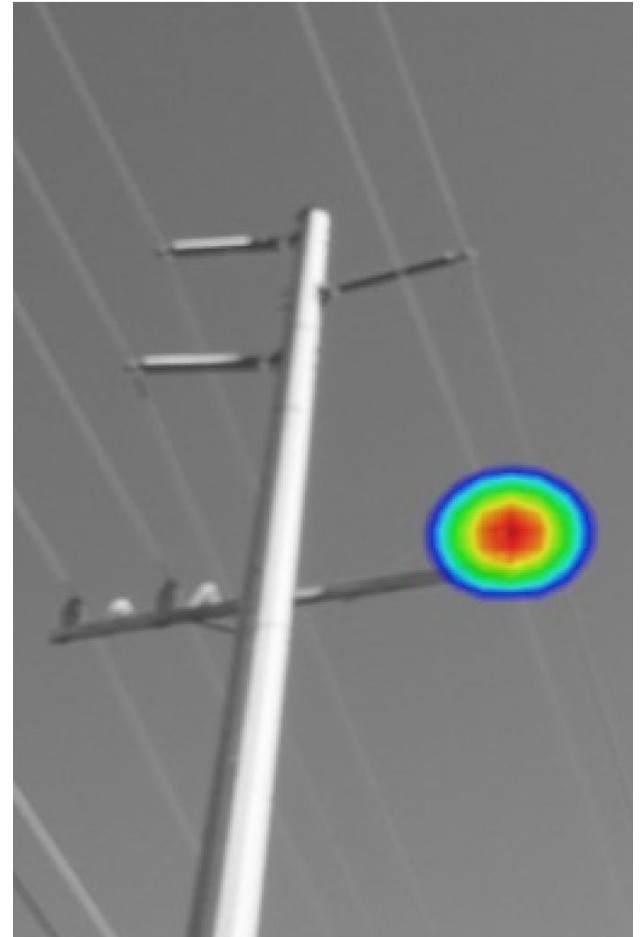
Examples of Findings - SCE



Industrial Acoustic Imaging Camera

FLIR Si124

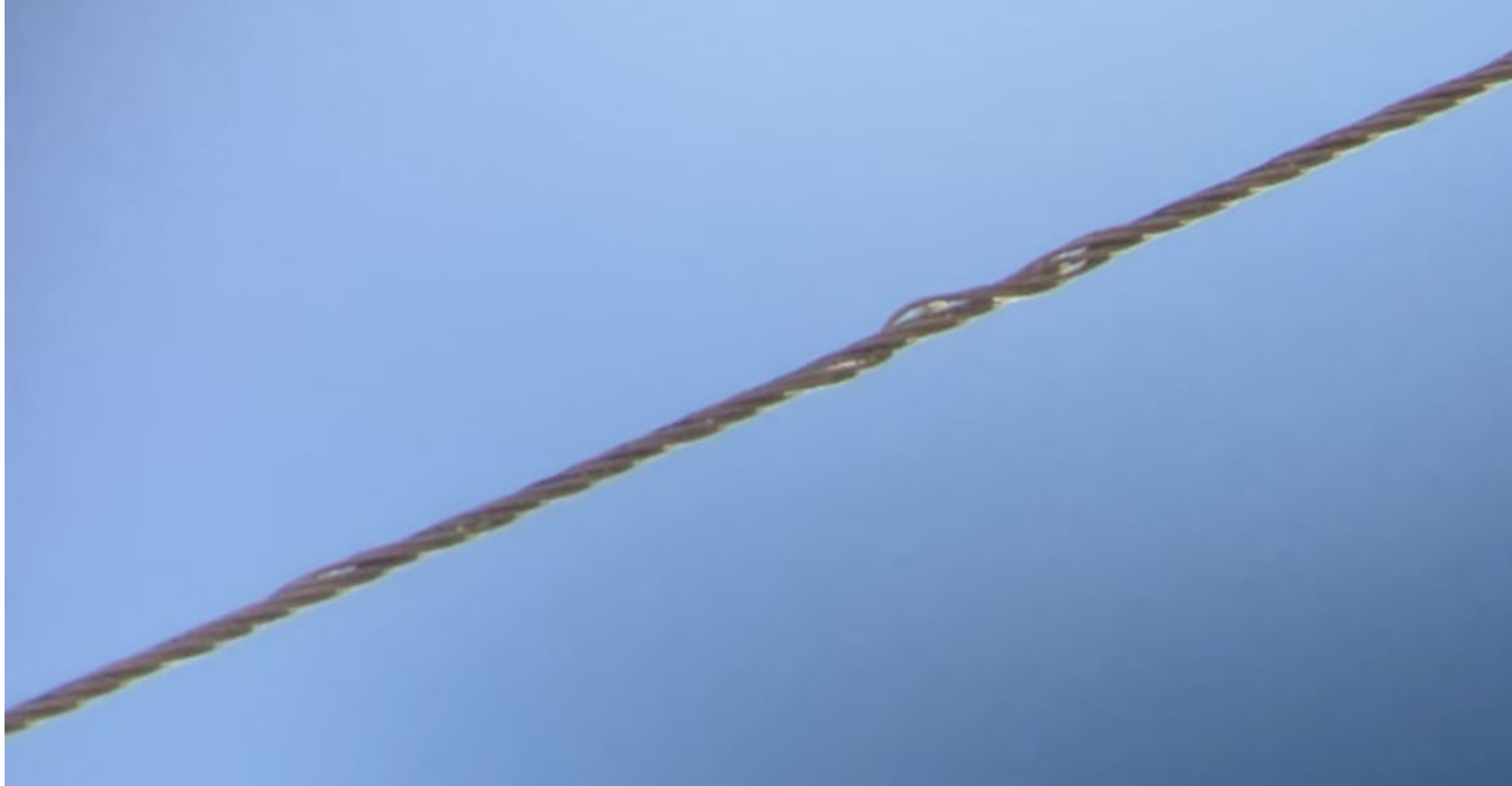
Examples of Findings - SCE



Examples of Findings - SCE



Examples of Findings – SDG&E



Examples of Findings – SDG&E

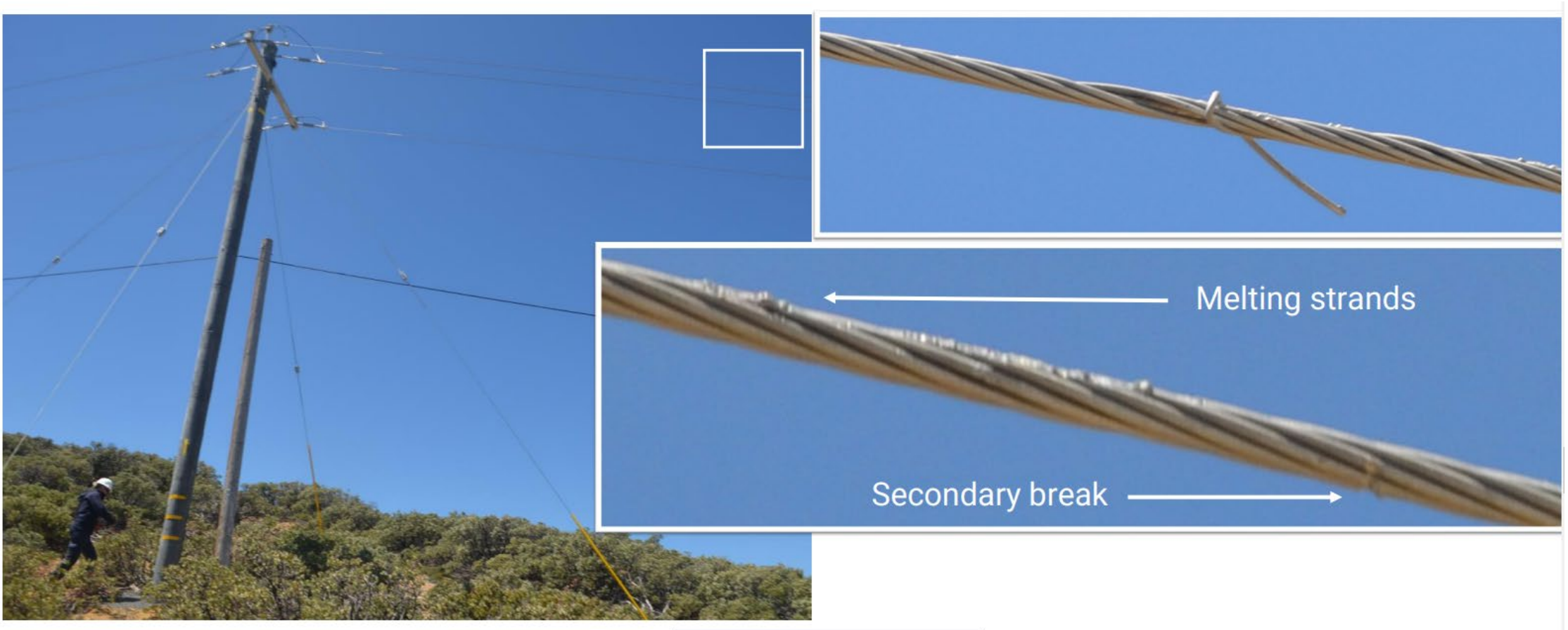


Examples of Findings – SDG&E



Examples of Findings – PG&E

Identified Condition – Broken Strands



Examples of Findings – PG&E

Identified Condition – Broken Strands

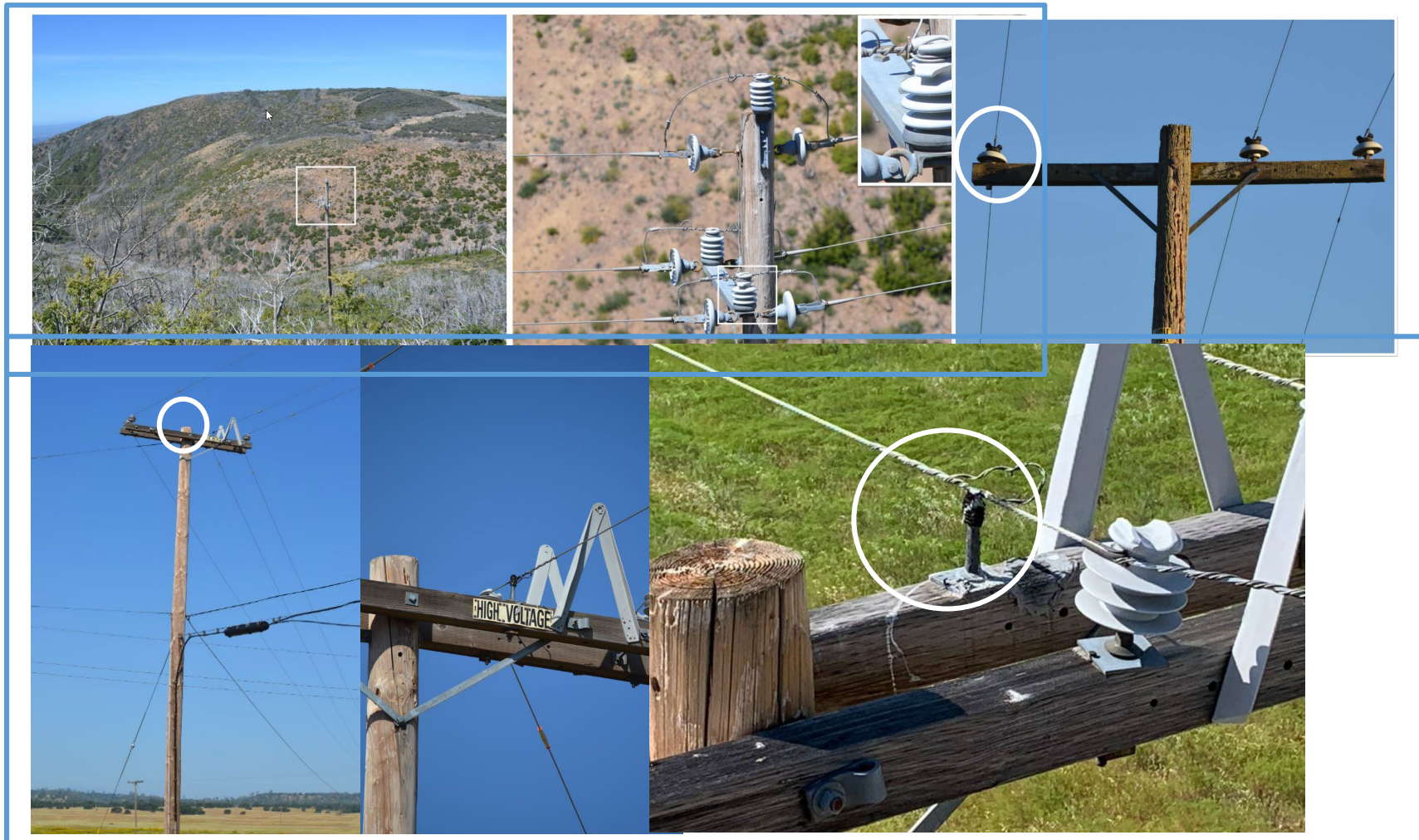


Examples of Findings – PG&E



Examples of Findings – PG&E

Identified Conditions- Broken Insulator/Pin, Melted Insulator



Technology Overview – PG&E

Situational Awareness Sensor Technology – Overview



Line Sensors / cFCI's

- Single phase, conductor mounted harvesting device; generally requiring 25 amps continuous power (line sensor) or battery-powered (cFCI)
- Continuously monitoring to capture overcurrent events
- Generates alerts and waveforms thru to PI and DMS; these alerts are usable in fault locator models like CYME to estimate disturbance location



EFD – Early Fault Detection

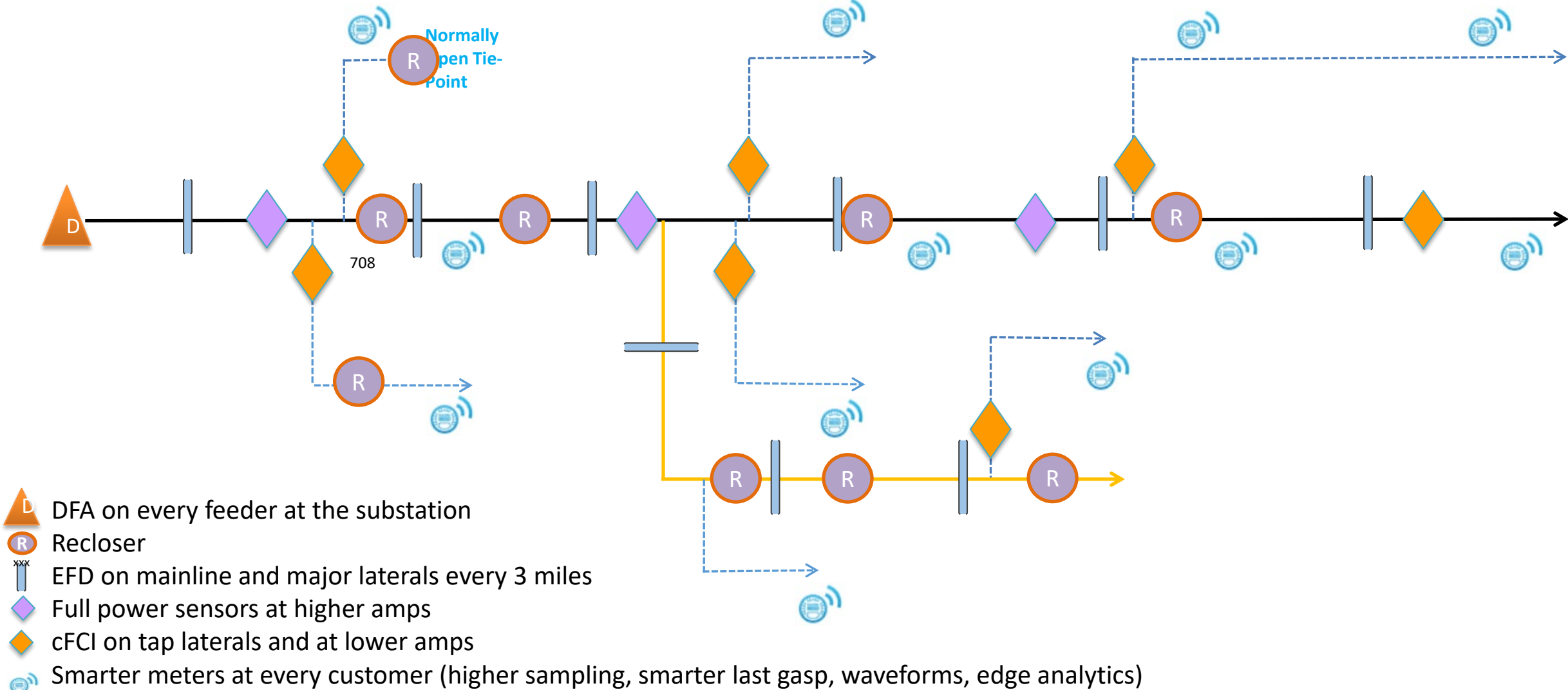
- RF sensors mounted underneath conductor; 3 miles between sensor sets
- Sensors work in coordination from set-to-set; samples on a duty cycle basis
- Display matrix identifies concentrated patterns of discharge to a single span



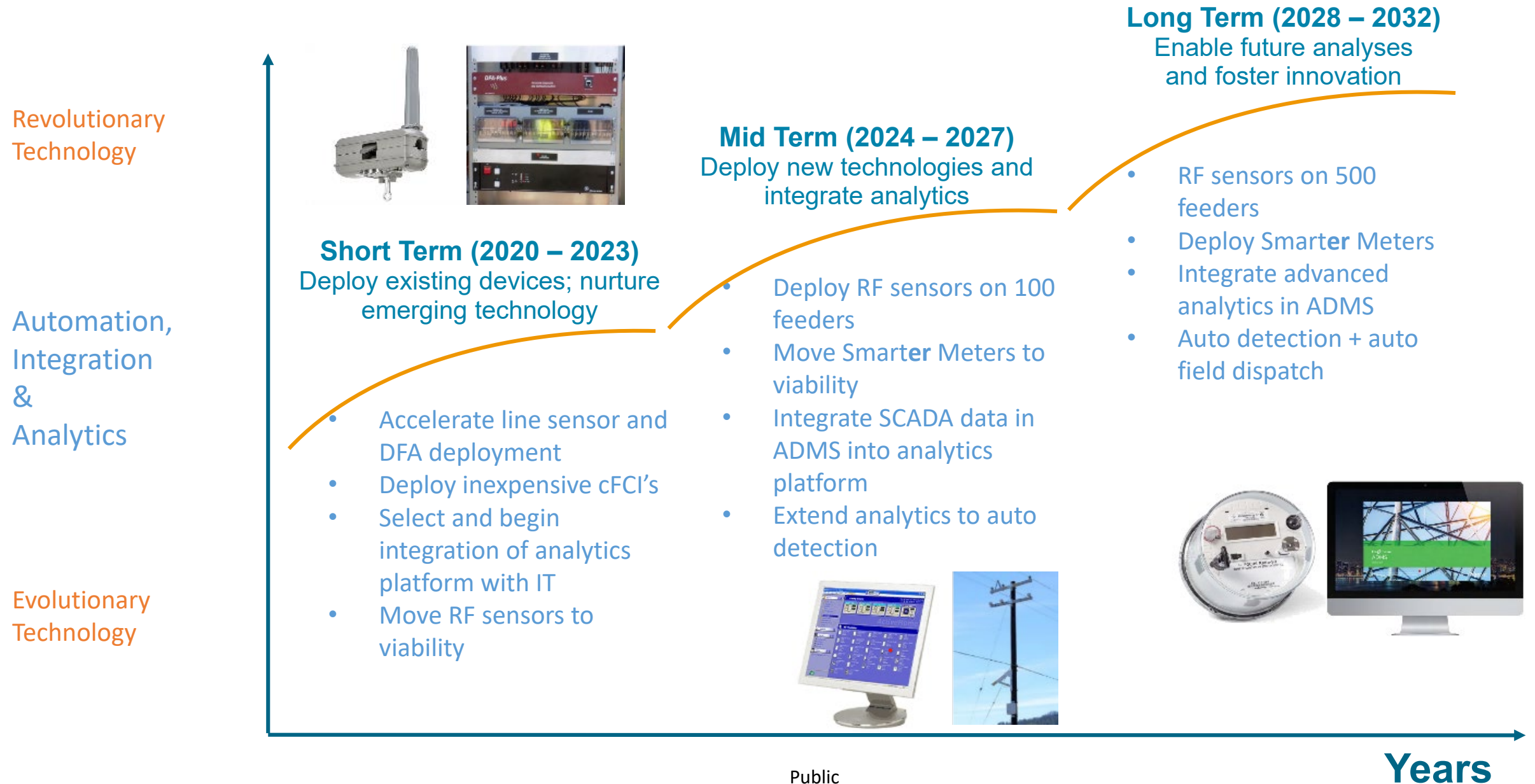
DFA – Distribution Fault Anticipation

- Substation CT / PT-based device measuring volts, amps and arcing
- Monitors magnitude, phase, harmonics, real and reactive power, cycle-to-cycle deltas in these values
- Clusters and categorizes events and generates waveforms; these alerts are usable in fault locator models like CYME to estimate disturbance location

Illustrative Circuit When Fully Implemented – PG&E



Rollout Process – PG&E



Rollout Process – PG&E

