2017 ADMS Program
Steering Committee Meeting

TRANSENSOR:
*T*ransformer *R*eal-time *A*ssessment i*N*telligent *S*ystem with *E*mbedded *N*etwork of *S*ensors and *O*ptical *R*eadout

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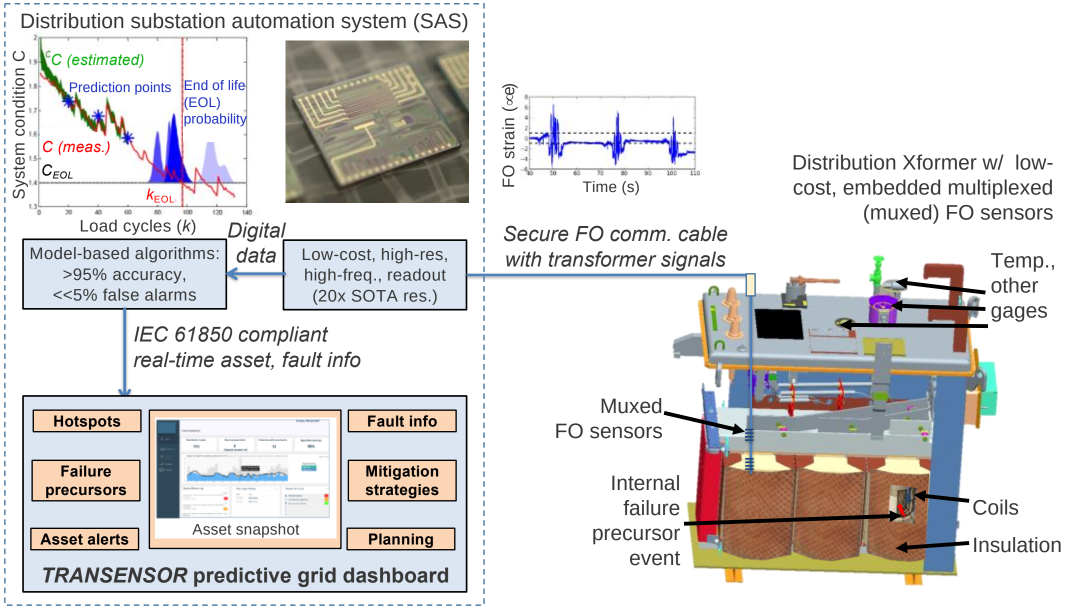
Partners:

October 12, 2017

TRANSENSOR

Objectives & Outcomes

- Low-cost, high-res grid asset optical monitoring focused on transformers
- Ensures safe, reliable grid asset management under uncertain DER
- Secure, interoperable; key enabler for DOE Grid Modernization Initiative



Technical Scope

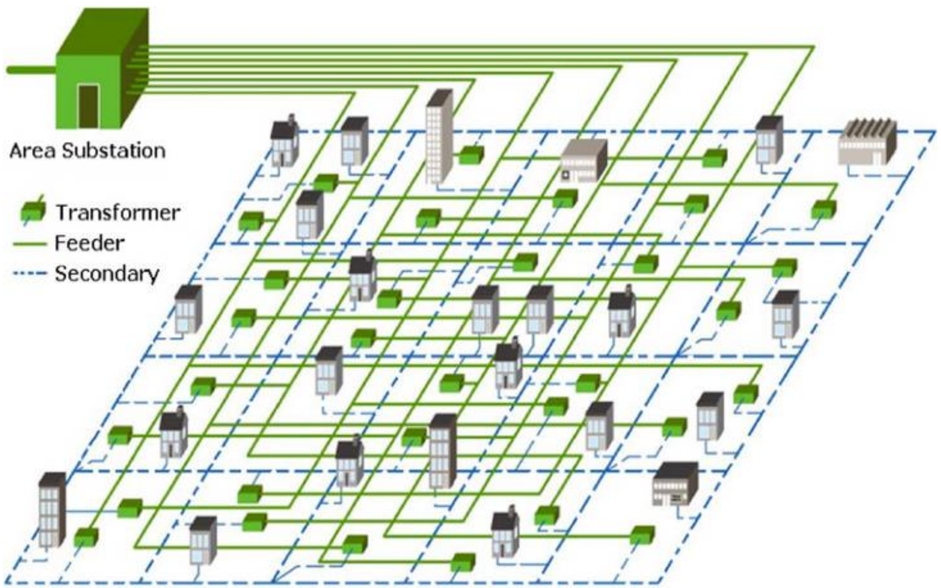
- Embedded fiber-optic sensing for key transformer internal parameters, state
- Phase I: Lab-level proof-of-concept with GE-GS distribution transformer
- Phase II: 6-month field demo at ConEd site with value analysis

Life-cycle Funding Summary ($K)

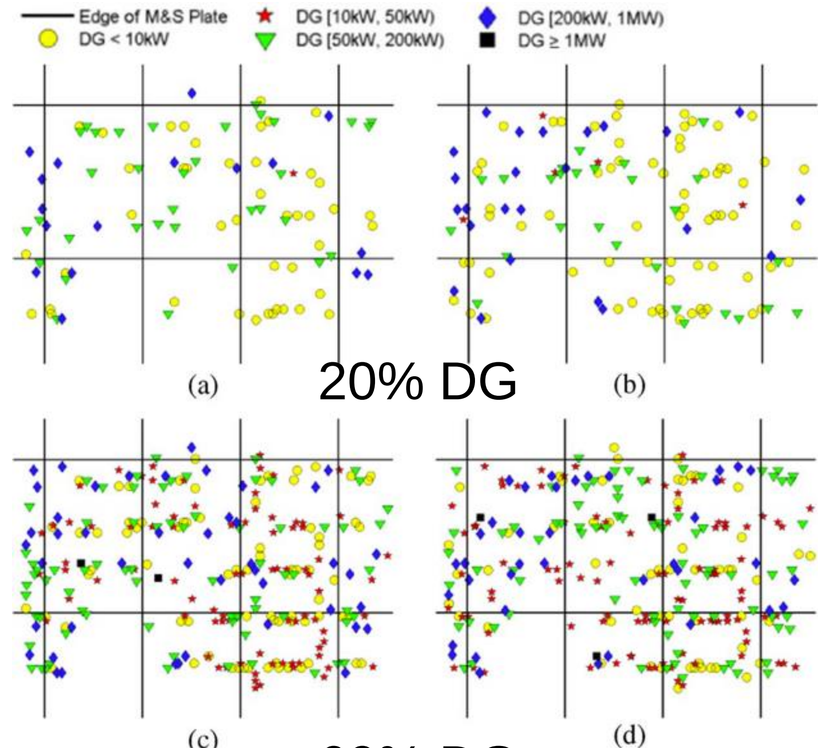
FY18, authorized	FY19, planned	FY20, planned
$773.6K	$620.3K	$106.1K

DOE Funds: $1.5 M/ Share 69%

Motivation: Effects of DER on grid/distribution



ConEd grid area (Sutton)



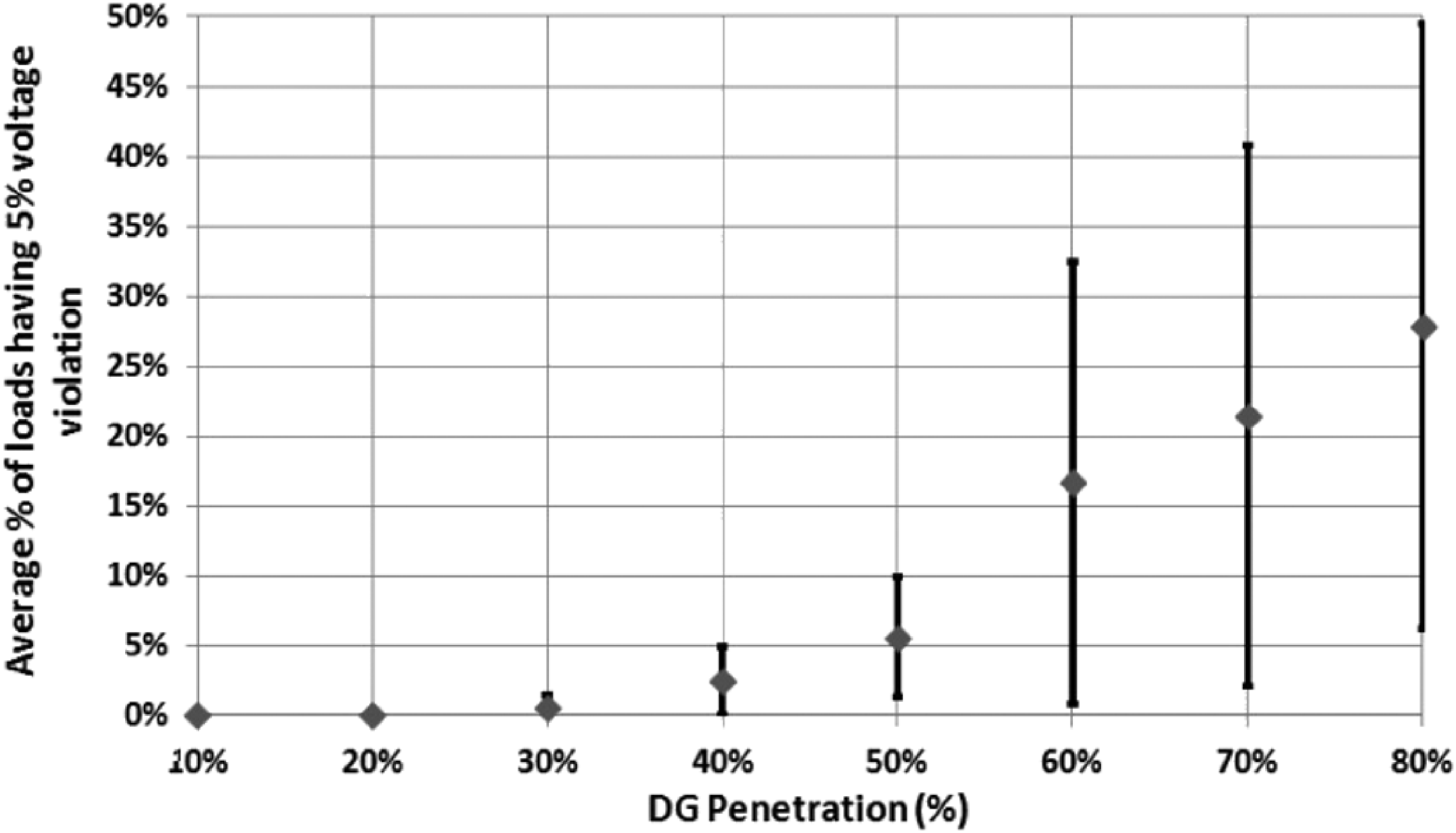
20% DG

60% DG

*Various levels of DG penetration simulated in mesh network**

*Chen et al., IEEE Trans. Power Delivery, *27*(4), p.2020, 2012

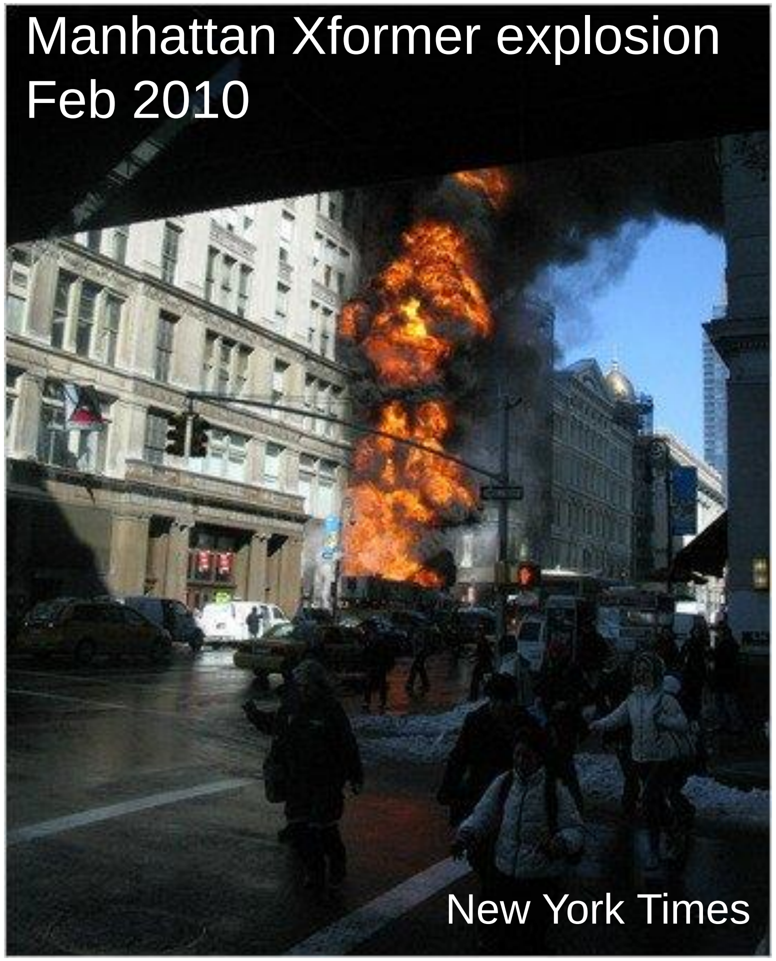
Motivation: Effects of DER on grid/distribution

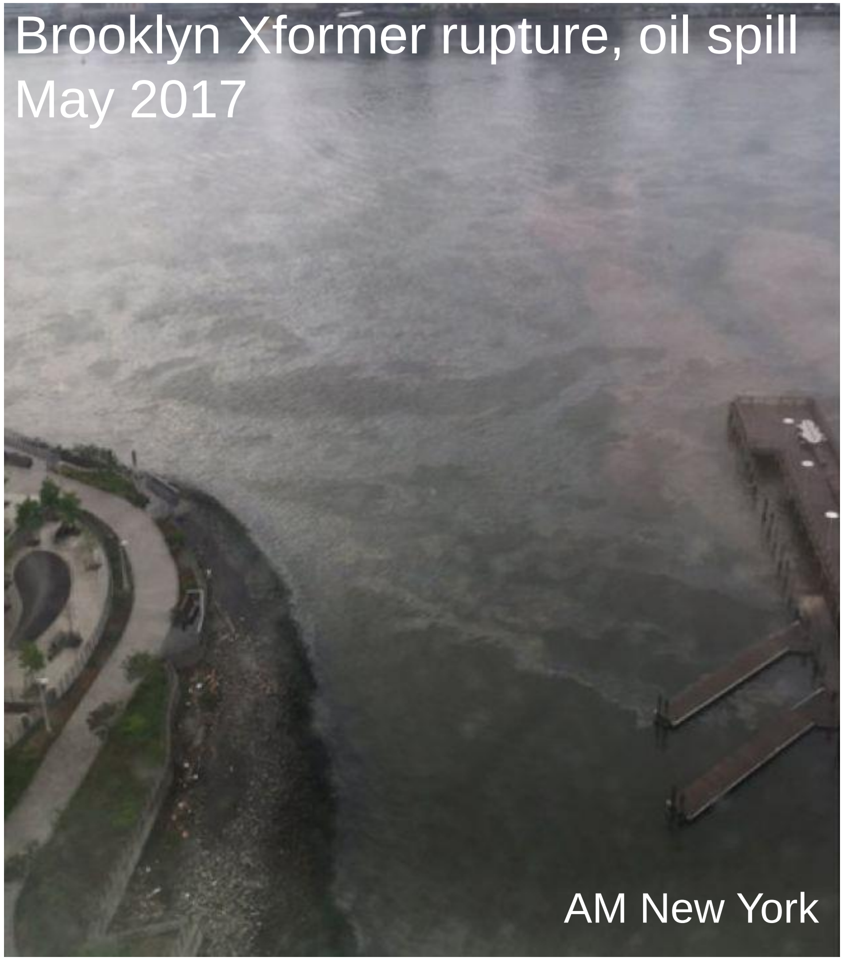


Significant Xformer V limit violations with increasing DG

*Chen et al., IEEE Trans. Power Delivery, *27*(4), p.2020, 2012

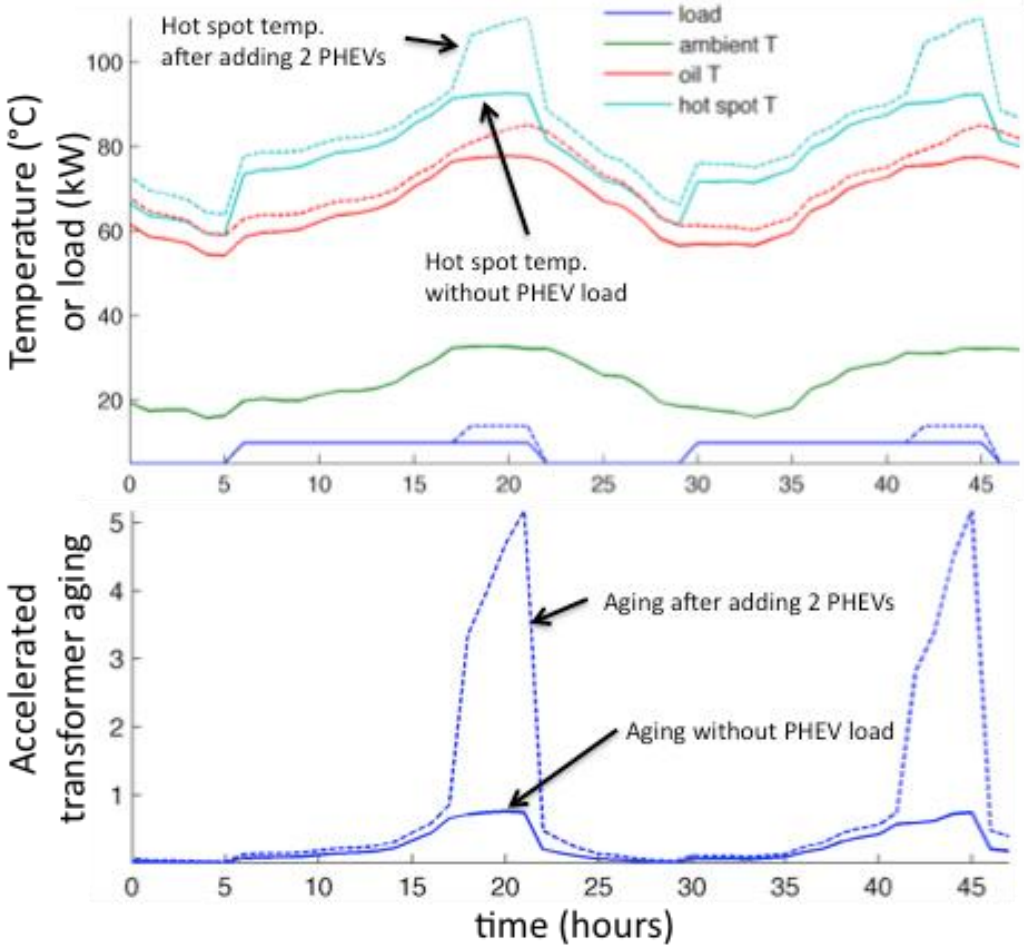
Consequences of Transformer (Xformer) Failure





Considerable public safety risk in urban metros like NYC

Similar Issues for Radial Networks, Other DER Loads



Aggravated Xformer heating, accelerated aging from PEVs

*Farmer et al., IEEE Intl. Conf. System Sciences, Hawaii , p.1-10, 2010

State-of-the-Art (SOTA) Xformer Sensors

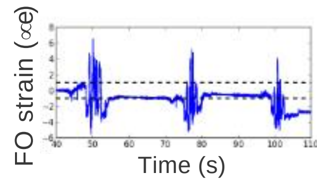
Siemens GasGard for multi-species DG analysis:
$25K+

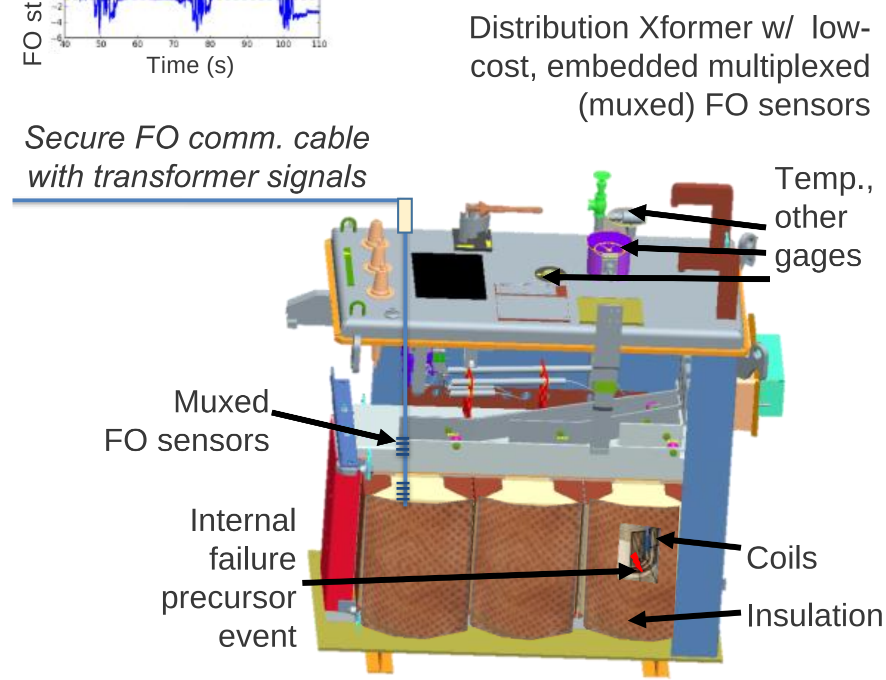
GE-GS Hydran dissolved gas (DG):
$4.5K

GE-GS Intellix - partial discharge:
$23K

SOTA sensors only economical for >$1M generation Xformers
Need low-cost sensors for $5K-30K distribution Xformers

TRANSENSOR: Low-Cost Asset Internal Monitoring



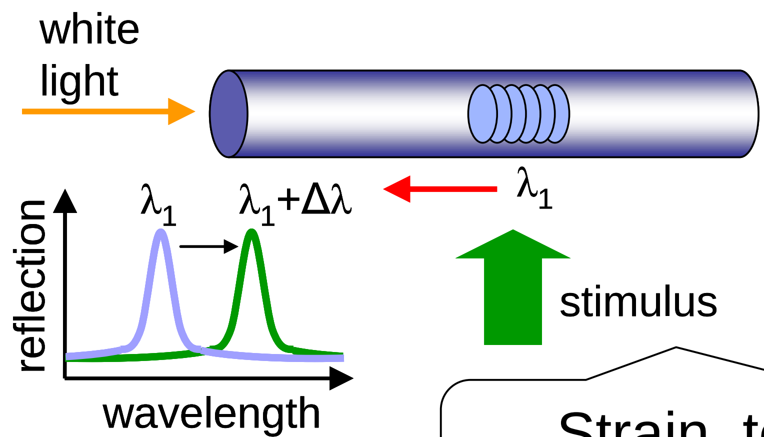


Build on earlier PARC SENSOR tech from ARPA-E AMPED

PARC Tech. 2-Min. Intro Video

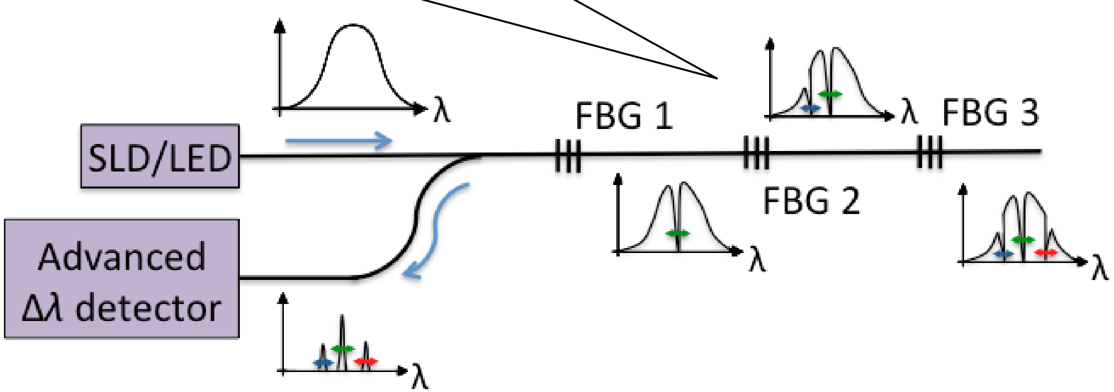
Online at www.parc.com/sensor

Fiber Optic Sensors Example: Fiber Bragg Gratings



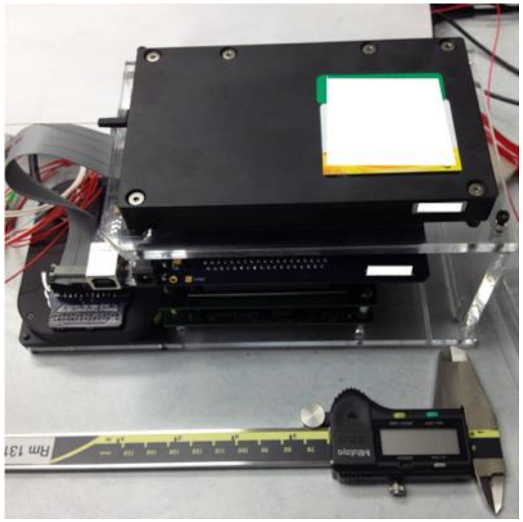
Strain, temperature, gas, chemical, current, voltage, ...

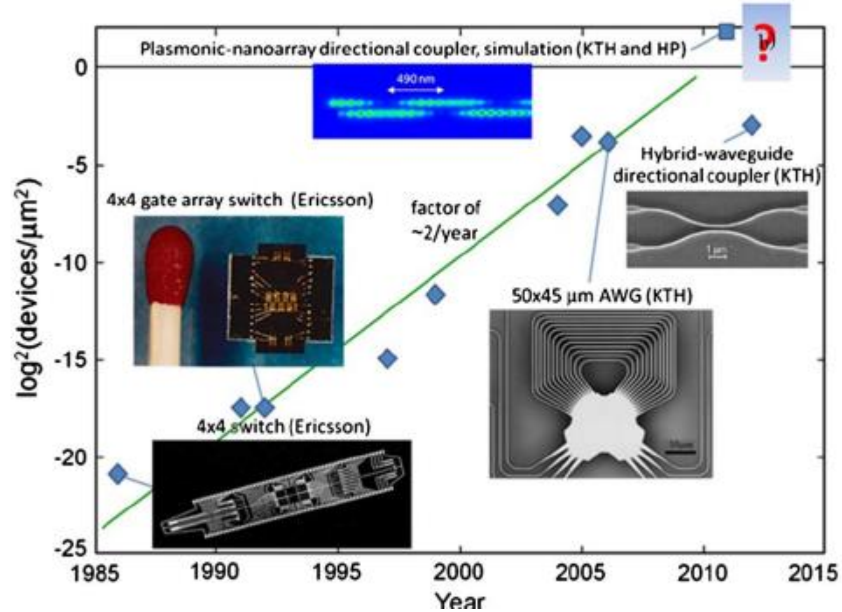
Multiplexable: multiple sensors on single FO



Breakthru FO readout at $150 for mass vol.

PARC's Breakthrough Optical Readout





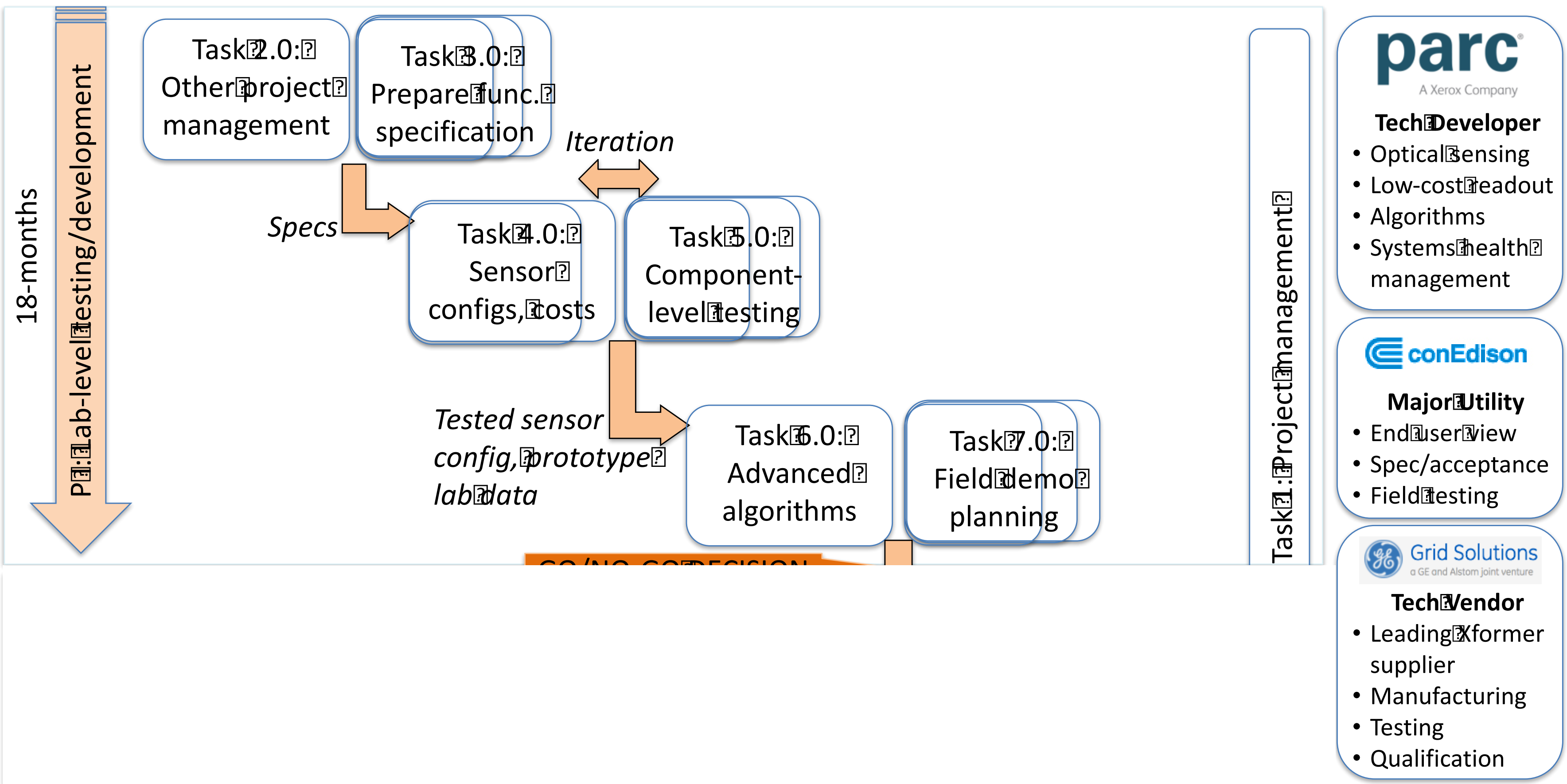
From Thylen and Wosinski 2011

50 fm (0.05 με) res.: 20x SOTA
Up to 480 channels at 40 Hz

~$200 for high-vol. system
Further cost drop feasible

Chip integration to enable major cost, size reduction

TRANSENSOR Project Plan



Phased iterative development leading to ConEd field demo

TRANSENSOR: Demo Platform, Plan

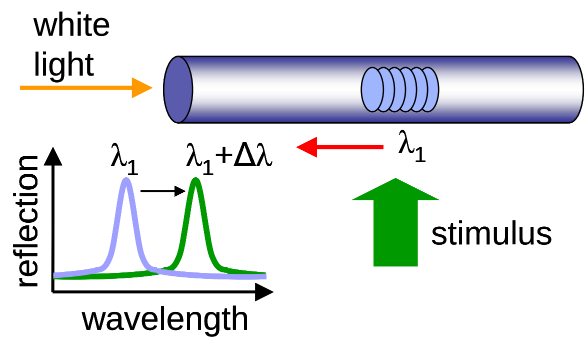
Multi-parameter sensing on demo platform - GE-GS SafeNet^{TM}

Field demo at ConEd site

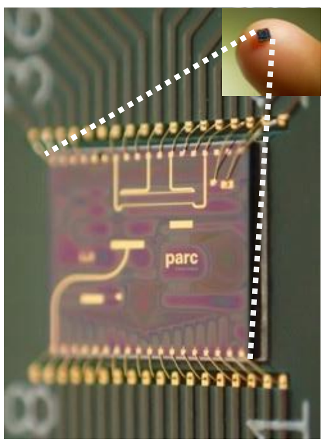
Key targets: >1 day failure prediction; sensing cost ↓ >75%
Culminate in 6-month demo at ConEd pilot site

Summary

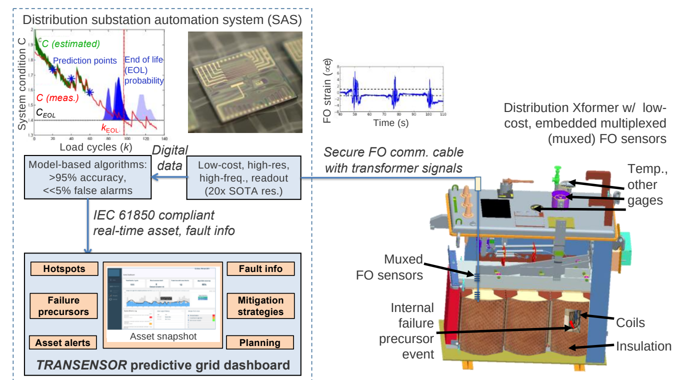
Grid management challenges with increasing DER



Fiber optics: a novel grid monitoring enabler



PARC readout for low-cost deployment



parc A Xerox Company · conEdison · Grid Solutions a GE and Alstom joint venture

Demo at ConEd w/ GE-GS Xformers

TRANSENSOR: key enabler for effective grid management

NOTICE OF RESTRICTION ON DISCLOSURE AND USE OF DATA

Pages 16-17 of this document may contain trade secrets or commercial or financial information that is privileged or confidential and exempt from public disclosure. Such information shall be used or disclosed only for evaluation purposes or in accordance with a financial assistance or loan agreement between the submitter and the Government. The Government may use or disclose any information that is not appropriately marked or otherwise restricted, regardless of source.

Back-up Slides

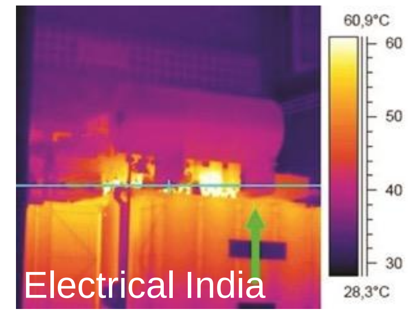
Include any back-up slides you would like to provide to the Steering Committee members and DOE program managers for additional information. The back-up slides will not be shared with others, unless specifically stated by the presenter.

TRANSENSOR: Key Targets


Siemens

1. Dissolved gas: 250 ppm res.

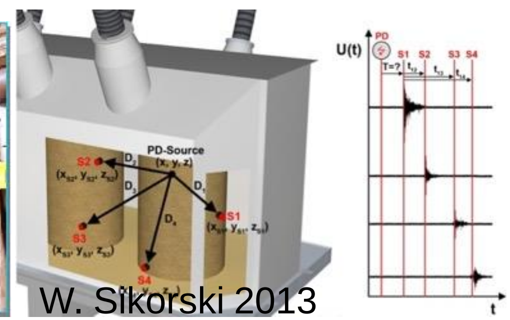
GE-GS SafeNet™



Electrical India

3. Int. temp.: 5 mK res.


TEPCO



W. Sikorski 2013

2. Partial discharge: 100 kHz, 1 $\mu\varepsilon$ res.

>1 day failure prediction; cost ↓ >75% over SOTA: <$1K

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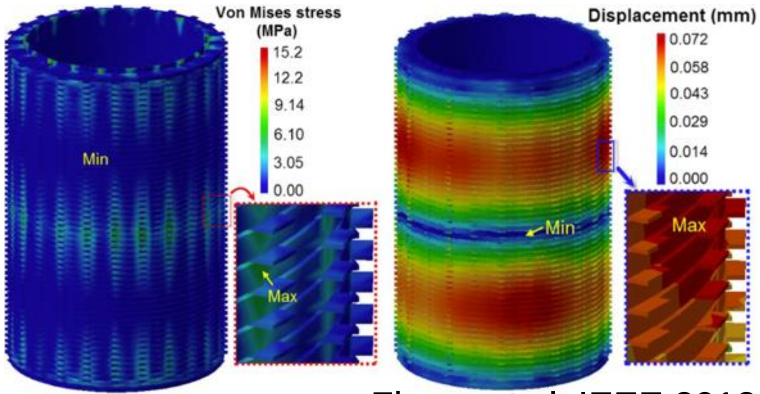
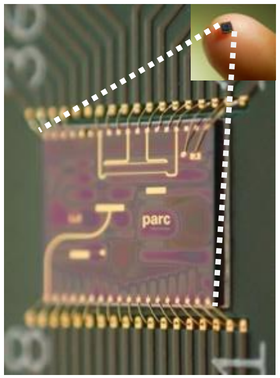
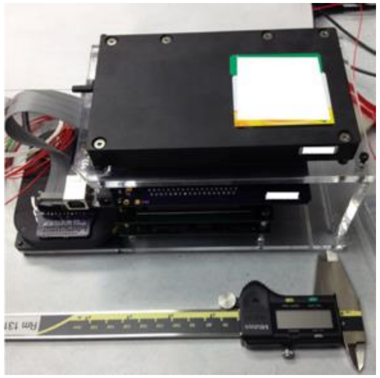
Key Risks (Likelihood %) and *Mitigation*



Zhang et al. IEEE 2013





1. Parameter-state relation (35%):
Alternate parameters, algo. weights

3. Chip integration delays (20%):
pilot with readout prototype

2. Scale-up of results (30%): *multiple iterations at lab, full scale*

Suitable mitigation strategies outlined for each key risk

May contain trade secrets or commercial or financial information that is privileged or confidential and exempt from public disclosure.

Key Elements to be Addressed in the Ensuing Slides

- Problems & needs addressed by the project
- Importance of the technology and the operational challenges it will address
- Project significance (in quantitative measures)
- Technical approach including anticipated hurdles or challenges and how those might be addressed
- Potential risks that could limit project success
- Project management plan (key tasks, milestones, and schedules)
- Project team and budget including high level budget breakdown
- Contact information: name/address/phone/email of presenter(s) and PI

General Guidelines

- Address all key elements provided in the preceding slide.
- Each project is slotted for 40 minutes (20 minutes for presentation + 20 minutes for Q/A).
- Don't include proprietary information in the presentation and the project summary, as both will be published for open access.
- The presentation and project summary are due COB on Wednesday, 4 October, to Tiffany Zachry (zachry@e2rg.com). Information received then will be sent to all ADMS Steering Committee members for review before the meeting.