Telecommunications Outside Plant Power Infrastructure: Past Performance and Technological Alternatives for Improved Resilience to Hurricanes

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Overview

- Introduction and motivation
- Historical background
- Power alternatives for OSP infrastructure
- Conclusions

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OSP Historical Power Background

- Initial deployment of locally powered OSP elements dates back to the 1970s in telephony networks. Additional needs appeared in CATV network.

- Copper to fiber optics plant led to a significant increase of outside plant increase in the past decade in order to support broadband services, such as VoIP and video.

- OSP locally powered elements:
  - Digital Loop Carrier (DLC) remote terminals (RTs) in cabinets, huts, or vaults.
  - Optical nodes (both telephony and CATV)

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OSP Performance in Past Hurricanes

- Rita (2005): 633 RT required backup power.
- Hugo (1989): 555 DLCs loosing power but only 10 destroyed
- Isabel (2003): approximately 800 DLCs lost power
- Andrew (1992): More than 1000 DLCs lost power (722 in Miami)
- Ivan (2004): Almost 1200 DLCs affected by power outages; most lost service.
- Frances (2004): 1100 DLCs lost service due to lack of power.
- Wilma (2005): 1714 DLCs lost service.
- Dennis (2005): 300 DLCs lost power. 82 of them failed.
- Katrina (2005): In Florida 1000 DLCs lost power and 34 were destroyed. In Louisiana and Mississippi Katrina effects were unusual, affecting more centralized network elements than distributed ones.

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OSP Performance in Past Hurricanes

» Ike (2008): 551 DLCs lost service with less of 3 % being destroyed

» Gustav (2008): Impact of power outages on OSP was less significant than in other events thanks to the use of permanent natural gas gensets

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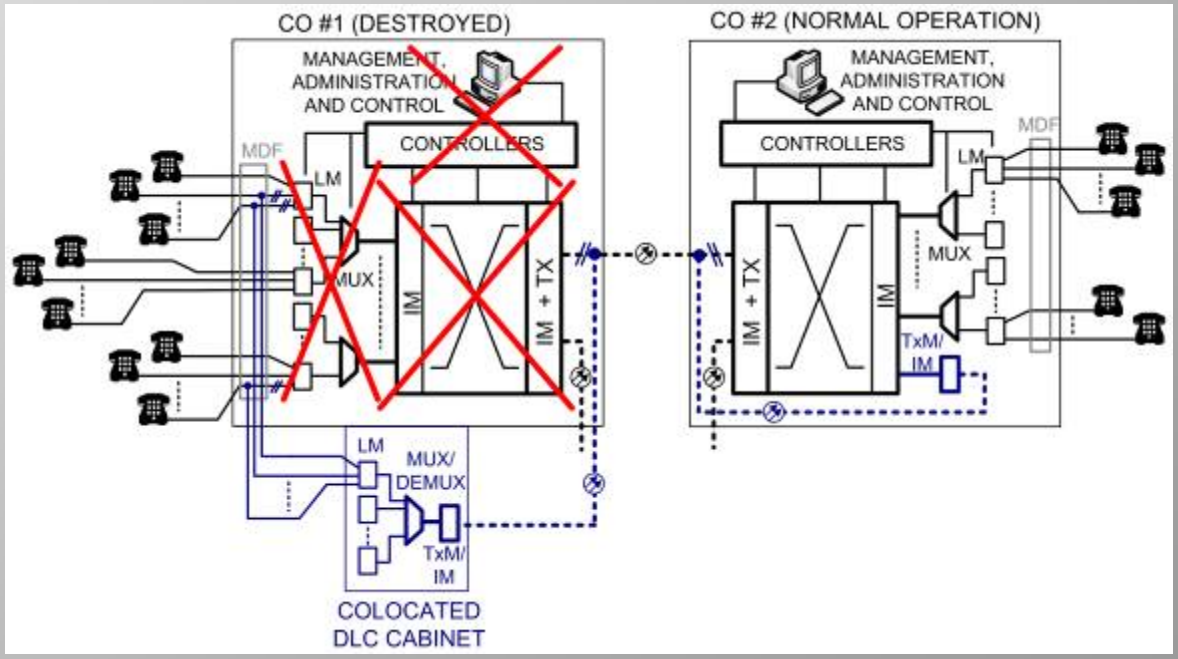
Uses and advantages of DLCs after Hurricanes

» Wireless communication networks are usually restored much faster than wireline networks because the former do not require fixed infrastructure (even cell sites can be mobile, e.g. COWs)

» DLCs approximate this characteristic by using fiber optic links. DLCs are excellent choices in order to follow an uncertain demand.

» After Katrina DLCs were used to replace destroyed COs or copper feeders.



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OSP Power Practices in Hurricanes

» Except after Gustav, in all these past storms each remote terminal required a portable genset (from a few kW up to 10 kW) that needed to be deployed within 8 hours of the site loosing power.

»Small of the shelf gensets tend to be less reliable than larger professional-grade ones.

» Damage after Gustav was prevented by mounting DLCs on platforms. Extensive outages was prevented by using fixed natural gas generators.

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OSP Power Practices in Hurricanes

» Eight hours of backup may be insufficient during hurricanes (hurricane force winds may last 12 hours or more), particularly in vulnerable locations.

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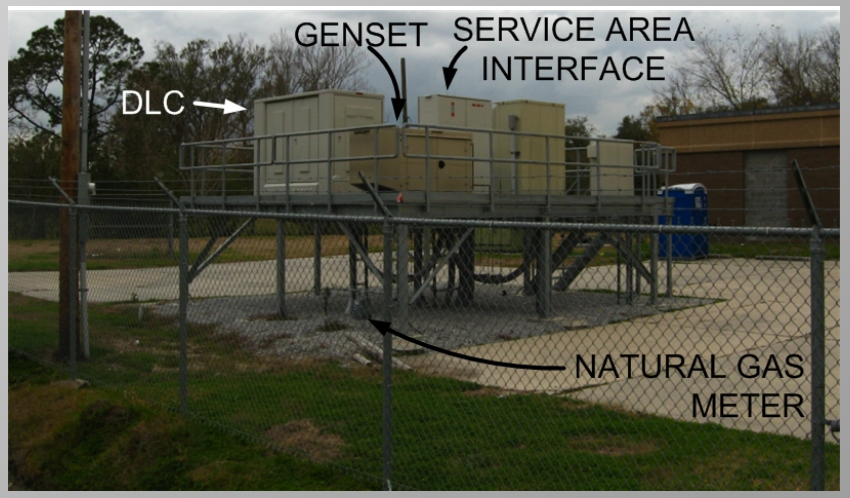
OSP Power Practices in Hurricanes

» Flexible and fast deployment of DLC to restore OSP wire damage

» Use of DLC to replace destroyed central offices after Katrina



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OSP Power Practices in Hurricanes

» Pole mounted infrastructure is more resilient than ground-level infrastructure, but gensets are difficult to place.

» High costs is a severe limitation to widespread implementation of all these practices.

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OSP Elements Power Consumption

- DLC RTs may provide service up to 500 subscribers in average.
- Local backup is usually provided by batteries with 8 hrs of autonomy
- Significant variations in power consumptions:

	Cabinet type(s)[1]	Measured peak power
	Type 80	2.07 kW
	Type 80G	0.85 kW
	Mesa 6	2.8 kW
	LSC-2030	1.4 kW
	LSC-2030	2.7 kW
	LSC-2030	0.5 kW

[1] Some cabinet types are indicated for reference. They are not the exact model.

	Cabinet type(s)[1]	Measured peak power
	Type 80 G + Type 82G + Type 52	3.5 kW
	LSC-2030 + Type 50	1.25 kW
	LSC-2030 + Type 52	0.75 kW
	hut	5 kW
	Type 82G	1.9 kW
	Type 80	1.5 kW

	Cabinet type(s)[1]	Measured peak power
	Type 80A	0.5 kW
	Type 50	0.7 kW
	Type 50	0.25 kW
	Type 52	0.5 kW
	Type 52	0.75 kW
	Mesa 2	approximate 2 kW
	CATV UPS	1.62 kW

[1] Some model types are indicated for reference and are not the exact model.

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Power Alternatives

- Backup Fuel Cells
  - Due to high cost of reformers, fuel cells typically operate powered by locally stored energy in hydrogen.
  - Fuel cells can typically power DLCs between 12 and 24 hrs extending the standard battery backup time beyond the normal time during which hurricane effects are felt.
  - Fuel cells weight less than batteries so structural stress on platforms is reduced.
  - Cost still is a concern in fuel cells systems.
  - Hydrogen resupply is an important issue after hurricanes

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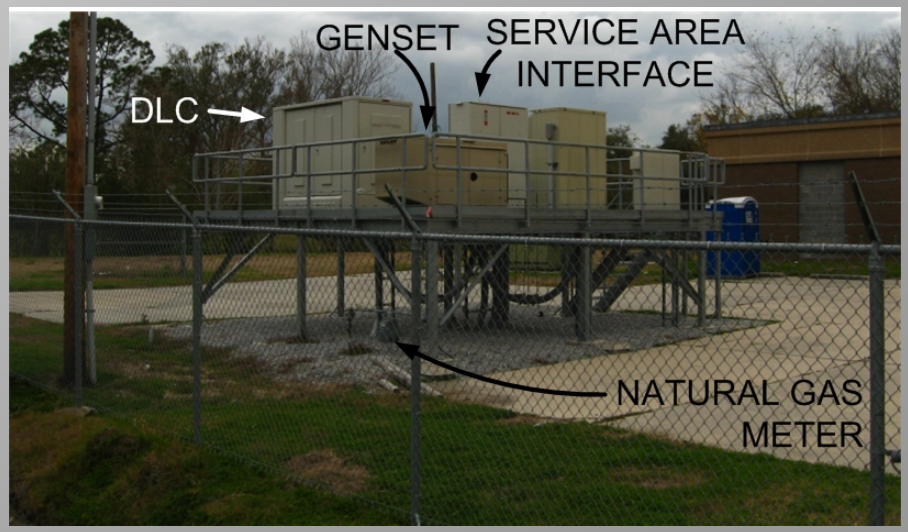
Power Alternatives

» Natural gas gensets

- Low logistics needs (no refueling needed).
- But important areas lack natural gas service.
- 25 kW gensets installed after Katrina
- 7.5 kW dc gensets also install after Katrina
- Commercialization opportunity for natural gas gensets rated for 2 to 5 kW



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Power Alternatives

- Propane (LPG) gas gensets
  - Compared with natural gas gensets, although LPG gensets require refueling, LPG is "universally available."
  - Less demanding logistical requirements than other options that also require refueling.
    - e.g., a 32 inches long by 27 inches wide by 28 inches high 6.5 kW genset equipped with a 46.3 inch high by 15.1 inch wide 100 pound LPG cylinder can support a 5 kW load for about 40 hours, vs. up to 24 hours with a fuel cell.
  - LPG cylinders are usually more resistant than gasoline or diesel tanks.
  - LPG gensets tend to require less maintenance and last longer than equivalent diesel or gasoline generators

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Power Alternatives

- Permanent diesel or gasoline gensets
  - Uncommon in OSP applications due to maintenance and security issues.
  - They also require periodic refueling which add significant logistical issues after hurricanes.

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Power Alternatives

- Distributed generation technologies
  - Power supply alternatives:
    - Fuel cell with reformers or generators fueled by natural gas
    - Renewable sources, such as PV modules or small wind generators
  - Renewable sources do not require an energy supply infrastructure but they need increased locally stored energy to overcome variable power generation profiles.
  - Renewable sources are designed to withstand hurricanes damaging actions

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Power Alternatives

- Distributed generation technologies
  - Used throughout the year, OSP sites with distributed generators can reduce electricity costs. But this advantage has value only if DG is deployed to a significant number of sites.

  - Limitations to widespread use for renewable energy generation:
    - high costs
    - lack of standard modular designs
    - Other significant issues:
      - aesthetics,
      - shadowing,
      - risk of theft,
      - large footprint (a 1 kW DLC needs 32 200 W PV modules occupying an area of 34 m^2)

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Power Alternatives

» Distributed generation technologies

- One alternative to overcome aforementioned limitations is to use hybrid systems as the one exemplified in the former locations of Delacroix central office destroyed by Hurricane Katrina.

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Power Alternatives

- Centralized power
  - OSP sites are powered directly from the central office.
  - Solutions with ±190 Vdc has been proposed in the past
  - The solution requires copper cables running from the CO to all DLCs.
  - Unless the power feeders are buried, outages can be expected during hurricanes.
  - Overcoming these limitations makes this solution costly.

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Conclusions

» In almost all past hurricanes extensive communication outages were caused by lack of power in OSP remote terminals.

» Several power options were discussed.

» However, there does not seems to exist a "perfect" solution that addresses OSP power issues during hurricanes.

» Hence, there are both important challenges and opportunities in the development of OSP powering technologies.

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THANK YOU VERY MUCH

QUESTIONS?