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
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)
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.
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.
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.
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 losing 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 were prevented by using fixed natural gas generators.
Eight hours of backup may be insufficient during hurricanes (hurricane force winds may last 12 hours or more), particularly in vulnerable locations.
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
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.
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:

<table>
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<tr>
<th>Cabinet type(s)</th>
<th>Measured peak power</th>
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<tbody>
<tr>
<td>Type 80</td>
<td>2.07 kW</td>
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<tr>
<td>Type 80G</td>
<td>0.85 kW</td>
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<tr>
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<td>LSC-2030</td>
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<td>LSC-2030</td>
<td>0.5 kW</td>
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<table>
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<tr>
<th>Cabinet type(s)</th>
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<tr>
<td>Type 80 G + Type 82G + Type 52</td>
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<tr>
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<td>Type 80</td>
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<td>CATV UPS</td>
<td>1.62 kW</td>
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</tbody>
</table>

*Some cabinet types are indicated for reference. They are not the exact model.
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.
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
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.
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.
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
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 m²)
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.
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.
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.
THANK YOU VERY MUCH

QUESTIONS?