

# Case Study: Derecho Storm Disaster Cedar Rapids, Iowa

August 10, 2020  
The EMP that didn't happen

Daniel P. Roesler  
Robert H. Sternowski

# Scenario

- Cedar Rapids hit by straight-line windstorm with heavy rain, 30-45 minutes duration
- Westerly wind 110 mph, 140 mph gusts
- Unpredicted, no preparation time
- Storm system traveled 770 miles, Nebraska formation to dissipation in Wisconsin
- Cedar Rapids urban/suburban city of 100,000

# What is a Derecho?

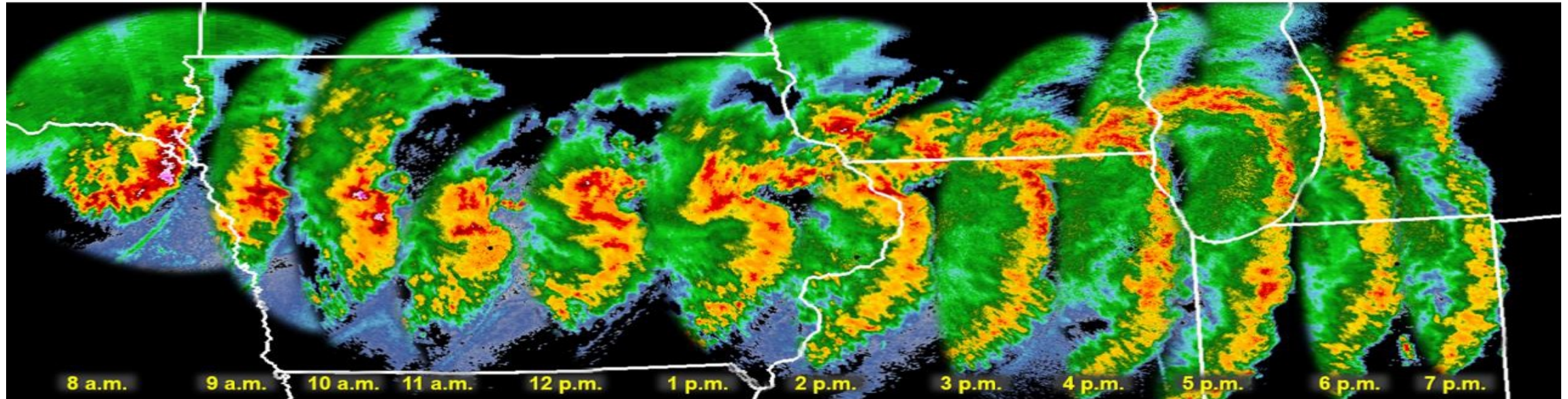
*( der – RAY – show; Spanish for “straight” )*

- Storm phenomenon unique to the Midwest US
- Same setup as tornadoes: warm/cold front clash
- Not predictable like a slow-moving hurricane
- Derecho is straightline winds from bow echo on frontal system
  - Tornado would be rotational, different phenomenon
  - Tornado localized <1 mile wide; derecho 50 miles wide
- Equivalent to Cat 3/4 hurricane, not rotating



## August 10, 2020 Derecho: Lowest Angle NWS Radar Reflectivity at One-Hour Time Steps

*All times in CDT*



This long-lasting, severe wind thunderstorm complex (known as a derecho) produced hundreds of reports of damage along with likely a few tornadoes.

 NWS Chicago | [weather.gov](https://weather.gov)

Aug 11, 2020

<https://cbs2iowa.com/news/local/the-iowa-derecho-in-their-own-words>

<https://www.midamericanenergy.com/articles/customer-news-derecho2020-stormresponse>

Cedar Rapids IEEE Joint Power Energy Society

<https://drive.google.com/drive/folders/1pKPc6miYA4zGnjAykD5Ckz7kNafq1Rui>

**SOFTRONICS LTD.**

High Frequency Radio System, Circuit & Software Solutions



# Timeline

- 8/10 1130-1200 CDT alert that storm is approaching
- 8/10 1230 CDT 8/10/20 storm hits
- 8/10 1300-1330 CDT all utilities disabled, state of emergency begins
- 8/11 1600 CDT small pockets of power trickle back on line
- 8/21 Last major block of power restored
- 9/25 Customers still without broadband internet



# Post-storm Communications

as of 1300 CDT 8/10

- Electrical power knocked out everywhere: trees on lines
  - Could only use battery devices
  - No means of recharging them
- No AM/FM/TV broadcast stations
  - No power; main AM station tower felled
- No NOAA weather radio (off air)
- Landline phones mostly knocked out due to overhead lines and jammed central office

Continued next slide



# Post-storm Communications cont.

as of 1300 CDT 8/10

- Cell service knocked out (variety of problems)
- Broadband TV/internet knocked out: trees on overhead lines
- Emergency police/fire repeaters remained operational
- Amateur radio repeaters operational on battery power
  - ***HF radio never activated to “jump over” disabled local communications***
- No newspapers printed (no power) or able to be delivered

# Post-storm Comm Summary

Service	Status	Driver	Medium	Comments
Cellular	Out/overload	Power, wind damage	Voice/internet	Thin surviving network towers overloaded
Landline	Out/overload	Tree damage	Voice/internet	Above ground infrastructure
Broadband	Out	Tree damage, power	Broadcast/voice/internet	Above ground infrastructure
Broadcast	Out	Power	Broadcast	No power: listener or broadcaster
Emergency landmobile	Working	Reinforced emergency system/power	Voice/data	Only mode working
Weather radio	Out	Power, remote feed	Voice	Lines down to NOAA
Amateur radio	Working	Battery power, many members	Voice	Never activated by agencies
SHARES	Not used	Apparently unknown to emergency agencies	Voice/data/internet	Not part of plans
Newspaper	Out	Power, blocked delivery	Print	Could not drive about; only walk
Word of mouth	Limited	Felled trees blocked movement	Voice	Could not drive about; only walk



# Emergency Activations

- Emergency services/responder activation plan depended on commercial internet, landline, pager, cellular
- The storm disabled all commercial communications
- Could not activate responders because they could not be notified

# State of Emergency

- No communications to/from public to establish injuries, aid needed, damage
- Streets impassable due to felled trees, numerous power lines down, felled structures
- Incident commander (fire chief) invoked emergency protocols; cross-functional city departmental team assembled at central fire station (downtown)

Continued next slide

# State of Emergency cont.

- Linn county emergency manager started up county emergency center at different location
- Emergency response was essentially operating BLINDLY, few eyes/ears on the street
- Gas/water/sewage operating normally

# SHARES Stations

**NCS579**

**ALE, Voice, FLDIGI**



**NNC71A**

**WinLink Express & RMS**



# Softronics System Integration Lab (SIL)

**URGIII Complete Rack**



PA-2220A  
PS-2220A

**Softronics 1 KW PA Drop In Replacement – Wide band Linear (>48 KHz)**



PA + Power Supply

# **Softronics System Integration Lab (SIL)**

**Softronics 1 KW PA Drop In Replacement for URGIII – Wideband Linear (>48 KHz)**



PA + Power Supply

RT2200 Controlled

Q9604 Tested up to 256 QAM

**SOFTRONICS LTD.**



*High Frequency Radio System, Circuit & Software Solutions*

# SHARES Station Status

## NCS579, NNC71A, Marion Iowa

- Off air August 10 – 21: Marion IA power outage
  - Antenna pole shook but did not break
  - B&W dipoles
    - Stainless steel wires twisted but survived
    - Type N coax center conductors pulled out
      - Did not realize low power output until after North Net check in since reception was still nominal
    - WinLink system also operating on low or no power
      - Did not realize message decrease in traffic
      - ADIF Analyzer wasn't being used at the time
  - Now installed tri-fuel and dual-fuel generators
    - City natural gas was available in storm aftermath
    - **Gasoline unavailable (no electricity for the pumps)**
    - Liquid Propane tanks were heavily used (cooking & some generators)
  - Adding UPS and auto-start for generators
    - Radios & Computers

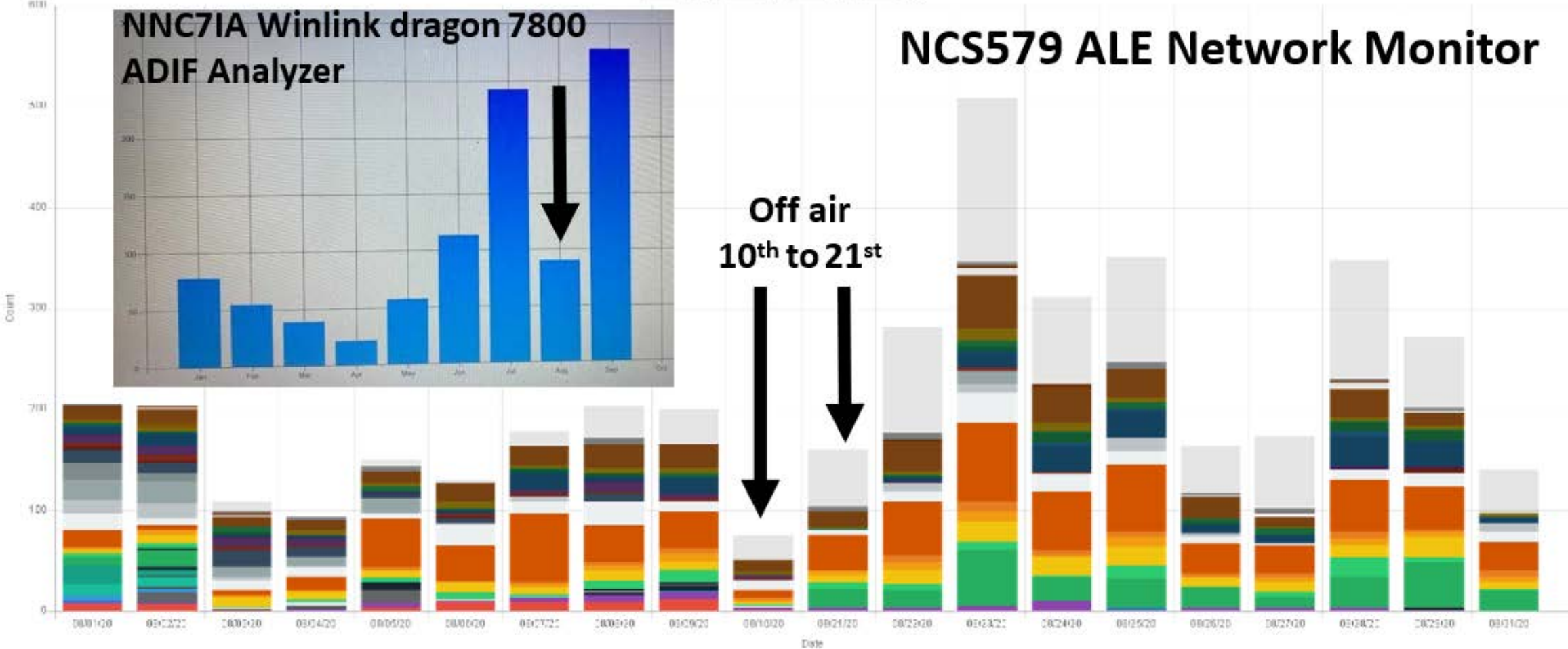
Elongated hole from wind movement of 45-foot pole





# SHARES Network Monitors

CallSign per Date Count



# Station Lessons Learned

- Keep battery power charged up for radios (i.e., ALE best practices 100 Amp marine battery)
- Ham radios need NTIA mod for home use when entity station is out of order...
  - E.G. Yaesu 897D
- Keep available outside backup antenna in safe storage
  - Not many trees left to use for support.
  - Have versatile antenna supports stored also
- Surviving antenna in basement using water pipes enabled JS8 and WSPR reception (needed tuner for transmit)
  - JS8 allowed reception of JS8 ALLCALL Messages

# Aftermath



# Aftermath



# Aftermath



*Softronic Ltd. Proprietary Information*

# Aftermath

**Primary AM Station WMT 600 kHz**



**SOFTRONICS LTD.**



*High Frequency Radio System, Circuit & Software Solutions*

# Aftermath

***But still a sense of humor...***



**“Minor tree damage...”**

# Public Response

- Slightly panicked
  - Could not drive for food/aid due to felled trees
  - Could not buy anything— no power to stores/pumps
  - No banking or ATMs or cash registers
  - No power for light/air conditioning/cooking
  - Remaining chilled food spoiled after days of no power
  - Could not call for help
  - Could not drive for help
  - City could not go out to check on damage and help
  - Very few storm injuries – zero fatalities



# Impact on Commerce

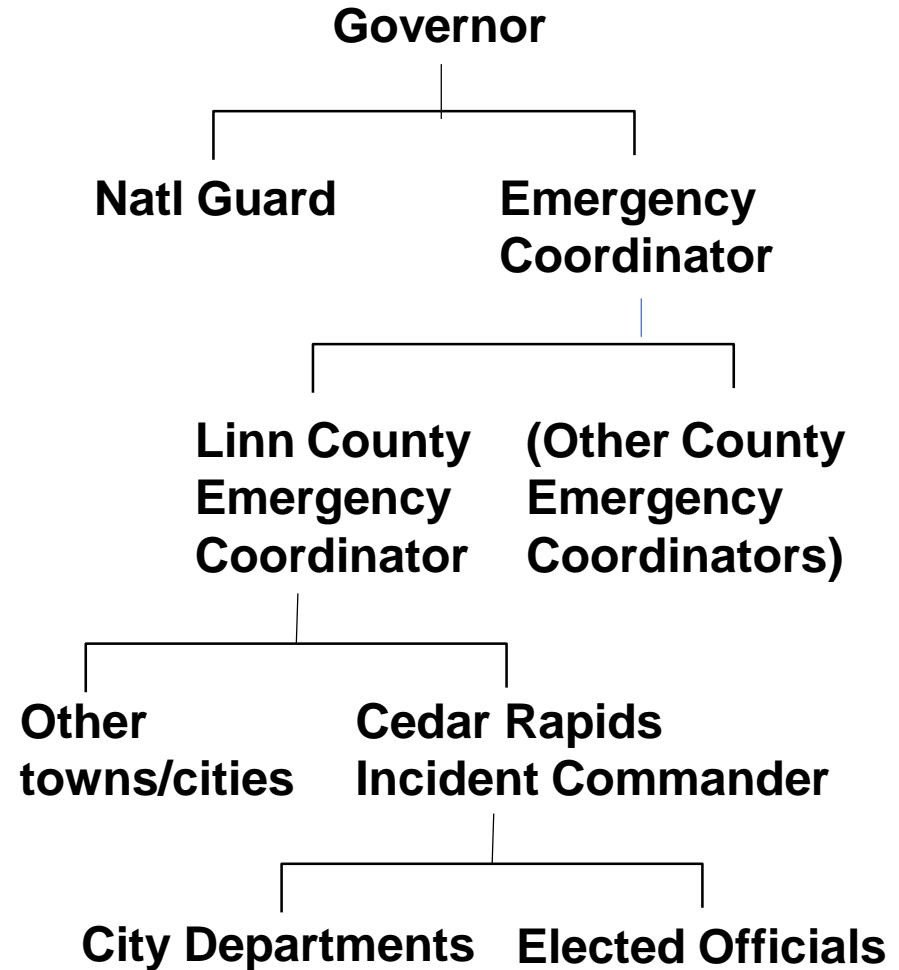
- Businesses mostly closed: lack of power
- Employees could not travel to work
- Deliveries could not be made due to debris on streets
- Businesses relied on cellular for operations
- No financial services (ATM, bank, credit cards)
- Could not pump gas: electric pumps
- ***Local economic activity dropped to zero***

***The first week***



# Governmental Organization

- State emergency organization subdivided into county emergency management functions
- Each city/town within a county had its own emergency protocols



# Government Response

- 8/11, one day after storm
  - City deployed snowplows to push trees off major streets and emergency routes
  - Residents pitch in and clear own streets
    - Fallen 2-3 ft diameter trees beyond DIY abilities
  - Heavy equipment was badly needed but slow coming
  - Primarily due to “fog of war”/lack of visibility:
    - State level could not see what happened
    - Declined aid from other counties, NGOs
      - Not sure it was needed
    - Did not request National Guard with heavy equipment
    - Residents needing emergency aid went without for days
  - The poorer residents, most needing help, were the last to be reached and serviced

# Damage Assessment

- Unprecedented damage
- Electrical power infrastructure destroyed
  - 1200 miles of wire, 500+ high voltage structures, 3600 wood poles broken, 6 communications towers damaged
- 70% of city's trees felled or badly damaged
  - Lack of prior windstorms: many vulnerable "weak" trees
  - Predominant overhead cabling destroyed by falling trees
- Many buildings and structures destroyed or damaged by sustained high winds
- Overwhelming amount of debris blocking access to everything

# Recovery

- 8/17 (1 week after)
  - Much of power, internet, broadband, telephones restored
    - 2000 power crew members (700 debris removal)
      - Power Crews from all across US and Canada
    - 200 National Guard with heavy equipment
  - **Cellphones came online with power restoral**
  - Resources overwhelmed by amount of debris to be removed
  - Worst pockets of need still being discovered
- 8/24 (2 weeks after)
  - Still known pockets of severe damage and people suffering in those pockets
  - Only isolated power outages remain
  - Still major broadband outages
  - Still overwhelmed by debris; help coming in
  - More pockets of need still being discovered



# Communications Restoral

- Cellular mostly restored with power restoral but overloaded; primary interim internet
- Broadcast restored as studios and transmitters found generators or had power restored
- TV viewing unavailable without power
- Broadband, landline infrastructure destroyed by trees; long term rebuild
- No power to print newspapers for a week, then able to distribute them as streets cleared

# Observations

- Very similar to an EMP event with regard to power and communications impacts
  - EMP: Would NOT BE ABLE TO RESTORE afterwards
  - EMP: Would not have infrastructure, tree and structure physical damage
  - EMP: No help would be coming
  - EMP: Vehicles would be disabled

# Observations

## **Derecho disaster:**

- Local disaster
- Power distribution destroyed (trees)
- Power generation untouched
- Water, gas, sewer unaffected
- Cellular lost (trees)
- Landlines lost (trees)
- Broadband lost (trees)
- Mobility lost (debris)
- Commerce halted (no power)
- Gas pumps halted (no power)
- Food, help trucked in

## **EMP event (“Kansas HEMP”):**

- Wide/national disaster
- Power distribution intact
- Power generation offline
- Water, gas, sewer off (power)
- Cellular lost (EMP)
- Landlines lost (EMP)
- Broadband lost (EMP)
- Mobility lost (EMP on vehicles)
- Commerce halted (no power)
- Gas pumps halted (no power)
- No external help coming (vehicle EMP),  
breadth of national damage

# Conclusions

- The Government did not know in detail what happened and where: BLIND for first few days
- Slow to request/mobilize rescue/emergency resources
  - Lack of communications, visibility key: **NEAR-ZERO SITUATIONAL AWARENESS**
  - **Emergency activation relied on vulnerable communications**
- Never planned for an event that:
  - Disabled ALL power and communications for an EXTENDED period of time
  - Was unpredicted, no preparation possible
  - Disabled mobility about the city

Continued on next slide



# Conclusions cont.

- Affected the entire 72 sq mi of city plus suburbs and surrounding areas (not localized like narrow damage “stripe” of a tornado)
  - No “bootstrap” help from surviving parts of city
- Unexpected weather phenomenon
  - Not unprecedented but rare, unusual
- Chaos due to lack of plans for an event this severe and long lasting
  - But CAN you plan for something like this?
    - Almost the same results as an EMP event

**Lack of Communications was the key problem hindering recovery**



# Moral

- Power stopped...
- Communications stopped
- ....Society stopped

<https://www.ready.gov/kit>



