AARON SCHULMAN *NEIL SPRING*

PINGIN' IN THE RAIN

University of Maryland

Residential links may fail

- Links are not redundant
- Equipment updates are rare
- Equipment operates in an uncontrolled environment

photo credit: Patrick Shoemaker, Ode Street Tribune

Weather causes residential link failures

Lightning destroys equipment and causes interference

Water seeps into unpressurized cables and equipment

Wind snaps tree limbs and stresses wires

Weather will always threaten residential links

Why measure weather failures?

Weather is a routine mini-natural disaster

To inform providers of weather-related problems

We rely on links for Phone, T.V. and Internet

Measuring weather-related failures

Identify residential IPs that will be subject to weather

Ping before, during, and after a weather event

Analyze the pings to find weather-related failures

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Finding residential IPs to ping

71.96.2.1	L100.DLLSTX-DSL-08.verizon-gni.net.
71.96.2.2	pool-71-96-2-2.dfw.dsl-w.verizon.net.
⋮	
71.96.2.253	pool-71-96-2-253.dfw.dsl-w.verizon.net.
71.96.2.254	pool-71-96-2-254.dfw.dsl-w.verizon.net.

216.27.175.1	vrrp-1-gw.216-27-175.atl1.speakeasy.net.
216.27.175.2	dns.atl1.speakeasy.net.
⋮	
216.27.175.253	5.ge-0-2-0.cr2.atl1.speakeasy.net.
216.27.175.254	dsl027-175-254.atl1.dsl.speakeasy.net.

Found 100 Million U.S. residential IPs

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Aiming pings at weather

Monitor the alert feed from the U.S. National Weather Service

<title>Severe Weather Statement issued May 12 at 4:46PM CDT expiring May 12 at 5:15PM CDT by NWS GreenBay http://www.crh.noaa.gov/grb/</title>

<summary>...A SEVERE THUNDERSTORM WARNING REMAINS IN EFFECT FOR CENTRAL WAUPACA AND NORTHWESTERN OUTAGAMIE COUNTIES UNTIL 515 PM CDT...AT 443 PM CDT...NATIONAL WEATHER SERVICE DOPPLER RADAR INDICATED A SEVERE THUNDERSTORM CAPABLE OF PRODUCING QUARTER SIZE HAIL...AND DAMAGING WINDS IN EXCESS OF 60 MPH. THIS STORM WAS LOCATED 7 MILES NORTH OF NEW LONDON...OR 20 MILES NORTHEAST OF WAUPACA...MOVING</summary>

<cap:effective>2011-05-12T16:46:00-05:00</cap:effective>

<cap:expires>2011-05-12T17:15:00-05:00</cap:expires>

<cap:urgency>Immediate</cap:urgency>

<cap:severity>Severe</cap:severity>

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Locating IPs covered by weather alerts

Locating 100 Million residential IPs

MaxMind database of IP to geolocation

Sampling IPs covered by a weather alert

Ping 100 IPs from each provider and link type

Finding the provider and link type of an IP

Reverse name (pool----.sangtx.dsl-w.verizon.net)

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Pinging to observe failures

One vantage point is not enough

Ten PlanetLab-based vantage points

Ping infrequently

From each vantage point, ping once every 11 minutes

Omit needless pings

Only ping IPs that reply before the weather

One ping is not enough

Retry immediately when a ping indicates failure

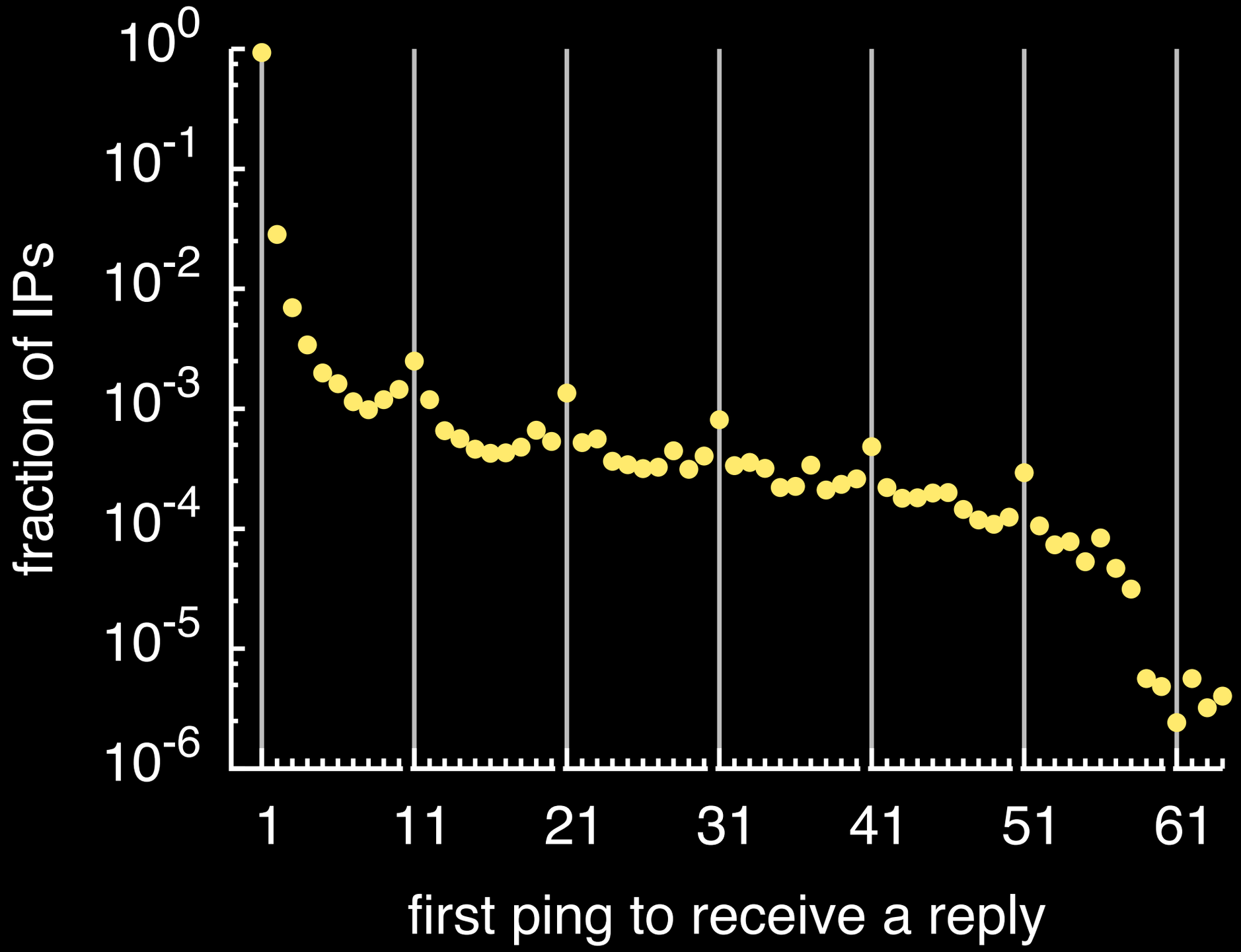
ARP shenanigans

What happens to your ping when the router does not know a MAC address?

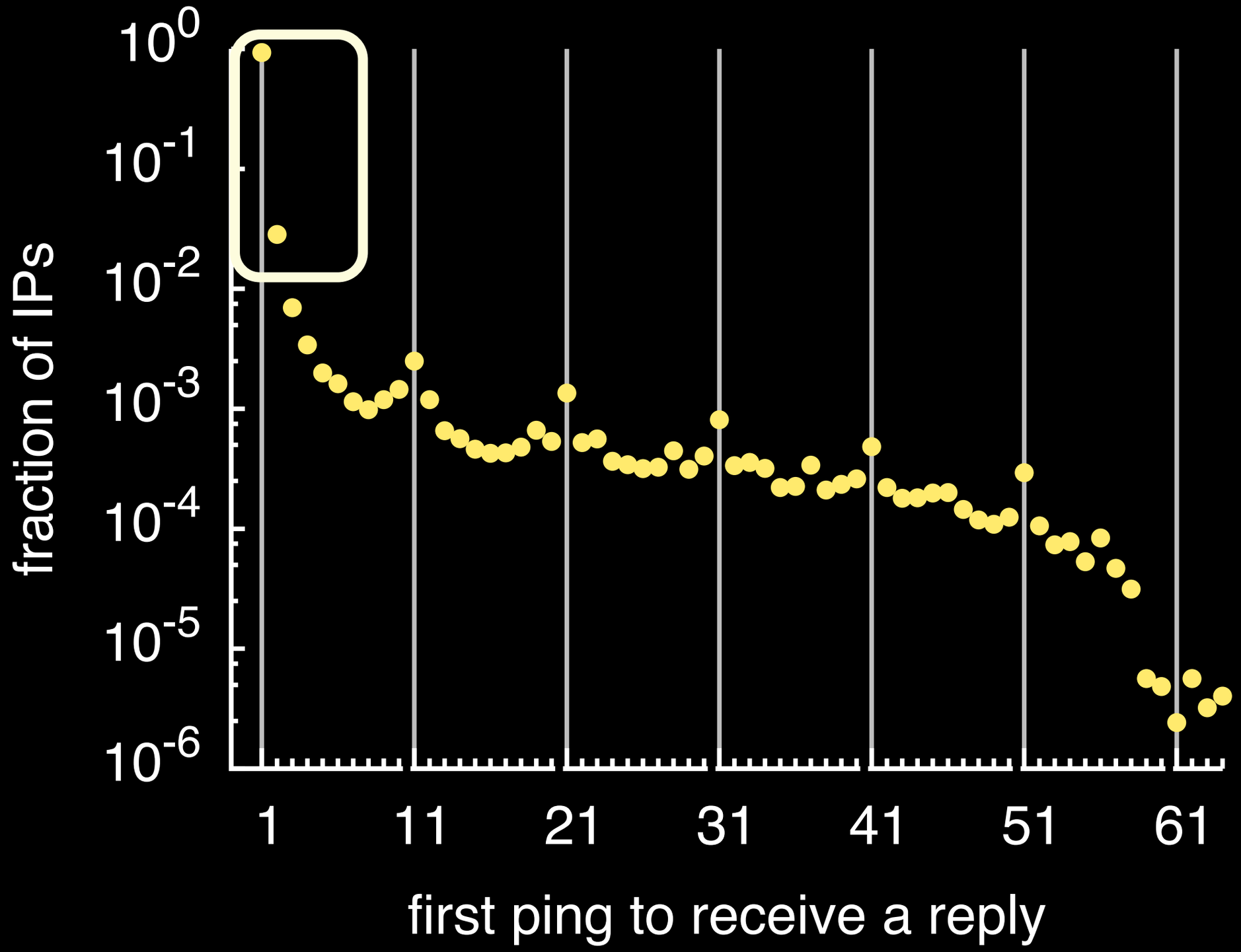
~1,000,000 reply within the first hour of pinging

Which ping is the first to reply?

One ping is not enough



One ping is not enough



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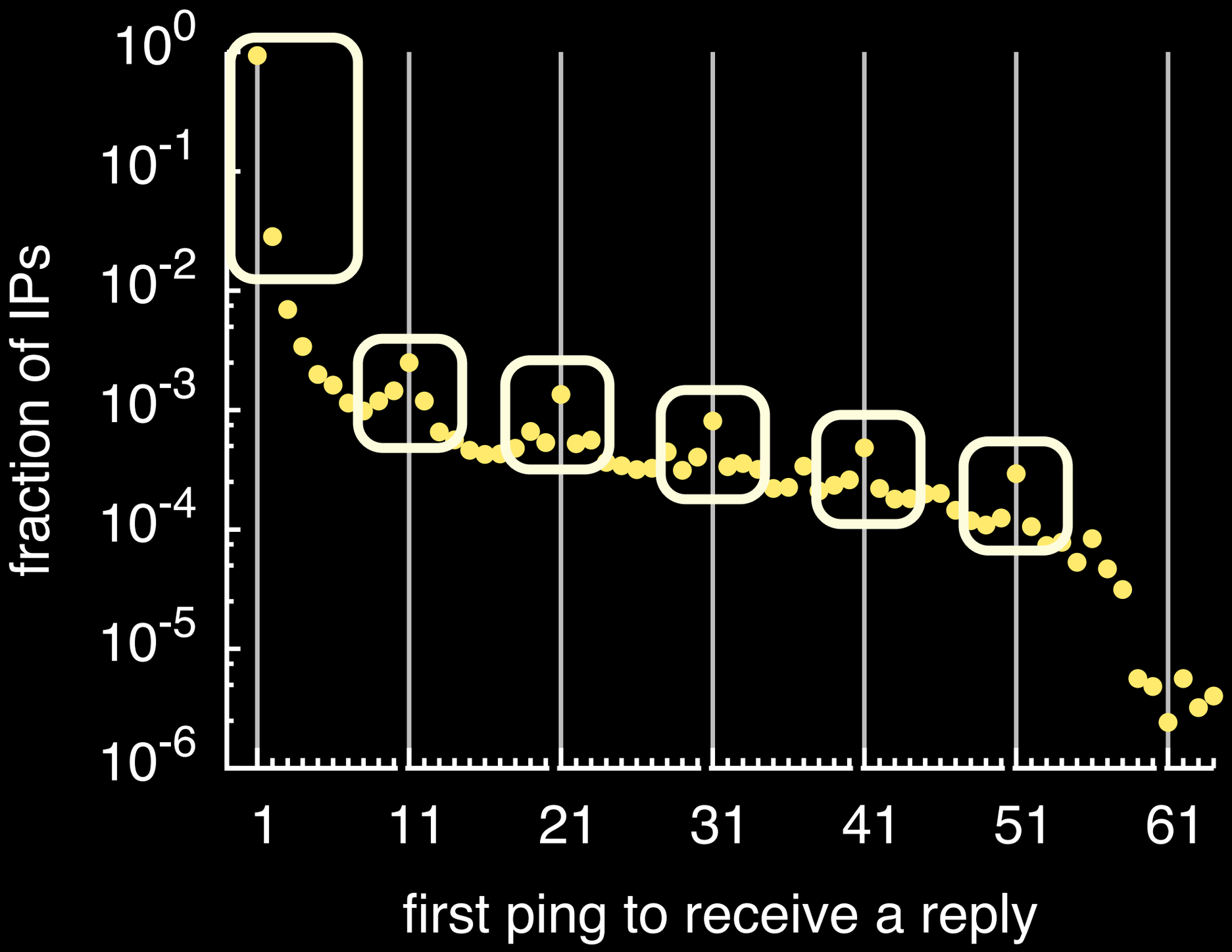

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U.S. airport weather stations monitor conditions

photo credit: Austin Cross

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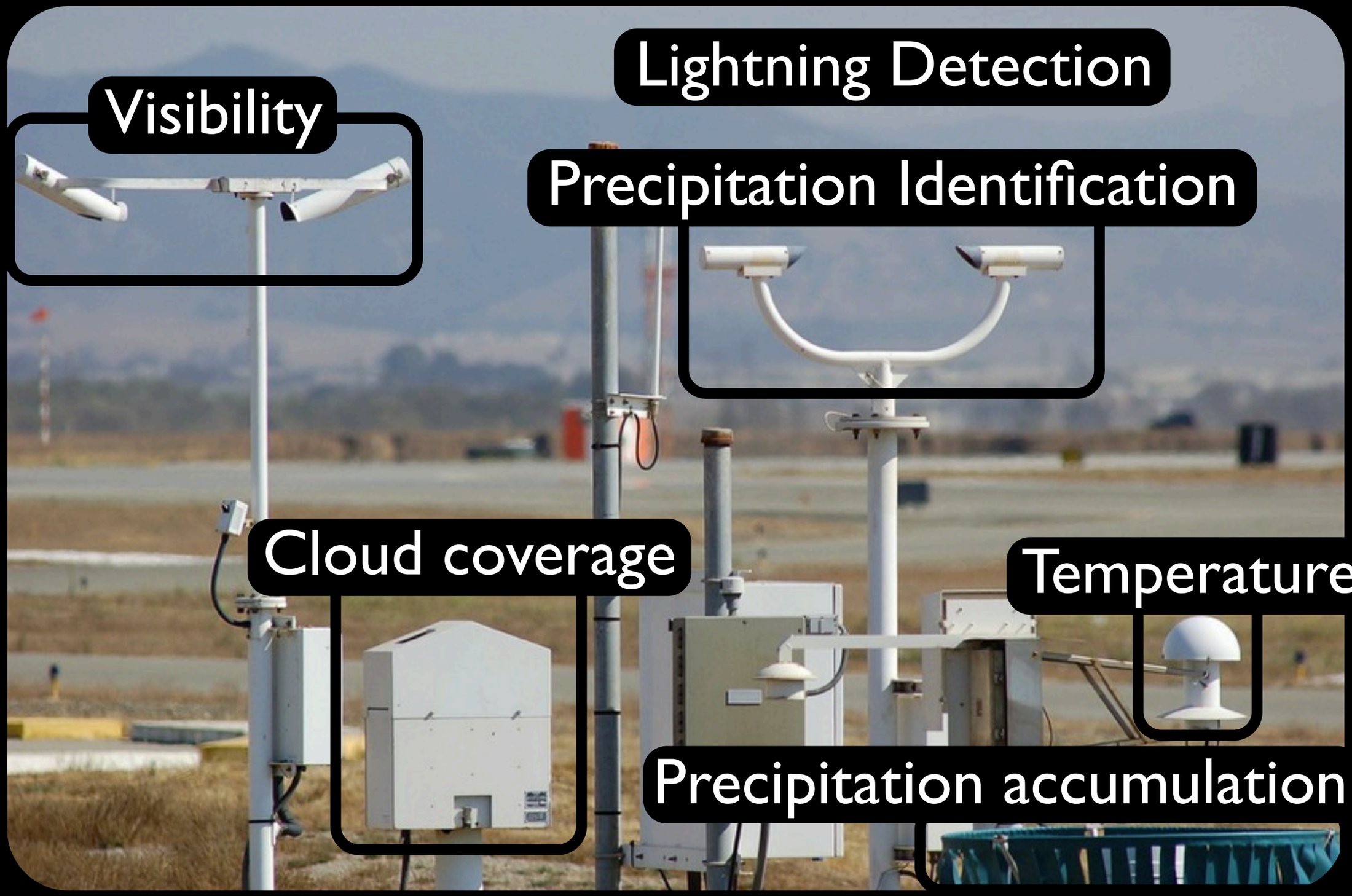


photo credit: Austin Cross

weatherunderground.com tracks history

12:57 PM,80.1,48.0,32,29.95,10.0,Variable,3.5,-,N/A,,Clear,METAR KFLG 051957Z VRB03KT 10SM CLR 27/09 A3029 RMK AO2 SLP141 T02670089,0,2011-07-05 19:57:00

1:57 PM,81.0,45.0,28,29.92,10.0,SSW,8.1,-,N/A,,Clear,METAR KFLG 052057Z 20007KT 170V240 10SM CLR 27/07 A3026 RMK AO2 SLP131 T02720072 58013,200,2011-07-05 20:57:00

2:57 PM,75.9,48.0,37,29.92,10.0,WNW,6.9,-,0.00,,Scattered Clouds,METAR KFLG 052157Z 29006KT 10SM SCT090 24/09 A3025 RMK AO2 RAB46E56 SLP130 P0000 T02440089,290,2011-07-05 21:57:00

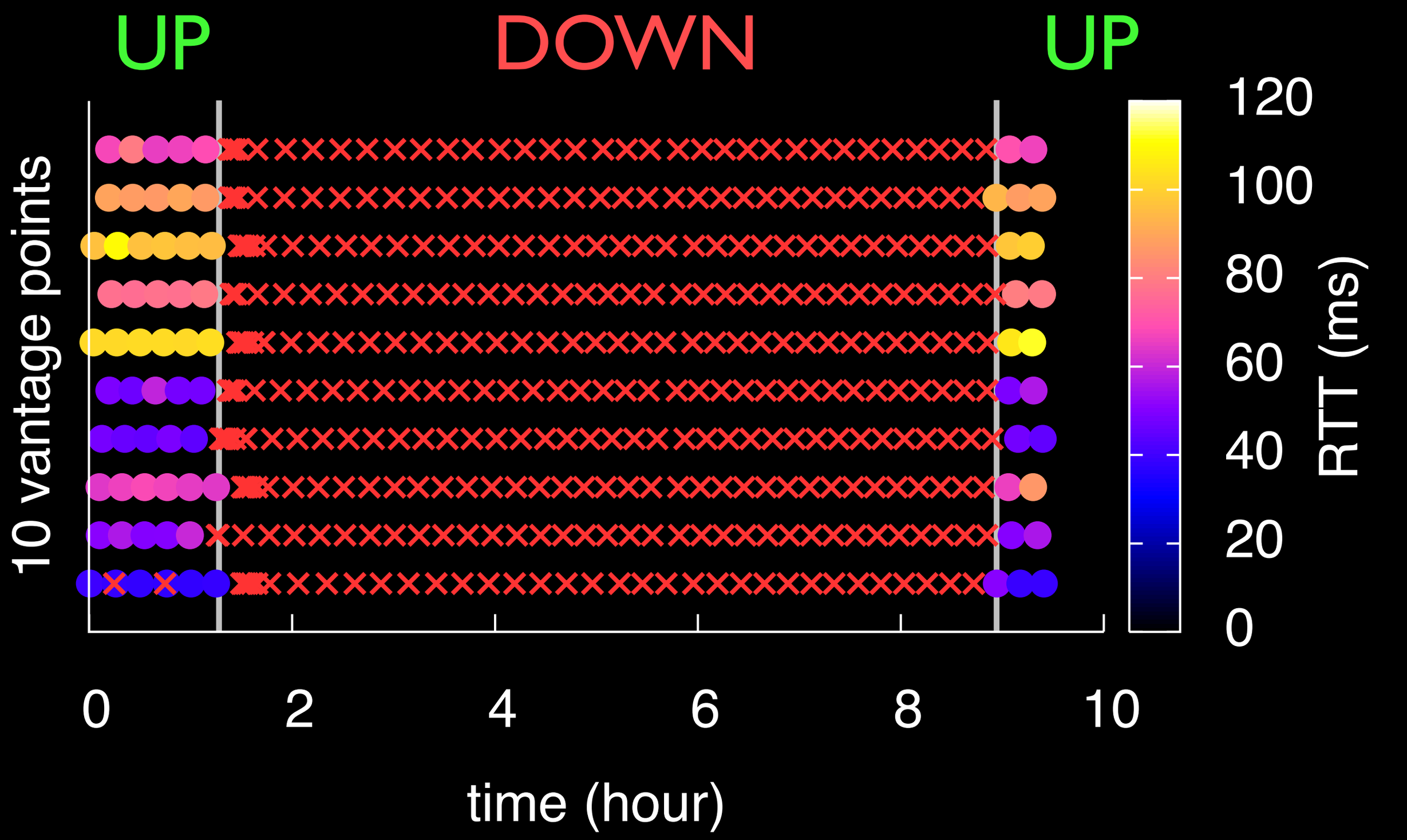
3:57 PM,75.0,45.0,34,29.93,6.0,Variable,3.5,-,N/A,,Haze,METAR KFLG 052257Z VRB03KT 6SM HZ BKN075 24/07 A3026 RMK AO2 SLP134 T02390072,0,2011-07-05 22:57:00

4:16 PM,64.4,55.4,73,30.27,5.0,North,13.8,17.3,0.07,Rain-Thunderstorm,Thunderstorms and Rain,SPECI KFLG 052316Z 01012G15KT 5SM TSRA BKN041 BKN050 OVC075 18/13 A3027 RMK AO2 TSB10RAB2258 TS OVHD P0007,10,2011-07-05 23:16:00

4:57 PM,64.9,55.9,73,29.95,10.0,West,8.1,-,0.13,Rain-Thunderstorm,Light Thunderstorms and Rain,METAR KFLG 052357Z 27007KT 10SM -TSRA FEW031 BKN095 18/13 A3024 RMK AO2 TSB10RAB2258 SLP140 TS OVHD P0013 60013 T01830133 10294 20167 58007,270,2011-07-05 23:57:00

5:13 PM,64.4,55.4,73,30.26,1.8,WSW,10.4,17.3,0.03,Rain-Thunderstorm,Heavy Thunderstorms and Rain,SPECI KFLG 060013Z 24009G15KT 210V280 1 3/4SM +TSRA SCT027 BKN085 18/13 A3026 RMK AO2 P0003,240,2011-07-06 00:13:00

Reducing pings to responsiveness



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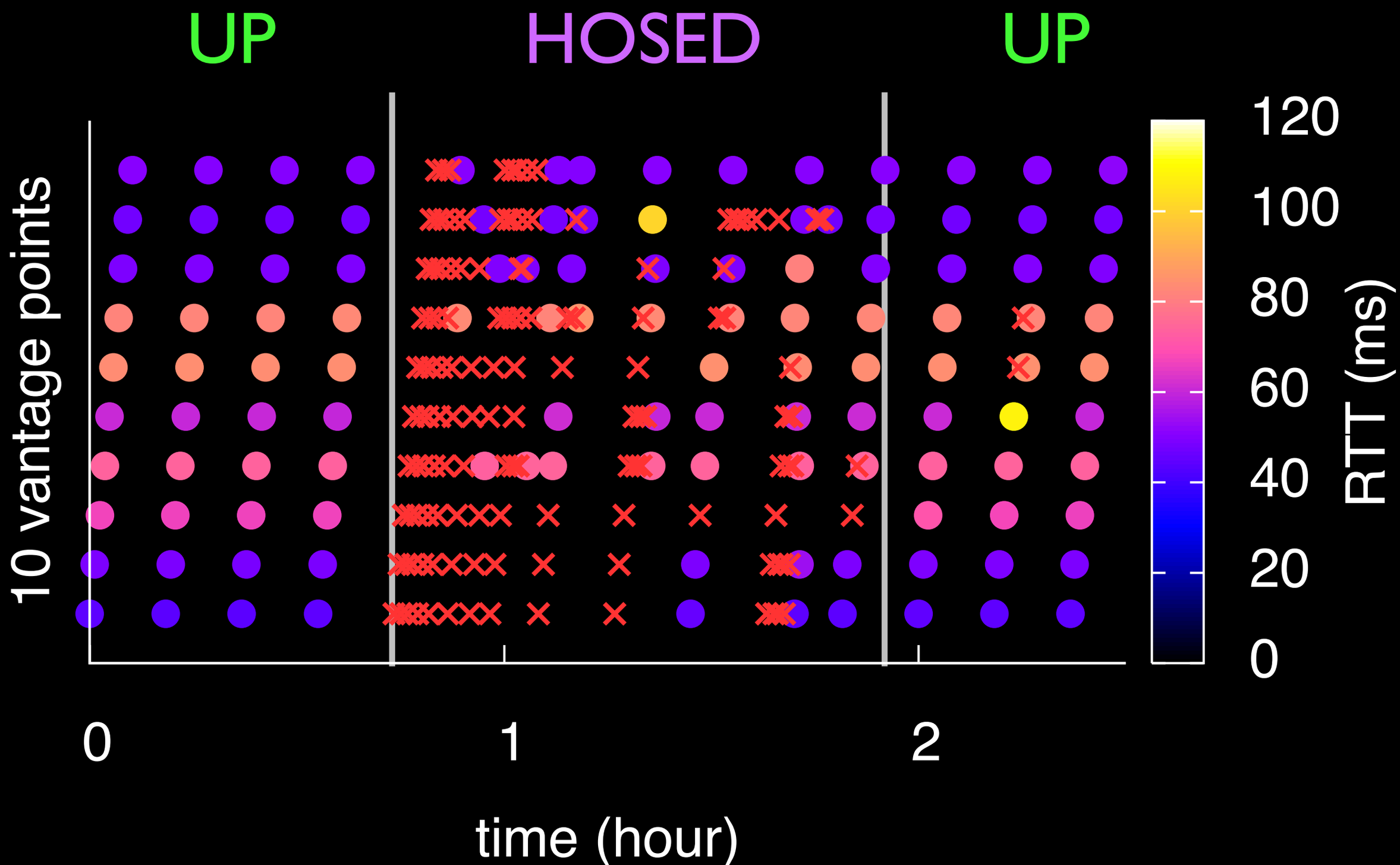

Pingin' during hurricane Irene

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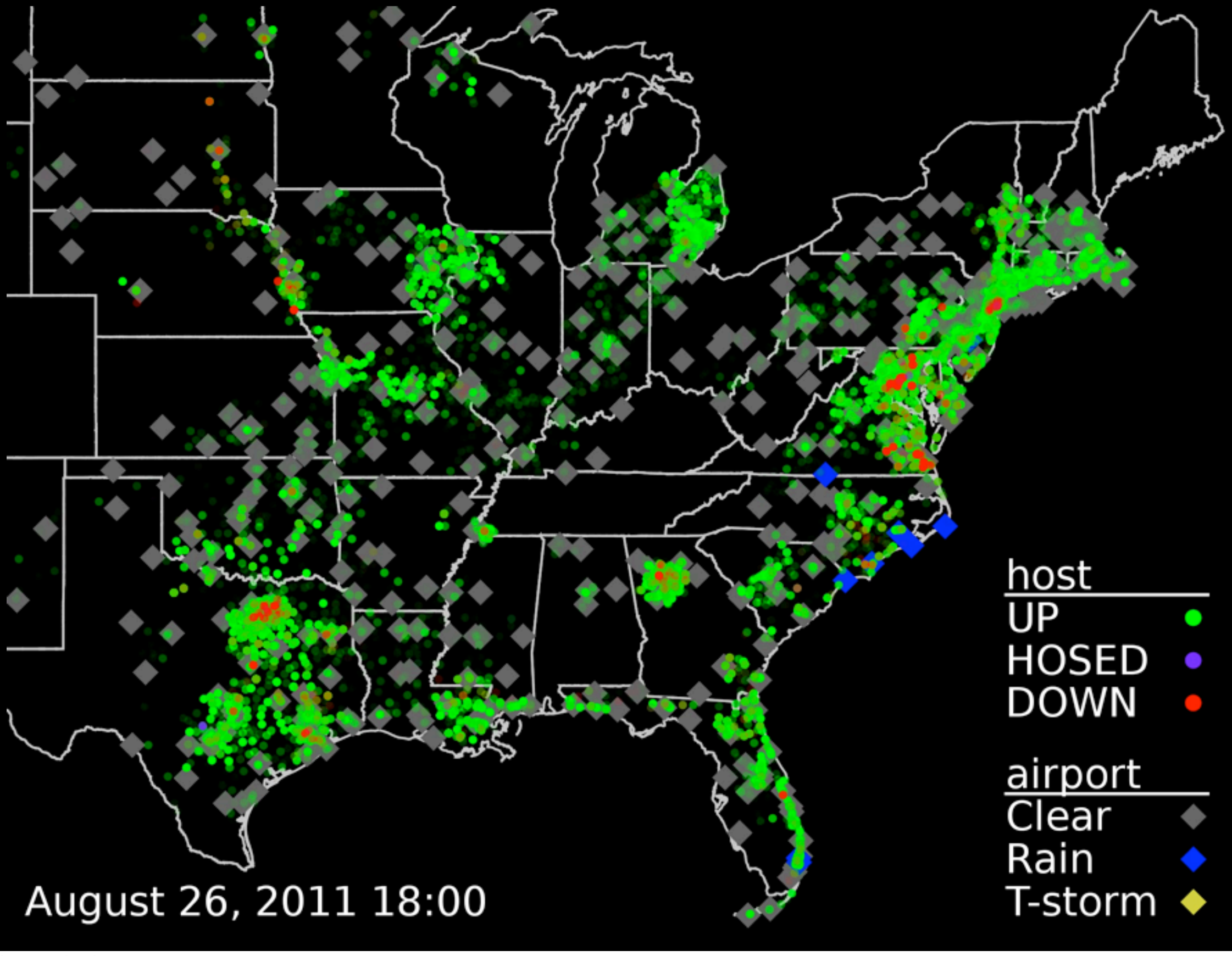

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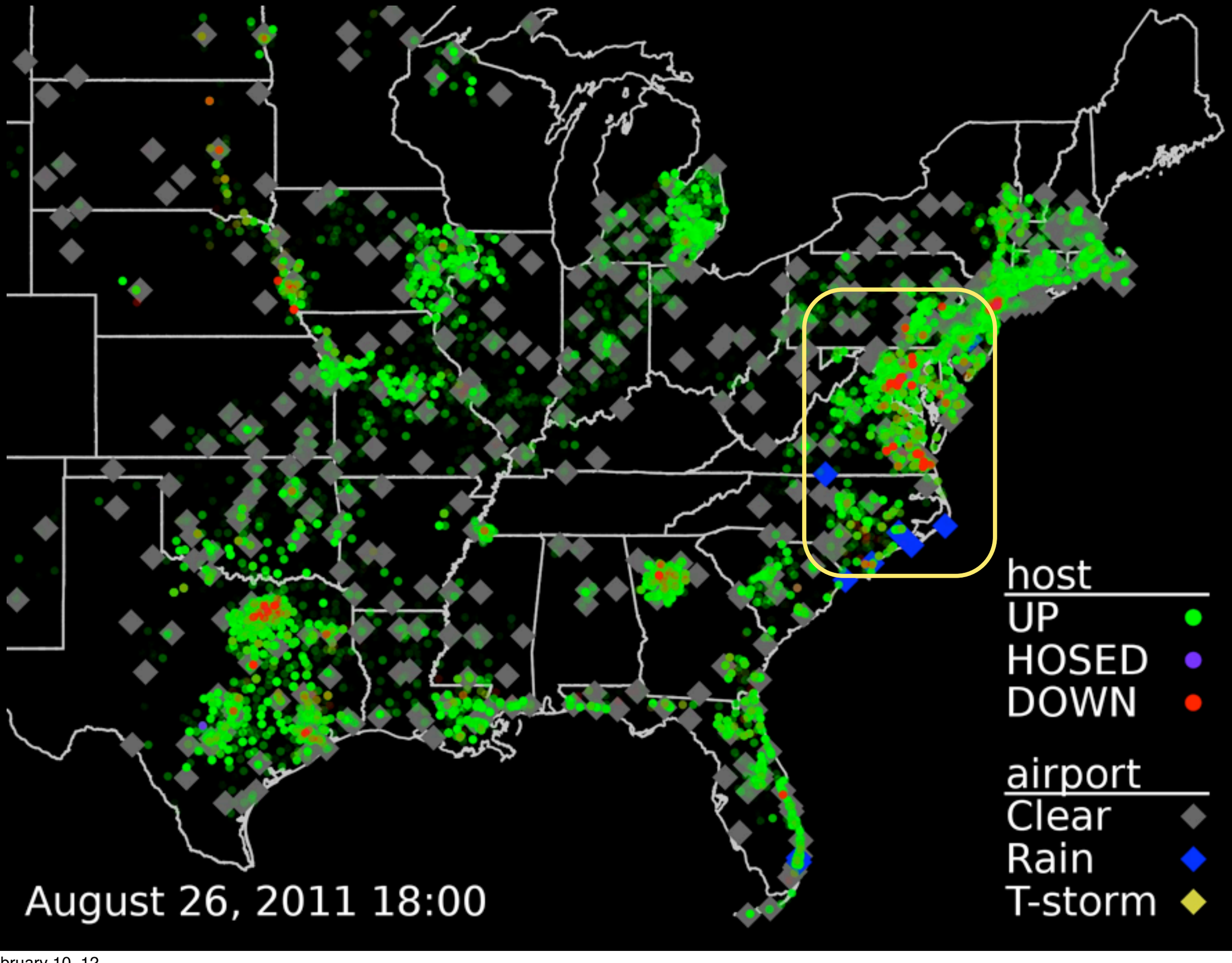


Preliminary results

Collected data

Pinged during 66 days (Spring - Summer 2011)

Focused on large providers with known link types

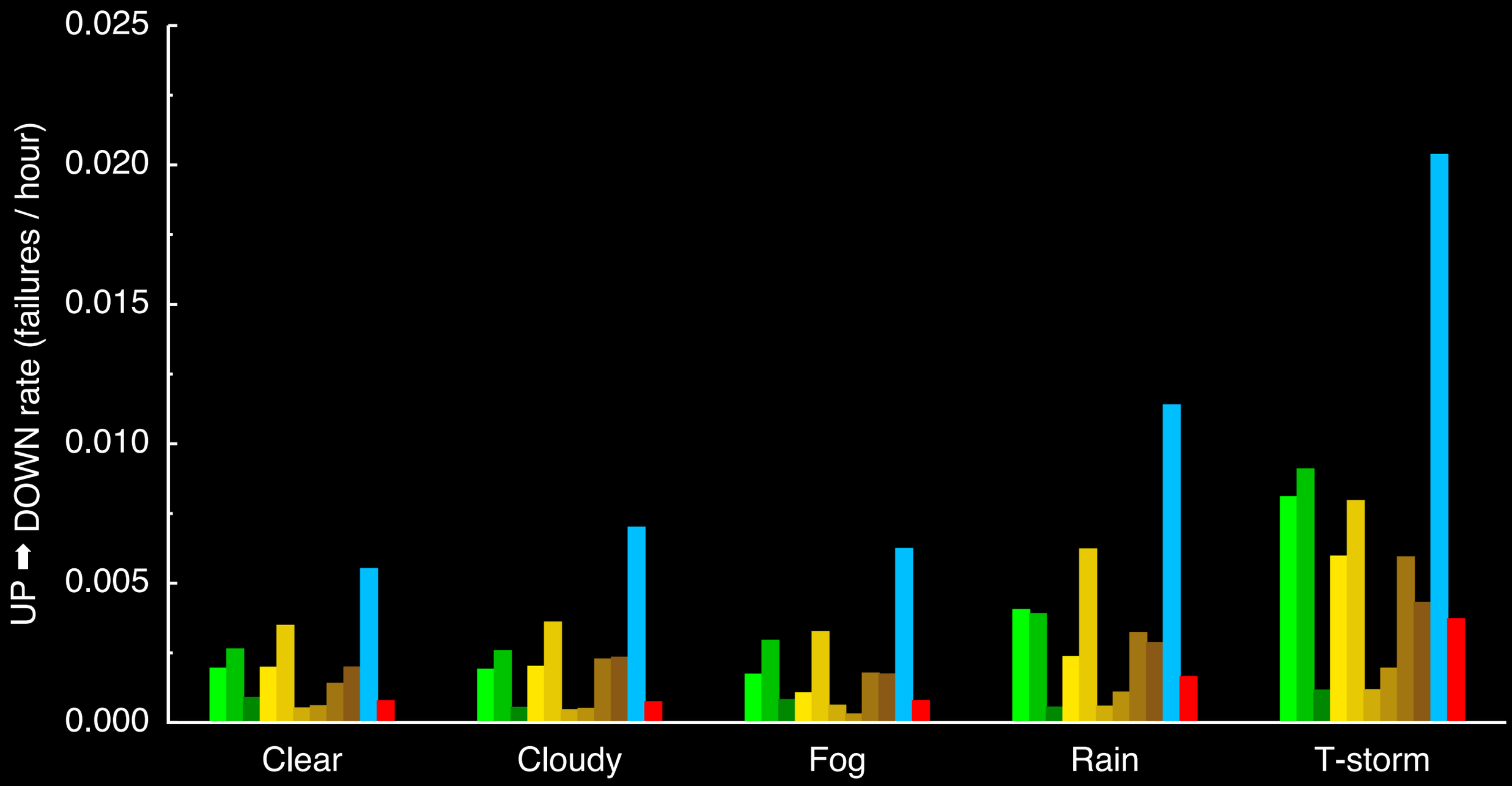
3 Cable, 6 DSL, 1 Satellite and 1 Fiber

Computed failure (UP ➡ DOWN) rate for each provider

$$\frac{\sum \#\,\text{failures}_{IP}}{\sum \text{time observed}_{IP}}$$

UP ➡ DOWN failures

Charter
Comcast
Cox
Ameritech
CenturyLink
MegaPath
Speakeasy
Windstream
Verizon DSL
WildBlue
Verizon FiOS



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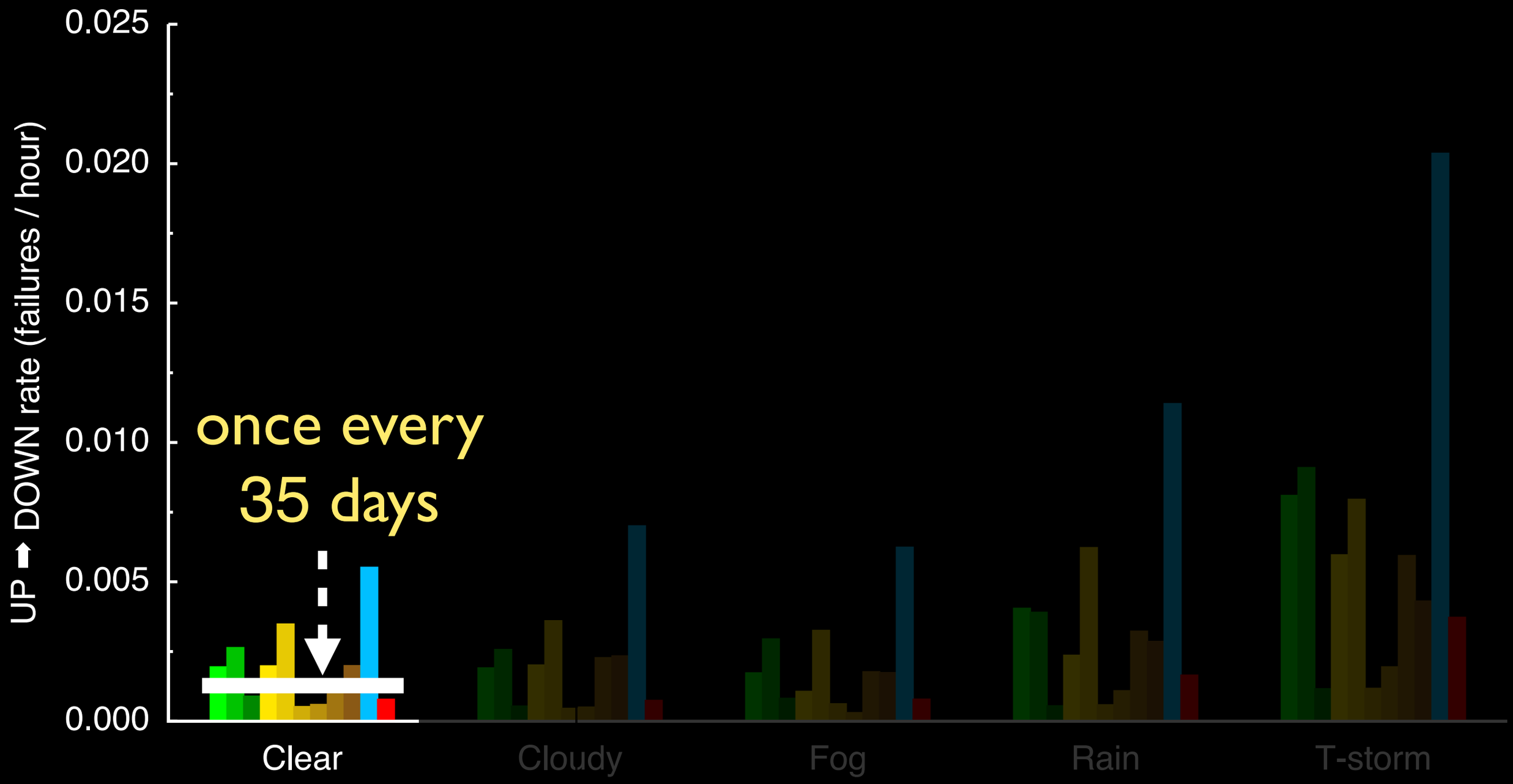

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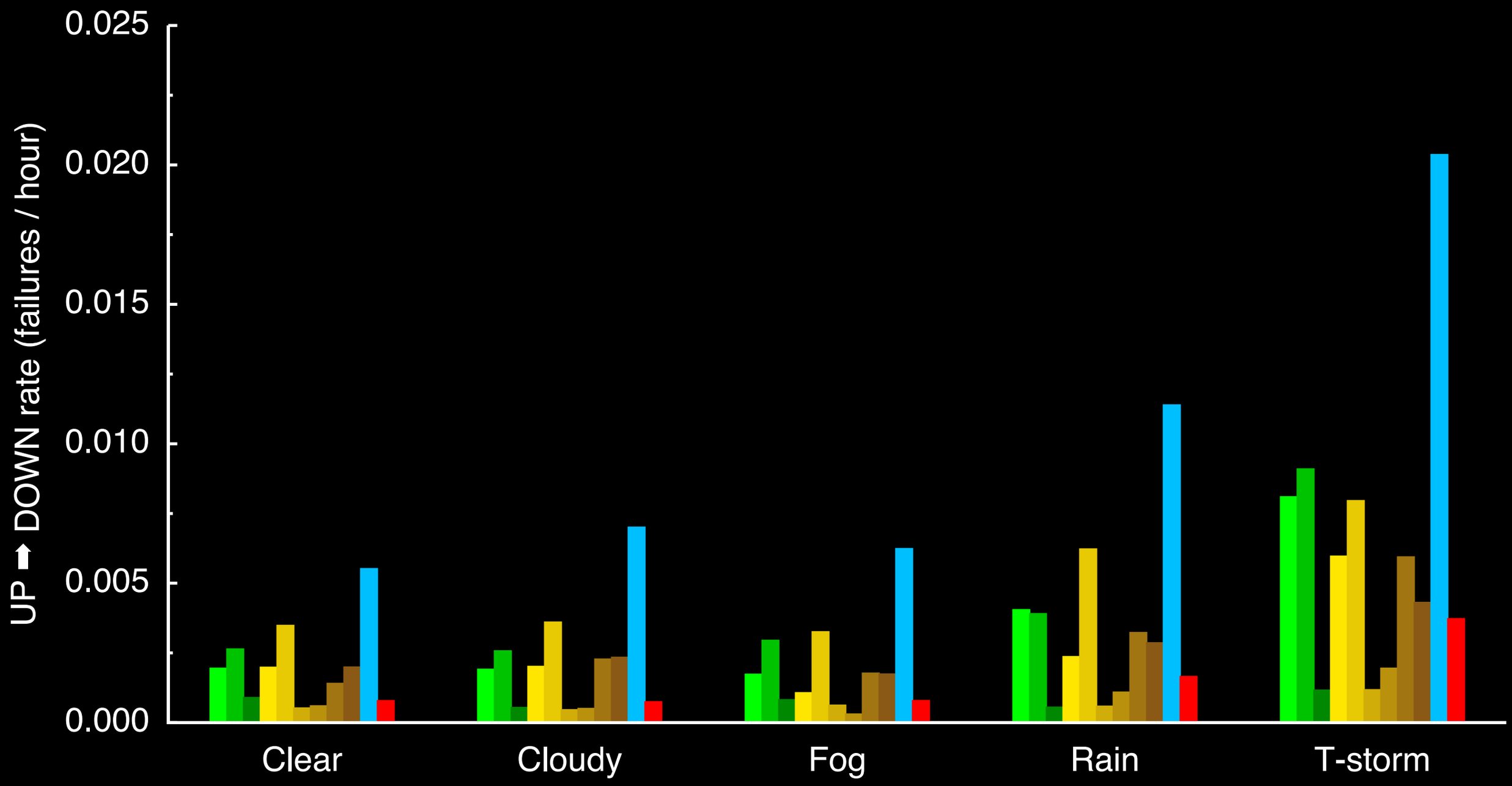

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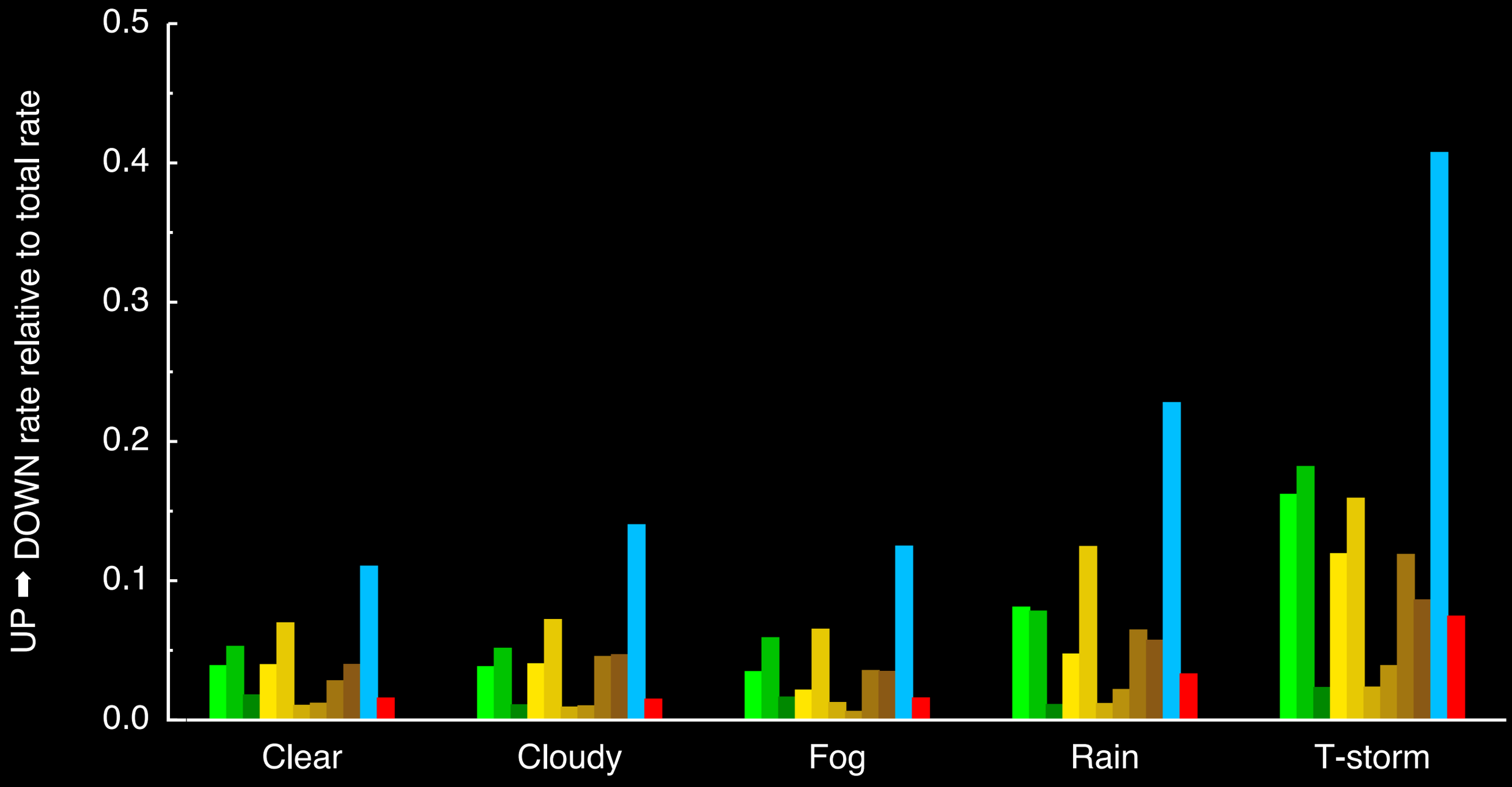

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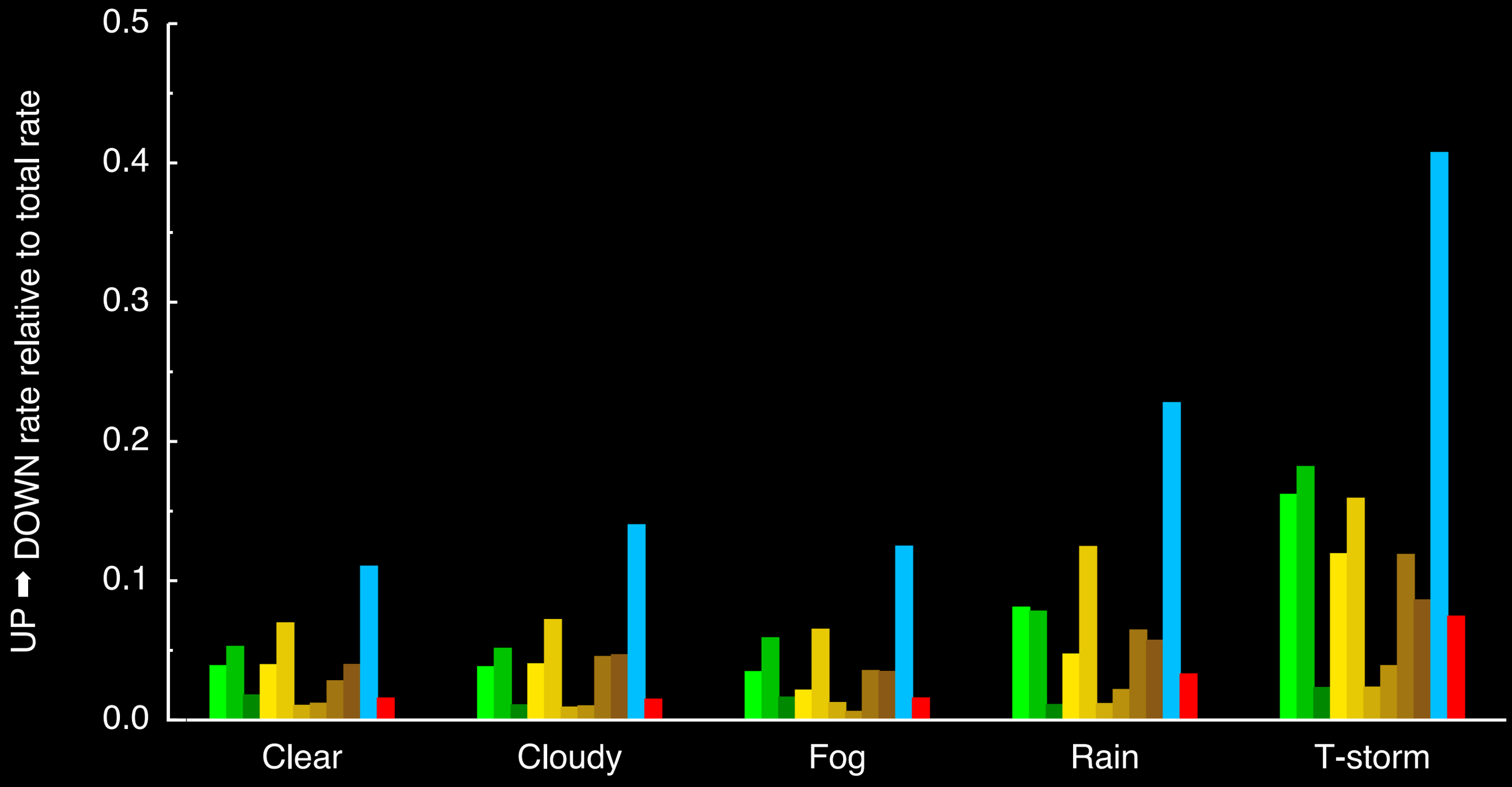

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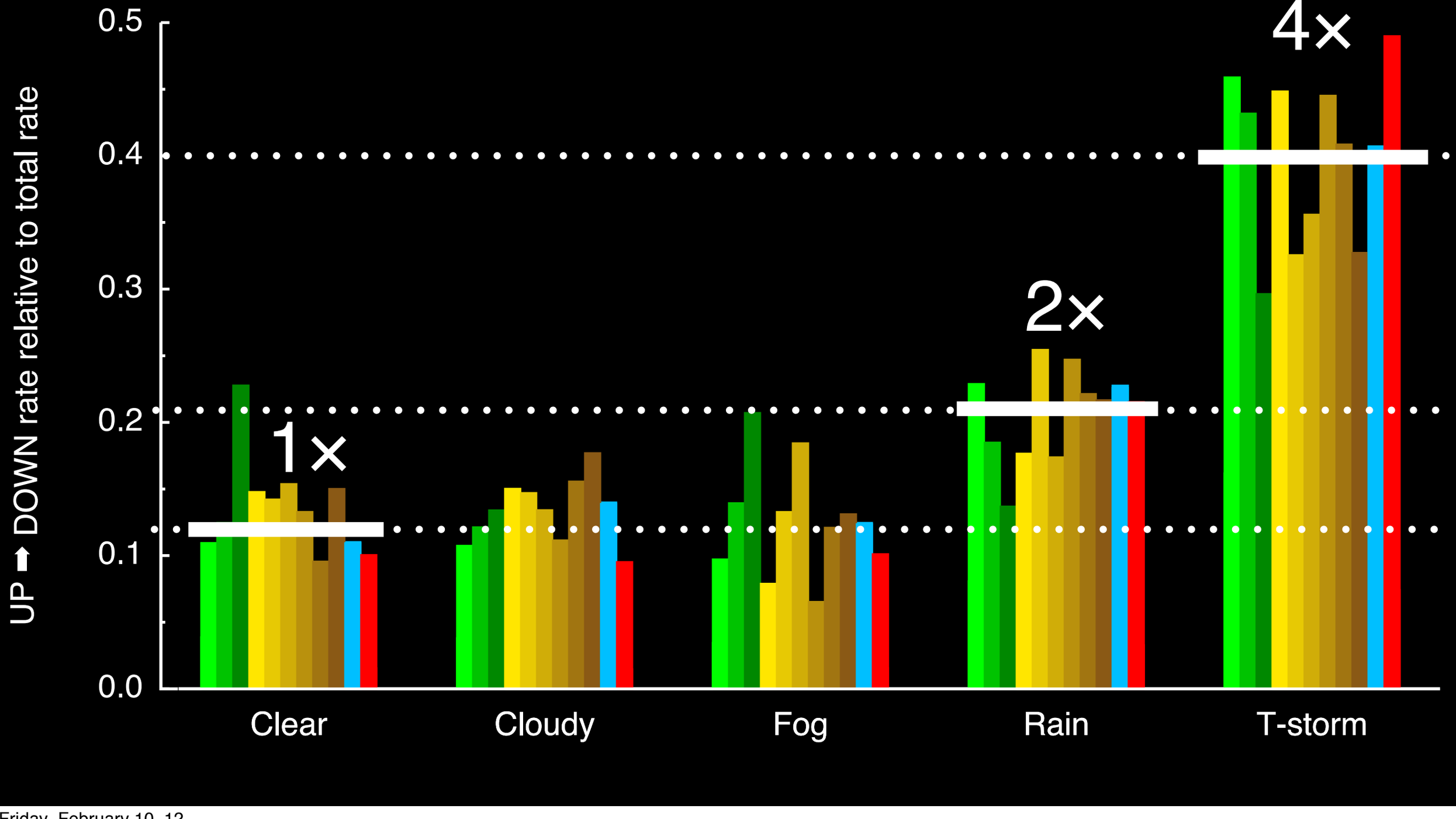

Next steps

Collect more data

Isolate power failures

Determine where the failures are in the network

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