



Geolocation in GPS-Denied Environments using Lightning

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Why This is Critical

“To accurately execute unified action, **Soldiers need to know where they and their comrades are located, where they are going, and when to strike.”**

- ARMY C5ISR Center

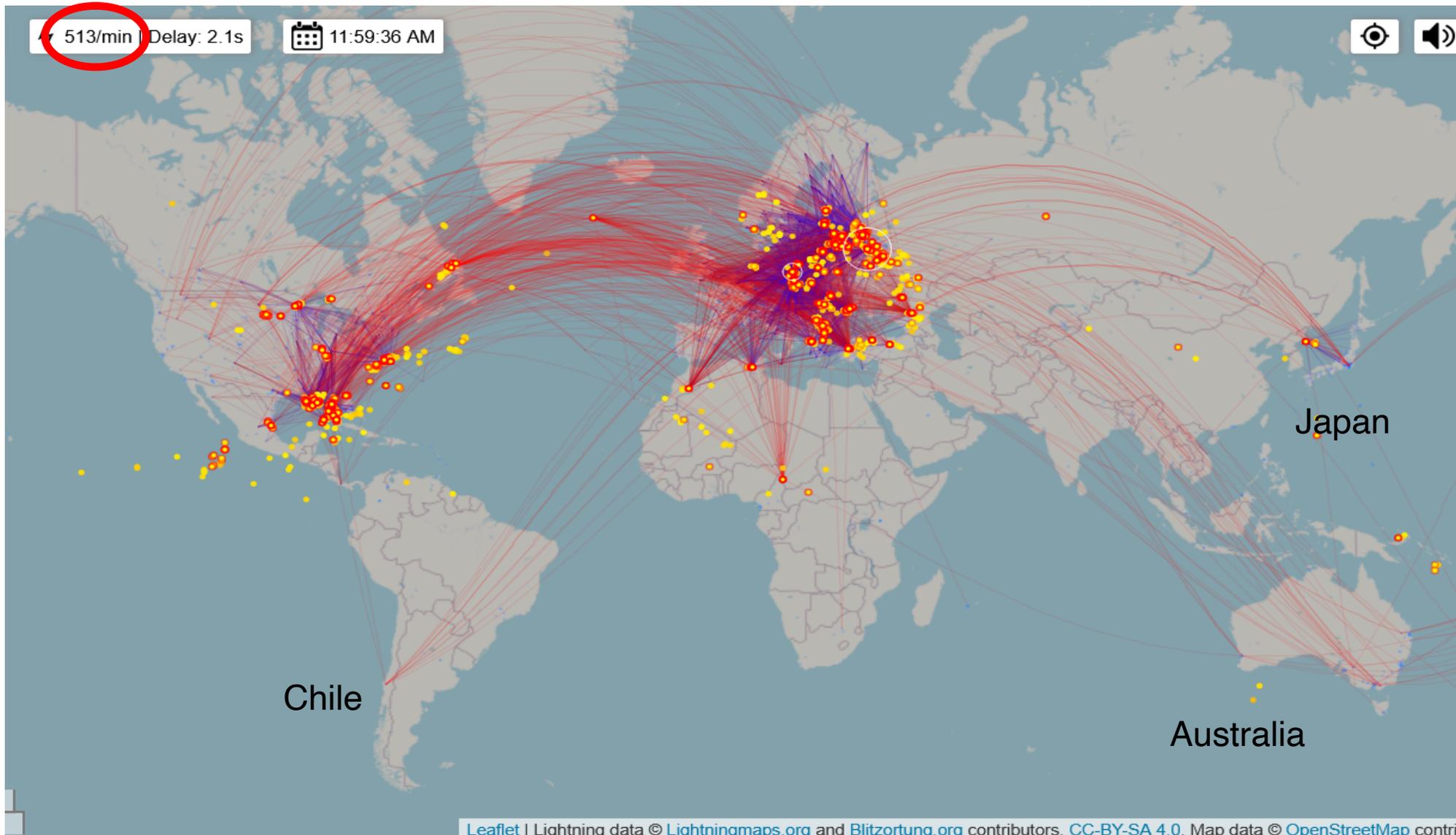
“...US has no robust backup to GPS, which could prove catastrophic in a military conflict.”

- Hudson Institute, Nov '24

Advantages of Exploiting Lightning for Geolocation

- Un-jammable, un-spoofable, un-bombable
- Abundant (average of 44 flashes/second)
- Detectable at transcontinental distances
- Accessible in terrain GPS cannot reach
- Inexpensive COTS gear
- Self-contained: no need for ground or space support

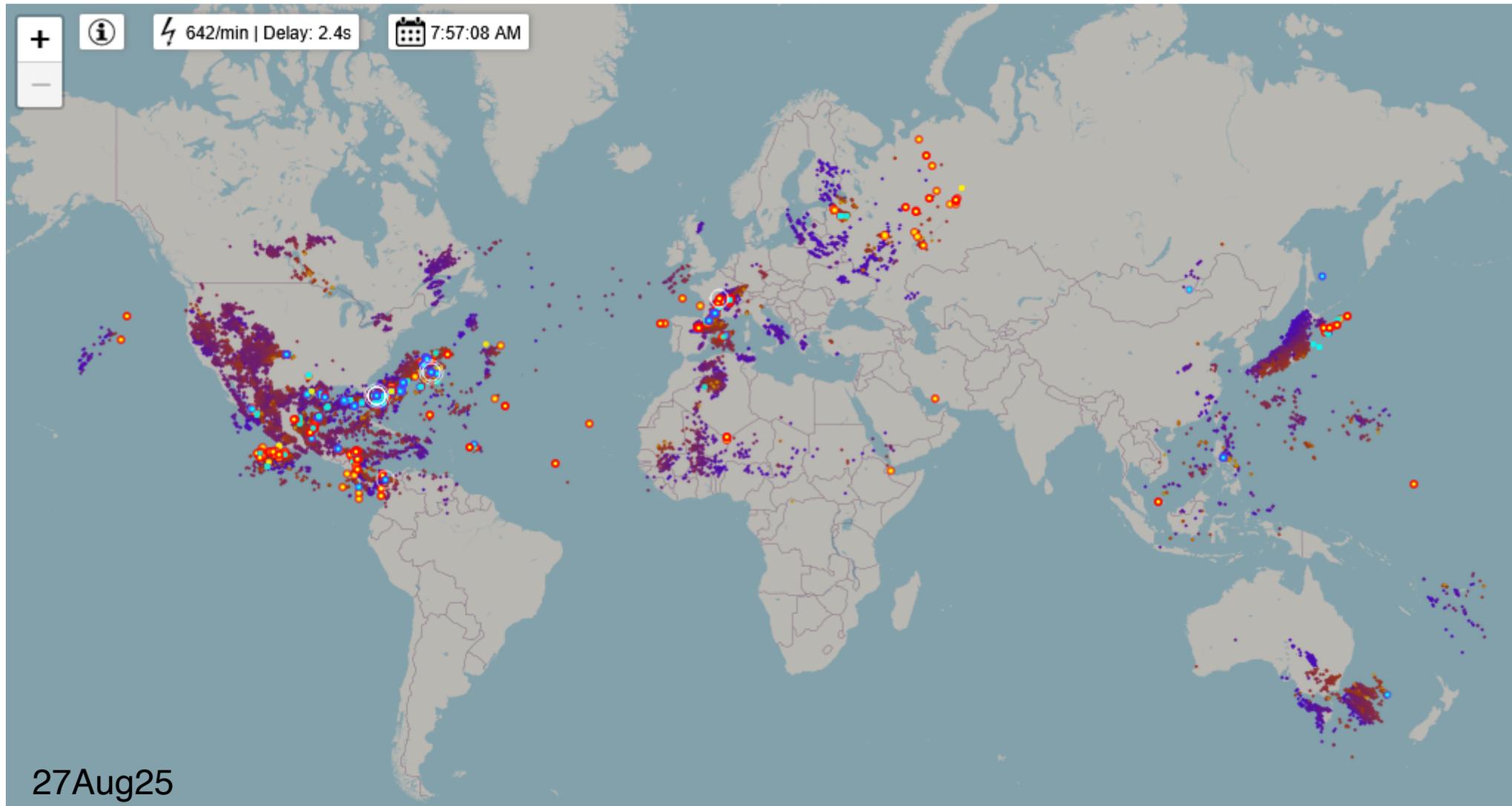
“Abundant and Detectable at Transcontinental Distances”



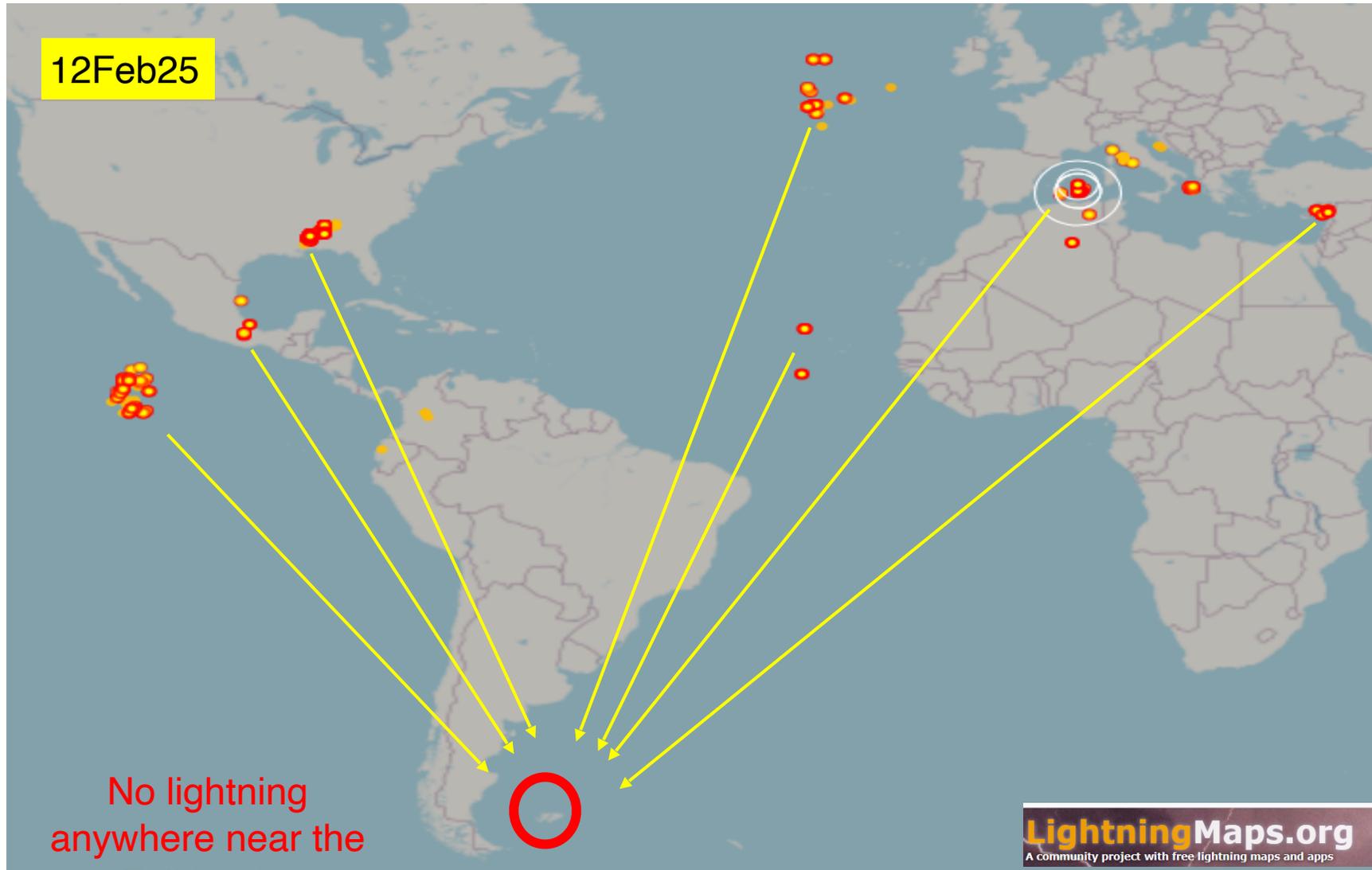
Colored dots are lightning (here, 513 strokes per minute)

Red lines connect volunteer observers to strokes their receivers detect. Signals from Europe detected in US, Chile, Japan, Australia,

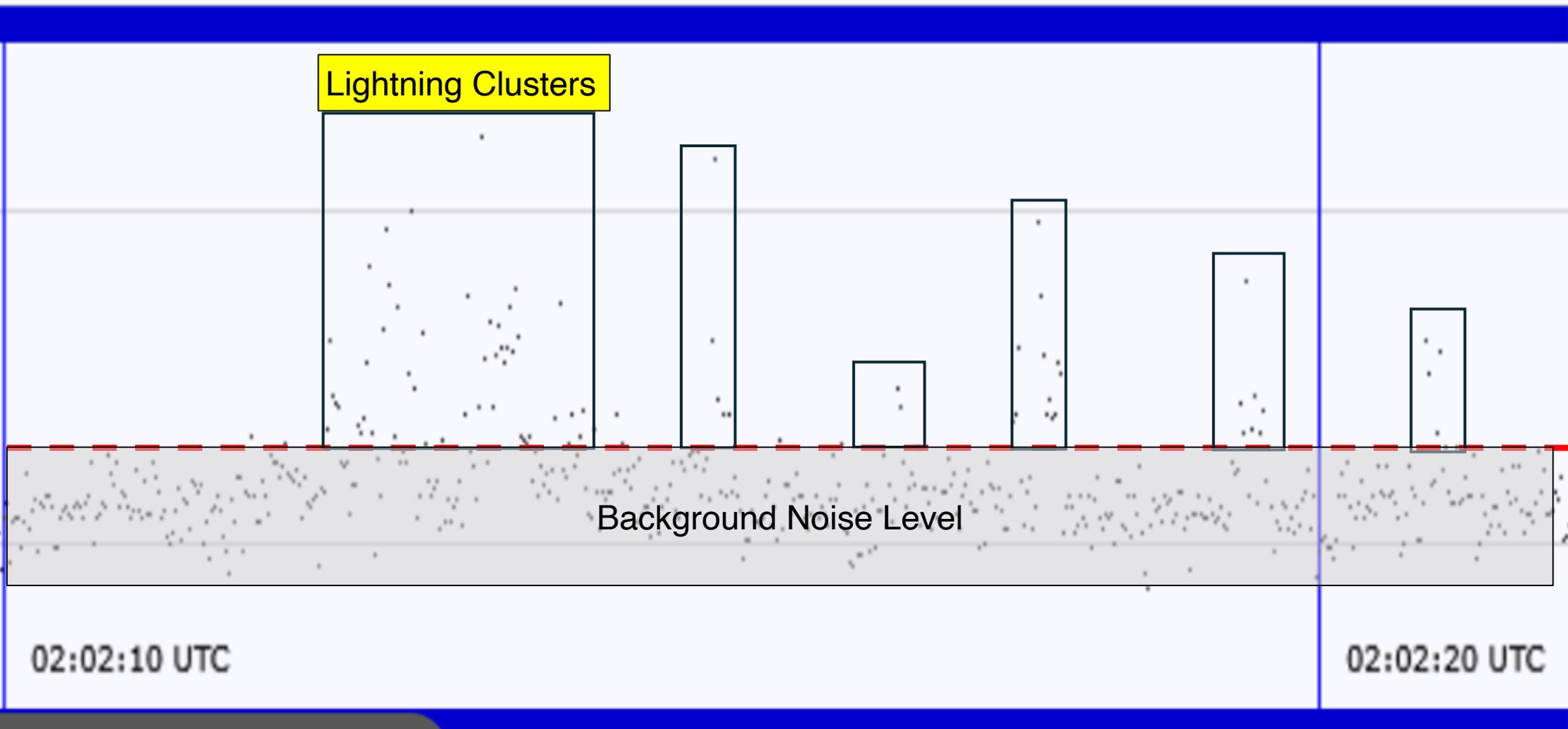
“Abundant”: 24 Hours of Lightning Activity on 27AUG25



“Abundant and Detectable at Transcontinental Distances”



Lightning Detected in Falklands by Software-Defined Radio



Basis: Time Difference of Arrival (TDOA) Data



Time of Arrival = T2

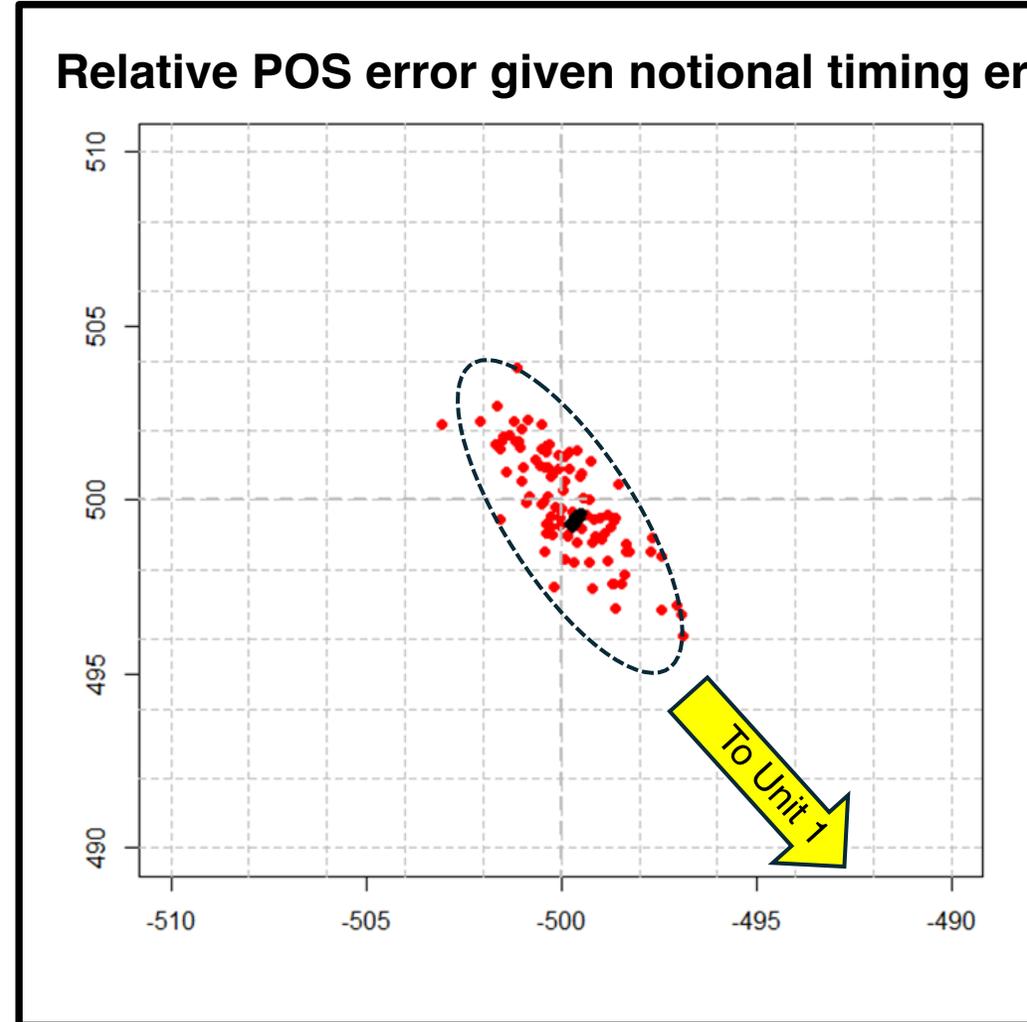
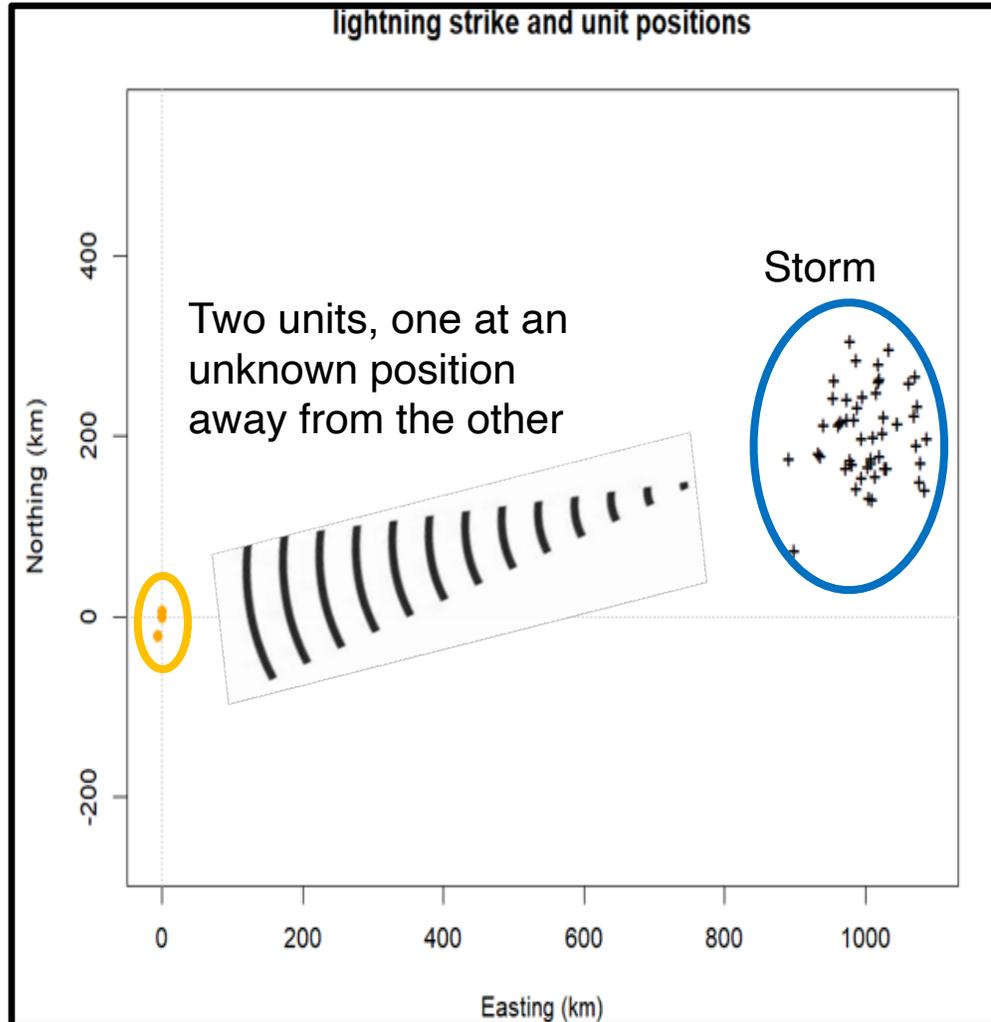


Time = T1



$$\text{TDOA} = T2 - T1$$

A Simulated Scenario and Illustrative Results



KERAUNOS SYSTEMS

"Keraunos" (κεραυνός):
Greek for "lightning" or "thunderbolt".

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