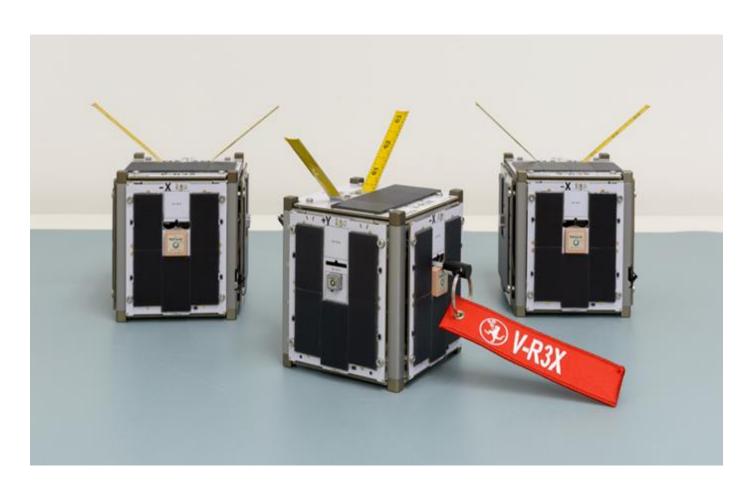
Exploring Time-series Telemetry from CubeSats

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Introduction

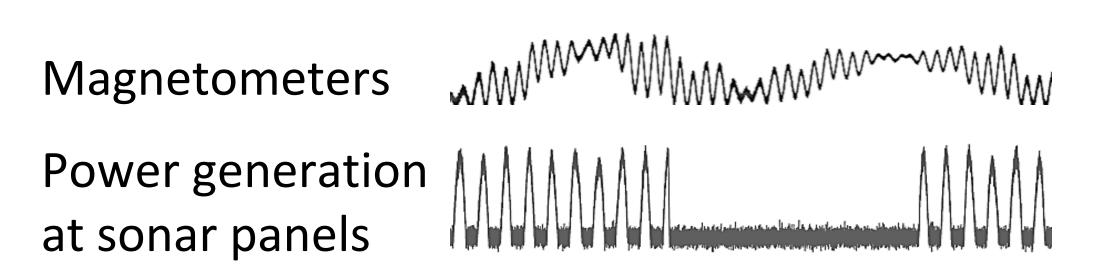


CubeSats: Sensors in Space

- Size: $10 \times 10 \times 10 \ cm^3$
- Weight: 1 kg
- Low Earth Orbit (LEO)
- Cheap & Low-power
- Application:
 Research, Education, By
 hobbyists...

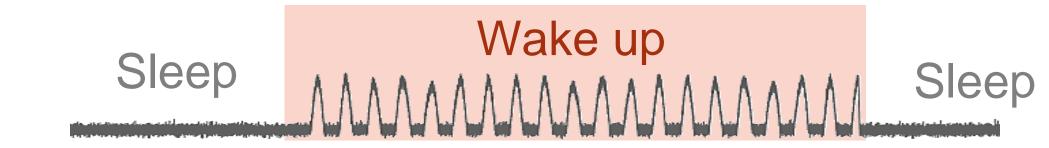
Telemetry Data

Time series measurements from different sensors



If the end users at the ground can obtain this information...

- Anomaly Detection & Debugging: identify and correct what is going wrong "A recent launch of CubeSats by CMU-team in collaboration with NASA and found that three of them were consuming much more power than expected"
- Time-aware Computing



Current Limitations of CubeSat Telemetry

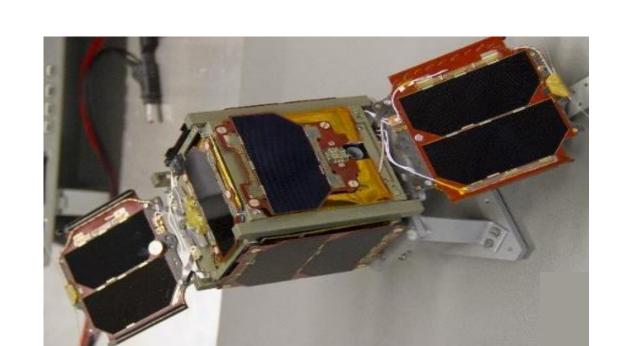
(1) Sparse ground station coverage



Available ground station in SatNOGS Network

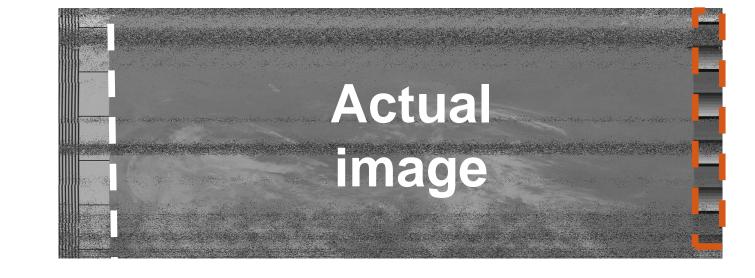
(2) Limited communication bandwidth

- Constrained power by small sonar panel
- Narrowband communication technology: LoRa (~kbps)
- Much of the downlink payload are reserved for actual data





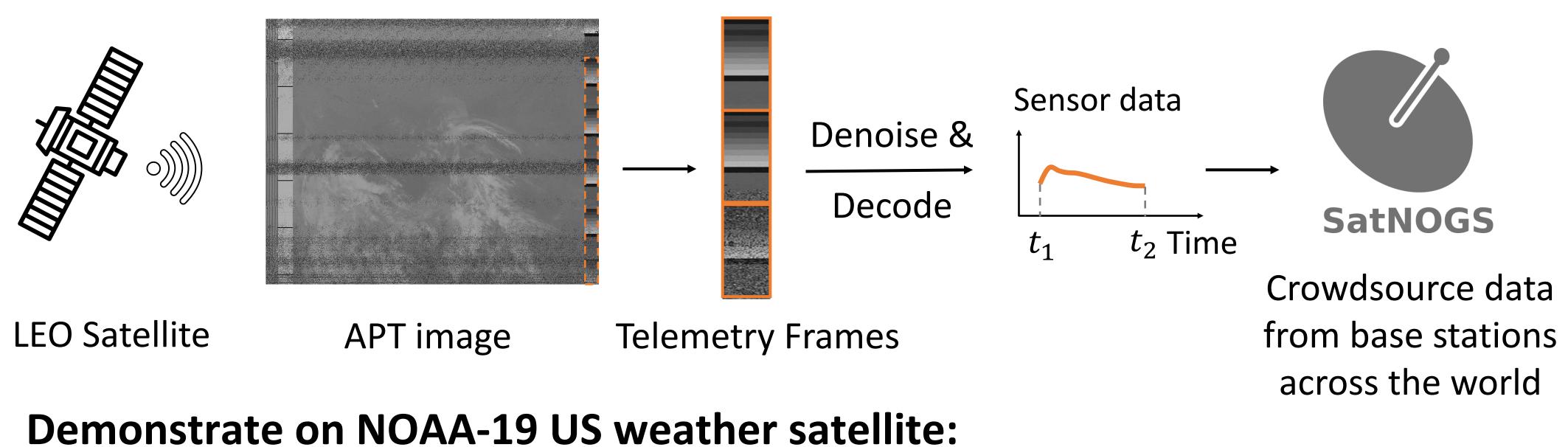
Telemetry data

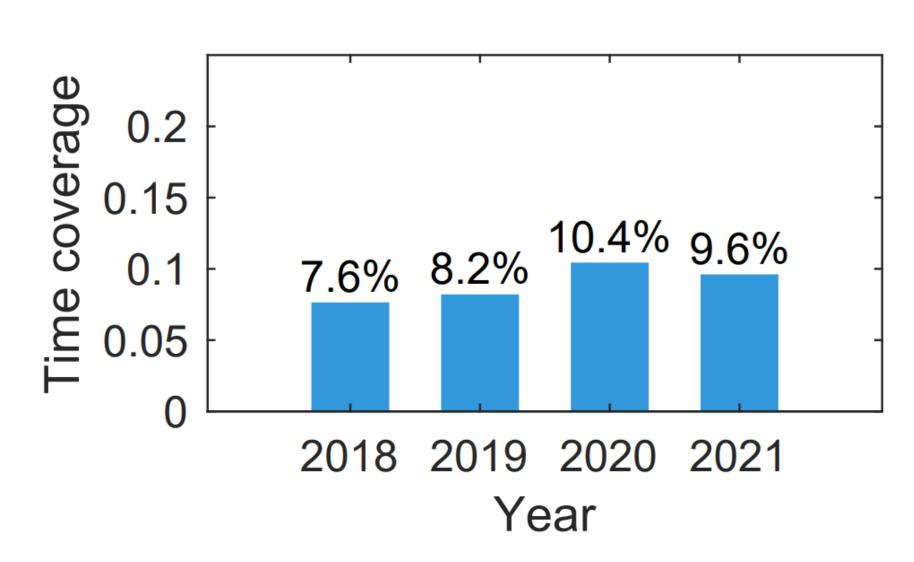


Question: Can we provide the benefits of time-series telemetry that big satellites enjoy to CubeSats?

Motivation Study

A software pipeline to retrieve telemetry data from LEO satellites:





Percent of time telemetry data is available

- Ground station number was increased in last two years
- 10% time coverage remains too little for real-time telemetry applications

Need to develop better approach for telemetry from CubeSats!

Design Space and Challenges

Compress Encoded message Space Wireless Channel Ground Received message Decompress

1 Deterministic basis compression

DCT, DWT, ...

- Telemetry signals are not necessarily sparse in these domains to achieve satisfactory compression ratios
- 2 Data-driven compression

Neural Network,
Dictionary-based, ...

- Only CubeSats themselves have access to the raw data, but with very limited compute and memory resources
- Base stations have large compute and storage resources, but don't have the access to data to perform training



Electrical & Computer ENGINEERING

