Is Turbulence Affecting Your Network?

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In-Flight Connectivity

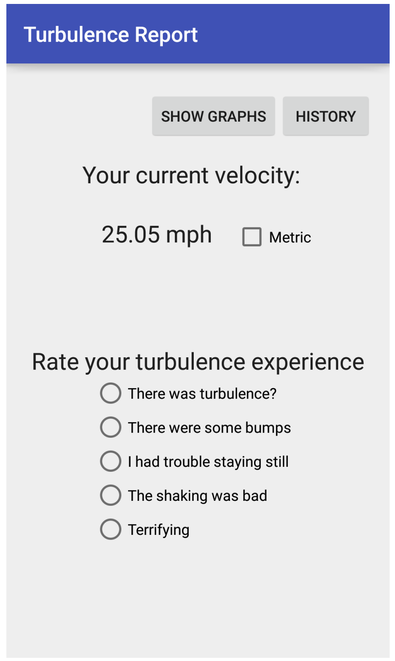
In-Flight connectivity (IFC) on commercial airplanes is in growing demand as people expect pervasive, high-performance access to the Internet. The highly unique IFC environment – with planes flying at high speed, thousands of feet midair – challenges efforts to maintain a performing, reliable Internet connection.

One of the unique features of the IFC context is turbulence, which causes a plane to shake as it resists strong winds. In that context, one would expect that the sudden changes in a plane's position will affect wireless network connection. Thus, the goal of this work is to study the potential impact of turbulence on IFC performance. To this end, we have developed an application to study the correlation between user-validated turbulence events, their intensity levels, and network performance.

Methodology

- Data collection through crowdsourcing app
  - IFC performance
    - Send pings to www.google.com
    - Perform DNS queries to observe delays
    - Record traceroute hops and delays
  - Turbulence
    - Monitor device velocity changes
    - Validation from user for turbulence detection
- Turbulence and performance analysis
  - Correlation analysis of detected turbulence measurements and IFC performance
  - Long, strong turbulence should be correlated with high packet losses / lower network performance

Crowdsourced Data Collection

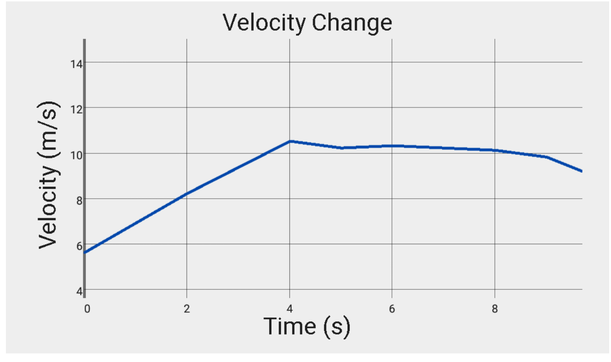


The active screen lets the user view their real-time velocity in either mph or m/s measurements.

If they encounter turbulence, the user has the ability to report their experienced level of intensity.

Network statistics during a flight are recorded in the background.

The "Show Graphs" button leads to this view



As the device's accelerometer values change, the velocity graph updates in real time to track potential sudden speed changes.

The user can scroll left and right to view detailed changes on the line graph.

Once a flight is finished, recordings and statistics will be automatically submitted. This can be detected from when an airplane slows down to less than 20 mph.

Discussion

- Confounding factors explaining packet loss
  - IFC networks are often congested
  - Other sources of interference
- Turbulence detection is challenging
  - The user may drop or shake their phone
  - Low intensity turbulence may be subtle on graphs
- Time granularity for correlation analysis must be small

Future Work

Implement aviation website background readings
Aviation websites (FlightAware.com & AviationWeather.gov) can help track altitude, turbulence, and sky conditions to have consistency between aircraft reports and user reports.

History of flight data
Adding a device specific history view option can contribute to a more transparent view of experienced performance of in-flight Internet connectivity.

Possible connection remediation
Using a transfer protocol that handles loss recovery more strategically than TCP may result in less frequent loss for a trade off in latency.

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AquaLab

References

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