Disclaimer:
This document is intended to document and analyze the performance of the Open Source ADS-B Receiver (aka Stratux) Project. All data in this analysis was collected from the author's Open Source ADS-B Receiver Build. Due to variations in component selection and packaging of the Receiver project the performance of other Open Source ADS-B Receivers may differ from those of the author.

Stratux Build used for this evaluation:

- EdiMax Wi-Fi Dongle
- Dual NooElec 820T2 dongles (originally specified 820T2 dongles)
- Raspberry PI - Vilros Kit
- 5V DC Fan
- 2V USB Wall Wart Power Supply
- SMA - MCX pigtails to interface to the antenna port on the SDR dongle

Antennas: Homebrewed vertical monoploes tuned for 1090 MHz and 978 MHz.
Installation: Stratux is setting on the Glare Shield of a Cessna 172.

In Issue 203 @Ergonomicmike raised an interesting point.

> As an aside, is it possible to saturate the Stratux w/ too much traffic? I suppose that you're showing empirically that we haven't hit a limit yet. (How would we know? Does the Stratux drop packets or freeze when overwhelmed?)

The topic has also be mentioned on the /reddit/stratux site.

In an attempt to answer the question the track plots of individual traffic targets were analyzed to determine the frequency and duration of dropped intruders. The following is a discussion of the analysis.

Point of Reference?
There is reference that can be utilized for the analysis, the TCAS specification. It defines the criteria for identifying Mode S intruders of interest for the analysis. Generally the criteria is: a Mode S intruder within +/- 10 nm and +/-10,000 ft of Own Ship. There are additional criteria but they were not considered for this analysis.

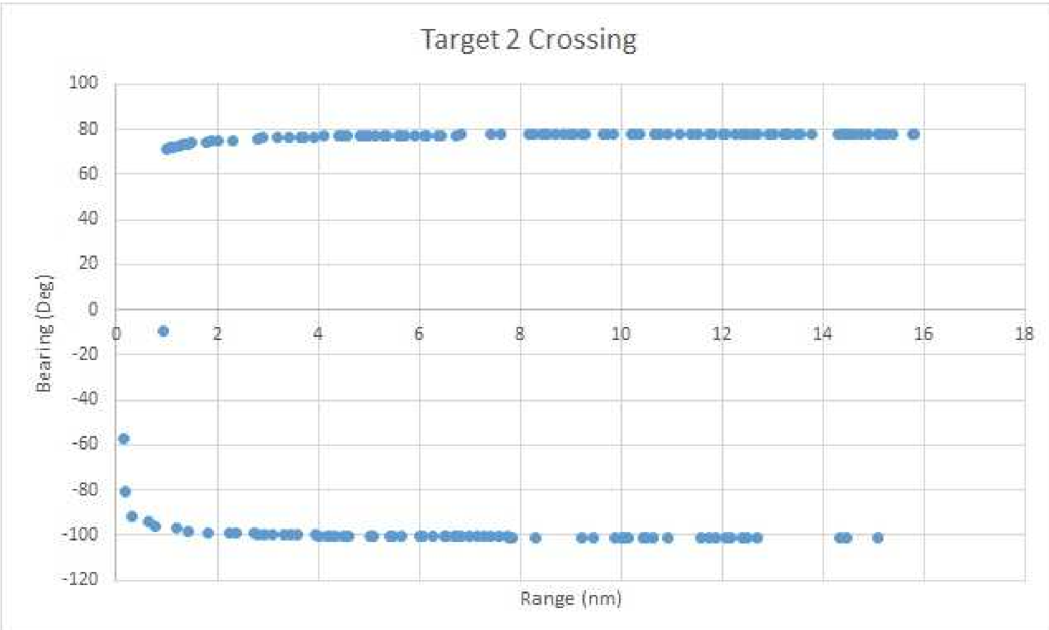
Which intruders?
For a given flight there can be hundreds of 1090ES tracks in the log. Since only 1090ES traffic is logged in a format that is readily accessible for analysis they were the only tracks that were examined. To aid in identify potential intruders the 1090ES and the Own Ship GPS logs were formatted, converted to KML files, and loaded into Google Earth. The resulting plot was analyzed to find those intruders that meet the range criteria, or as close as possible. Analyzing only the 1090ES traffic presents some challenges - namely having few targets within +/- 10,000 feet of

Own Ship. Two intruder targets that crossed over the Own Ship path were analyzed in this exercise. These images are from one of the intruders.

Image 1: This is a Google Earth plot of the above images. In this image the Own Ship track starts on the right edge and continues to the left. The Target 1 track (longer track) starts on the lower left hand side and continues Northwest crossing the Own Ship track. Target 2 tracks the opposite direction. (Image from Google Earth.)

Image 2 (Target 1): Plot of The passing of Target 1 that came with 1 nm of Own Ship. The plot starts on the upper half and progresses Clockwise until the tack ends at the bottom of the plot. The plot zooms into the track that is within +/- 15 nm of Own Ship.

Image 3 (Target 2): Plot of the passing of Target 2 that came with 1 nm of Own Ship. The plot starts on the lower half and progresses Counterclockwise until the tack ends at the top of the plot. The plot zooms into the track that is within +/- 15 nm of Own Ship.



The above plots show how signal reception is affected as the target aircraft passes over Own Ship.

Target 1:
Target 1 is approaching and overtaking Own Ship from behind. At approximately 10 nm out the signal is lost, but why?

As stated earlier Stratux is setting on the glare shield. When the Intruder Aircraft is low in the horizon behind Own Ship Stratux has visibility of the Intruder through the rear window. As the Intruder overtakes Own Ship is moves high on the horizon until the Stratux antennas are shaded but the Own Ship fuselage. The shading starts when the Intruder is approximatly 10 nm behind Own Ship and continues until it is approximately 1 nm in front of Own Ship.

The approximate two seconds gaps in the track plot are due to the diversity of the Intruder Transponder. The Intruder transponder squits the 1090ES DF-17 message at a one second interval with the following pattern: BBTTBBTT. As the Intruder aircraft gets closer to Own Ship the Top antenna 1090ES squits are shaded by the Intruder aircraft airframe. The shorter gaps are when the Intruder is squitting on the top antenna. The longer four to six gaps occur when the Intruder bottom antenna squits are missed. Two of the more common reasons for missing the bottom squits are Intruder aircraft antenna shading when an aircraft is in a turn, or due to packet collisions at the receiving station.

Target 2:
In this plot the intruder aircraft is going the opposite direction and is meeting Own Ship from the front. We can see the “dead spot” as the intruder passes overhead.

Conclusion:
Even though this analysis was performed with 1090ES Intruders at a height approximately 20k feet above Own Ship, it still provides some insight into Intruder tracking and demonstrates how antenna shading affects target tracking. If Own Ship is equipped with ADS-B Out the antenna shading will be mitigated by the intruder information that is broadcast by TIS-B or ADS-R. With a 1090ES dongle and ADS-B out installed the Own Ship will have redundant Intruder monitoring capability.

A future installment will analyze 978 UAT track plots.