Executive Summary – 2011 USAF/DDRTO Flume Test Report

In 2011, OSD Rapid Fielding Directorate, Rapid Reaction Technology Office (OSD/RFD/RRTO) funded a USAF experiment that would test Saratoga Data Systems' (SDS) patent pending, commercial off the shelf (COTS) data transfer software, Flume™, in some of the most demanding networking topologies that the US DoD encounters. Facing some of the most challenging networking conditions in the world, through 35,000 tests, Flume was demonstrated to move data to / from airborne platforms at up to 39x current rates. Furthermore, operating under periods of intense intermittency and corruption, Flume was able to accurately transmit data files when traditional methods failed all together. The conclusion of the RRTO/USAF tests stated that Flume's capabilities could allow the USAF to move data at unprecedented rates over airborne networks.

More Efficient Technology to Transfer Data

(in varying networking conditions, bit error rate and latency)

500 Kbyte File	< 1 Sec Delay	1-2 Sec Delay	2+ Sec Delay
1e-9	FTP	Depends on DR	Flume
1e-7	FTP	Depends on DR	Flume
1e-5	Flume	Flume	Flume

1 Mbyte File	< 1 Sec Delay	1-2 Sec Delay	2+ Sec Delay
1e-9	Flume	Flume	Flume
1e-7	Flume	Flume	Flume
1e-5	Flume	Flume	Flume

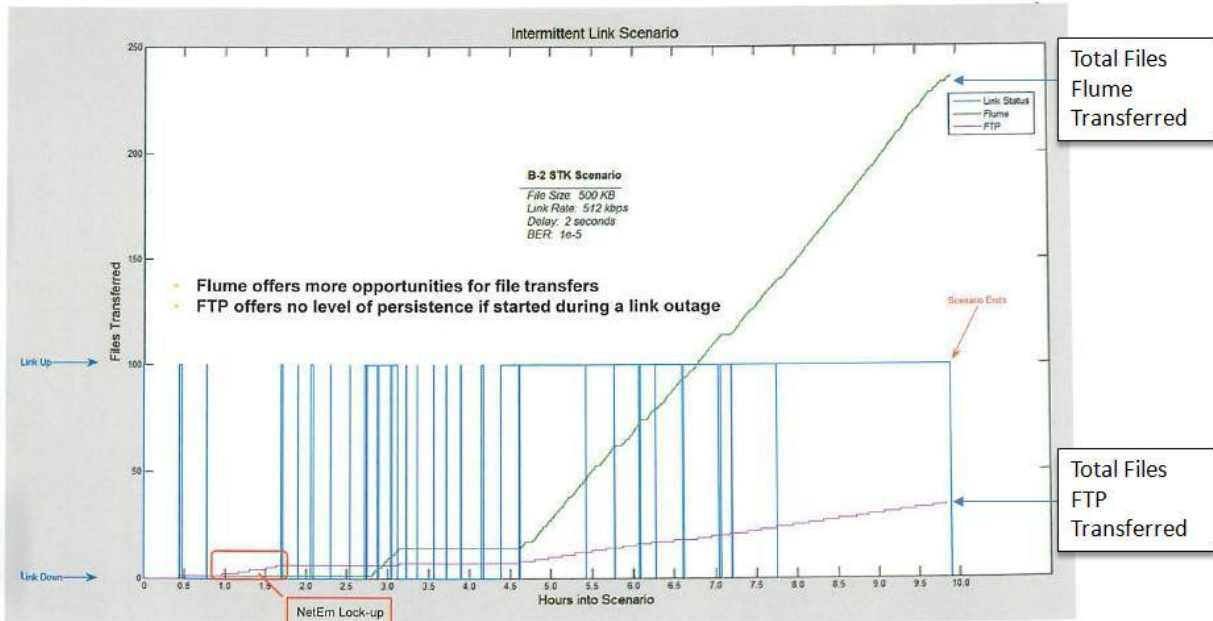Source: USAF/MITRE Flume Test Report, 16 August 2011

One condition that is not illustrated is the intermittency (or disconnects) of the network. When introduced to standard internet traffic, disconnects / intermittency can cripple transfer rates, or stop them all together. USAF airborne networks have some of the greatest incidences of intermittency of any modern network due to challenging atmospheric conditions, orientation of antenna / aircraft etc. Thus, airborne ISR and mission data is highly susceptible not just to slow transfers, but the inability to transmit at all under some conditions.

Flume is designed to be persistent and resilient in the face of intermittent network conditions. Flume allows users to set the application to persist in its efforts to transfer data over limitless periods of loss of connectivity, rapidly re-establishing communications when the connection is reestablished. The result is that Flume is able to "burst transmit" data through small periods of connectivity, or string together many small windows of connectivity to move a larger data file.

The result of Flume's resilience in the face of network intermittency is that when disconnection is introduced to benchmarking tests, Flume further distances itself from traditional methodologies. These conditions were introduced in the 2011 USAF testing. After completing benchmarking with latency and corruption injected

into the channel of communications, the USAF team then added intermittency to model real flight missions for USAF aircraft. The following chart is a graphical depiction of this testing, showing the status of a link (up or down) over the course of a mission. Flume and a standard / baseline technology were both run through this scenario and the value that Flume brings to the mission is self evident – facilitating the transfer of approximately 10x the mission files to / from airborne aircraft than can be accomplished using traditional technologies. In short, Flume can make ISR or mission data links 10x more effective, with no changes to the network needed.

B-2 Scenario 512Kbps Results
Source: USAF / MITRE Flume Test Report, 16 August 2011

Other key results from the DDRTO 2011 testing include:
Having conducted more than 35,000 individual tests cases, the 2011 USAF testing regimen was extensive and exacting in its evaluation of Flume. The results from the Langley AFB effort were conducted to ensure a 95% confidence in the accuracy of the comparisons between Flume and baseline technologies. The USAF team noted that in addition to the high confidence levels reported in their results, that even in the face of significant induced corruption, *Flume ensured absolute data integrity, with 100% payload accuracy reported in all tests.*
While the Langley AFB team focused on applying Flume to simulated airborne mission sets, the WPAFB tests also leveraged other features of Flume for possible exploitation by other USAF programs. Among these features were some of the data efficiency techniques that Flume can apply to an already accelerated transfer rate. In these explorative tests, the WPAFB team discovered that using Flume's acceleration capabilities as well as its additional data efficiency methodologies, *an 89x acceleration compared to standard TCP was achieved.*