DISCUSSION CONCLUDING AAS 13-502

JIM KIESSLING noted that STEVE ALLEN had mentioned the maritime Automated Identification System (AIS) broadcast standard; he wondered if there were similar issues related to broadcasts for aviation. ALLEN had heard of no trouble, but his knowledge was limited to what became "public enough" to come to his awareness. On any given day, ROB SEAMAN wondered how much trouble happens that is totally unrelated to the leap second: how big are some of the issues ALLEN raised relative to other factors? ALLEN suspected that weather caused more trouble than the leap second on June 30, 2012, and the existence of multiple factors did not help the discovery of issues related to the leap second. In 2012, when the U.S. Naval Observatory set their NTP servers to the wrong year, it probably caused less trouble overall than the last leap second due to its limited scope; however, the problems created were unexpected and altogether different than problems experienced with leap seconds.

DANIEL GAMBIS wondered if the leap seconds that occur in June were more or less problematic than those which occur in December. ALLEN replied that it does not seem to matter to machines on which calendar day a leap second occurs. ALLEN also doubted that most people are willing to publicly report on vulnerabilities that affect business; however, a few computer-system administrators were to be applauded for openly reporting problems and explaining how to overcome them. ALLEN hoped that the Linux kernel and other OS kernels would get better at handling leap-second events as a result of more widespread reporting of symptoms and solutions. New kinds of processors and architectures will always be coming into existence that might introduce new problems, *e.g.*, multiprocessor architectures.

JOHN SEAGO speculated that the day of the week might play a greater role in the visibility and persistence of leap second issues versus the time of the year. The last leap second fell on a Saturday, and many places of business are unstaffed or understaffed over a weekend. HARLAN STENN noted that one of the indicators of computer 'deadlock' caused by the last leap second was that energy consumption spiked at some data centers, then it spiked again as air-conditioners sought to remove excess heat. This condition should have caused the data centers to send out alerts to the system administrators to monitor machines, regardless of the day of week. ALLEN affirmed that system administrators do not get a break.

STEVE MALYS noticed that ALLEN had focused on Linux operating systems but wondered if there were other systems that were adversely affected. ALLEN replied that Linux was "a lot of it" and he did not know how to break out the percentages between Linux versus other operating systems. ALLEN said that other operating systems were either less susceptible, or else their engineers worked around problems in different ways; there are significant differences between the handling of BSD Unix and Linux systems. STENN believed "the squeaky wheel makes the noise" and that we would not hear about the systems that work. KIESSLING also thought that we might not hear about some proprietary systems doing things that their owners do not want known; STENN added

that "their customers might." ALLEN said that Skip Newhall's movie* showed what might happen within a heterogeneous ensemble of timekeepers; it is difficult to predict how one system will respond relative to another system, and thus it is difficult to predict how the entire ensemble will behave.

GEORGE KAPLAN wondered what STENN meant when he used the word 'deadlock'. ALLEN said that both 'livelock' and 'deadlock' had been mentioned; ALLEN's interpretation was that 'deadlock' usually refers to something that "stops dead" and is usually synonymous with "crash". ALLEN said the so-called 'livelock' was pervasive during the last leap second; this is when the processors in a multi-processor system operate at 100% in an attempt to use up cycles waiting for the correct time to conduct an operation, yet the correct time is never seen. ANDREW MAIN offered a more precise definition of 'deadlock': it is a condition where multiple processes are waiting on each other (or in some cases a process is waiting on itself) to finish an operation before moving to another operation. STENN added that 'deadlocked' processors appear to be "stopped" but are, in fact, busy; STENN's use of 'deadlocked' did not intend to suggest that the processor "died" but that it has simply halted useful processing. Meanwhile, CPU utilization increases to 100%, increasing temperatures and costing "millions of dollars in electricity." SEAMAN questioned the anecdotal figure of "millions of dollars"; he had not discovered anyone who had assigned monetary figures to increased energy consumption. ALLEN thought the availability of accurate monetary figures would be unlikely, wittily noting that "there's not much profit in counting up how much you didn't profit."

MALYS observed that many problems were caused by an available software patch or bug fix not being installed in advance; he asked if these problems are fixable by people who understand what to do about them. ALLEN thought the attitude of the Linux-kernel hackers is totally apolitical. They are technicians; they know that there must be ways to make this work right and they will find it. Their attitude is that "storms happen; they will find a way to get through the storm."

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* http://www.youtube.com/watch?v=CaOpGrs0x_U