Multi Wave Link -an interactive database for co-ordination of multiwavelength programs

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Final Report

MultiWaveLink is an operational database used by the international astronomical community to plan and coordinate multiwavelength observational campaigns on various celestial objects. This facility has been and continues to be an essential tool for the organization of numerous simultaneous ground-based and satellite observations. The communication available through the *MultiWaveLink* database to over 220 subscribed scientists in over 20 countries has recently, within the last 6 months, supported efforts to observe M dwarf flare stars, cataclysmic variables, low mass X-ray binaries, blazars, an OVV quasar, and a soft gamma-ray repeater error box simultaneously with space-based missions.

The *MultiWaveLink* system has both an interactive component and an electronic mail alert notice component. The interactive portion contains a database of schedules from several of the world's larger observatories and orbiting satellites. Lists of observers, observatories and their available instrumentation are additionally contained in the system. Another feature added to the software allows the user to search the Royal Greenwich Observatory e-mail listing of international astronomers. This capability is often used by astronomers to find the electronic address of colleagues for improved communication. However, the most productive aspect of the *MultiWaveLink* system appears to be one of the simplest parts of the system: the electronic mail alert notices for observing campaigns.

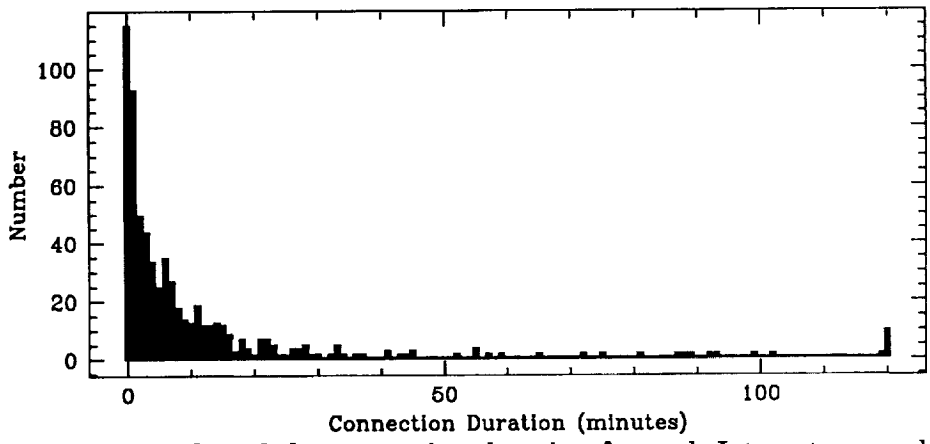

Figure 1: A plot of the connection duration for each Internet or modem connection against the number of connections of that duration. The duration is plotted with histogram bins of 1 minute and covers 22 months of operation.

Information useful in planning the structure of future astronomical databases can be obtained by studying the patterns of use of the *MultiWaveLink*

system. We have analyzed 22 months of *MultiWaveLink* usage from September 1991 to July 1993. The duration of the connection time for each individual usage of the *MultiWaveLink* system by users logged in through modem or by Internet connection is shown in Figure 1. The number of logins is plotted against connection time in a histogram with connection duration bins of one minute. Durations equal or longer than 120 minutes were grouped into the last bin. The median duration is 3.8 minutes with 90 percent of all connections less than 23 minutes in length. The high number of connections with durations less than 2 minutes likely result from a combination of users testing their connection to the system and users familiar with the system attributes who have a short task to perform.

The number of users of the system for each of the 22 months analyzed is shown in Figure 2. This plot clearly shows a higher frequency of usage during the earliest 3 months. This frequency is attributed to the increased advertisement of the system at that time. Since that time, the system averages around 10 users per month logging into the database.

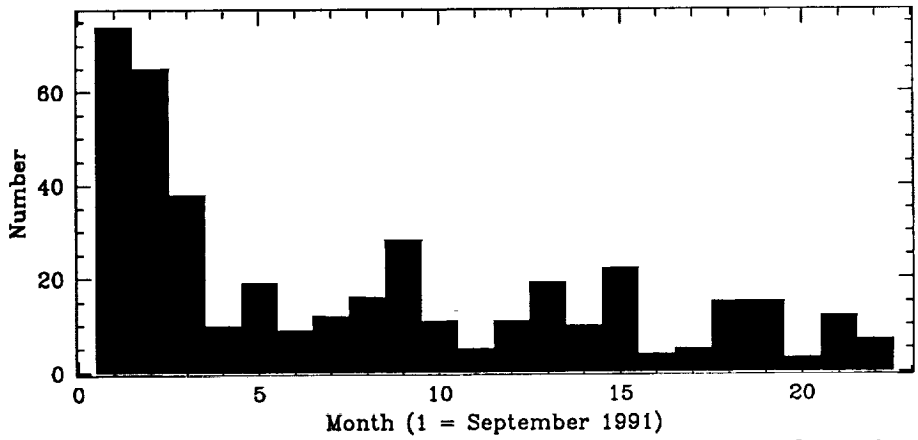

Figure 2: The number of logins per month to the system is shown in the above histogram.

The starting hour and day of week for connections into the database are shown in Figures 3 and 4. The starting hour is based upon the *MultiWaveLink* computer's clock which operates on the local time at Penn State (EST/EDT). The distribution of the starting hour plot follows closely the normal working hours for scientists in the 4 times zones of the continental United States. The peak at 4 hours is attributed to European astronomers. The drop after 11 hours likely arises from breaks for lunch at institutions in the Eastern time zone.

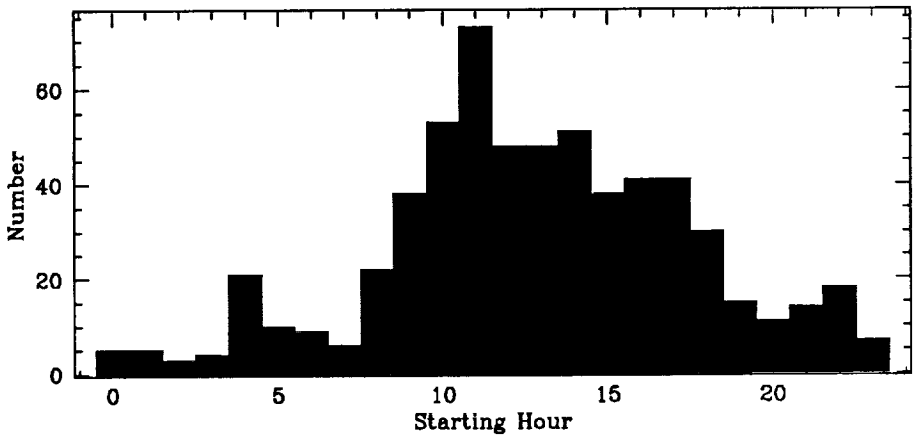

Figure 3: The number of logins by the starting hour to the system is shown in the above hisogram.

The day of the week plot, Figure 4, shows a peak of usage on Wednesday with the logins dropping off earlier and later in the week. The database is infrequently used on the weekends with a lower rate on Sunday than for Saturday.

The number of times a particular machine has been used over the Internet to log into *MultiWaveLink* over the 22 month interval is recorded in Figure 5. The data are shown for the 169 different machines used to log into the system. Several of the single logins shown in the histogram may have arisen from users on computers other than their usual machines. The two largest number of logins by machine are actually gateways into the Internet. Otherwise, the histogram should follow the usage of individual subscribers. It appears from these data that around 10 percent of the subscribers account for nearly 40 percent of the total logins onto the system.

Feedback from users of the system has shown the most useful part of the *MultiWaveLink* system to be the electronic mail notification facility. The alert mail exploder system is designed to provide support to satellite observations, organize simultaneous multiwavelength campaigns and informs interested scientist about observational opportunities (e.g., novae, supernovae and soft gamma-ray repeaters). Currently, subscribers can either request by e-mail or directly through the Internet assign themselves to 8 different object classes for alert notices. Recently, the system has been used for purposes not previously envisioned. For example, accurate coordinates of Nova Sgr 1993 were requested by the ORFEUS team at the end of their Space Shuttle mission to observe this nova from their platform. This request was

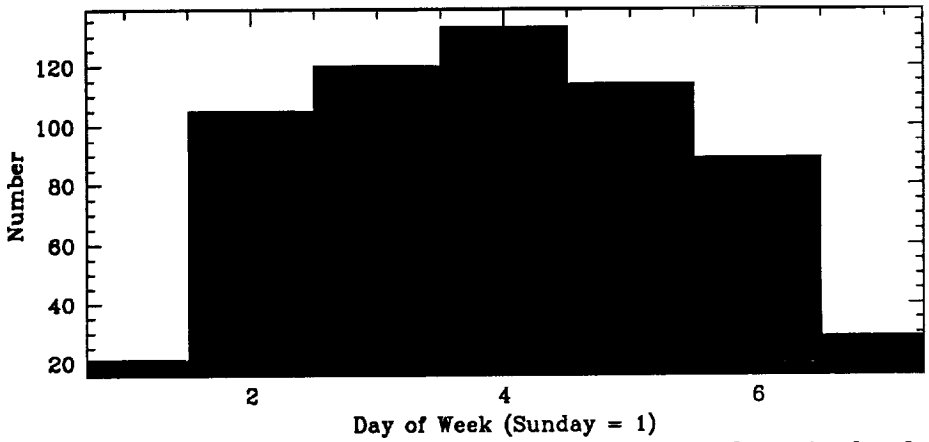

Figure 4: The number of logins by the day of the week is shown in the above histogram.

sent to subscribers to the novae and, the more general, cataclysmic variable object classes within one minute of receiving the notice through electronic mail. The request was rapidly answered by a *MultiWaveLink* user who sent the coordinates directly to the ORFEUS team.

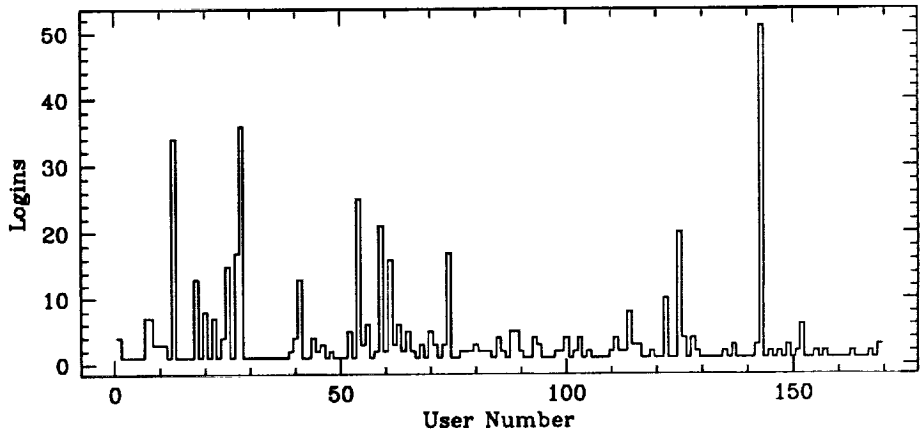

Figure 5: The number of logins per Internet address to the system is shown in the above histogram.

The alert system has received over 20 notices during the past year. Alerts are monitored by an individual familiar with the fields associated with the available object classes and assigns each alert to the appropriate categories of observers. In this manner, observers are not overwhelmed by too many alert notices of little interest to their particular fields of expertise or beyond their

instrumental capabilities. Nevertheless, subscribers can assign themselves to more than one category and many choose to belong to all categories.

Systems such as *MultiWaveLink* require continuous upgrading of the schedules and the other information in the database. In addition, the databases need to adapt to and utilize improving technologies. These improvements include adjustments to new computer system environments, such as advanced windowing systems, and the production of more efficient means for acquiring and disseminating information. While it is difficult for a program without a continuous source of funding to provide up-to-date information and adjust to technological advances, the *MultiWaveLink* system has strived to maintain its service to scientists. The variety of uses of the alert mail exploder has shown that this particular aspect of *MultiWaveLink* is an invaluable tool for the international astronomical community.

MultiwaveLink Augmentations- Report of Activities

The Multiwavelink grant was augmented in order to carry out activities associated with the XMM Optical Monitor multiwavelength camera project.

The Optical Monitor will be co-aligned with the X-ray cameras and spectrometers on the ESA X-ray MultiMirror Mission Observatory, in order to provide truly simultaneous imaging and timing data from a wide UV and optical band. Thus XMM will be the first truly purpose-built multi-wavelength observatory. The activities carried out in the US for NASA include the production of a Digital Processing Unit. This DPU tracks the moving images, calculates the instantaneous pointing direction, re-registers photon data to the correct celestial location, and finally compresses the data. The hardware is being fabricated at Sandia National Laboratories Albuquerque under direction from Penn State. The higher level coding for these functions has been carried out by Penn State, which has also been responsible for the simulation of performance, and production of data analysis software.

Over the period of the augmented grant, the PI and Project Manager have been responsible for direction and co-ordination of US activities at PSU and other labs, and for communication with the OM international partners. A Research Associate and graduate student have performed the software coding, simulations etc.. Completion of the software to support one of the two OM detectors was accomplished, and tested on a breadboard version of the DPU hardware. These tests were performed at the PI group's premises in the United Kingdom, in the spring of 1993. The tests were carried out using a proto-type detector and central instrument computer unit. The tests showed that functionally all the requirements for successful operation were demonstratable.

The activities at Penn State are now being continued with the support of a NASA contract administered through the NASA GSFC International Projects Office.

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