Agreement on Packet Radio Standards
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shift keying (ffsk). Msk and psk are considered to be the most promising methods at this time.

7. The SSC will have to be open for different experimental approaches until there is general agreement and experimental validation of "the" optimal method.

Considering all the alternatives which were discarded, the above resolutions represent a significant narrowing of focus. If that wasn't enough, more was yet to come!

Eric Scace reviewed the work which had been done by the NJ & AMRAD packeteers to adapt the international (CCITT) X.25 protocol to amateur needs. The amateur subset, called AX.25, has been specified in link- and network-level documents by Terry Fox, WB4JFI and Gordon Beattie, N2DSY, respectively. Hank Magnuski distributed a tutorial document on connectionless protocols and described work which had been done to develop Revision 4 of the TIPM and LIPM software. This is the first implementation of TNC software utilizing only amateur call signs (and not firmware encoded) for addressing.

By the evening of the October 8, the group began to recognize that only very minor differences separated the AX.25 and LIPM.04/TIPM.04 approaches. The TAPR protocol users were willing to implement an interface based on the recommendations which would come out of the meeting. The differences were resolved and led to the unanimous adoption of a subset of an internationally recognized link level protocol (specifically it is called ANSI X3.66 ADCCP-HDLC BA Class, with options 2, 4, 7, 8, & 11).

Why is this important? First, this link-level protocol allows two AMICON ground stations to construct a packet pipeline. This same protocol can be used between two stations in a terrestrial backbone net. The same protocol can also be used for terminal-to-terminal connections, whether direct or via a simplex packet repeater. It represents only a slight extension of the CCITT X.25 LAPB link level protocol. And finally, it does not restrict future development of ISO Level 3 virtual-circuit or datagram protocols.

The key feature of the new design is the adoption of a scheme for using call-sign addressing in a packet. The frame format looks like this:

FLAG1	TO CALL	FM CALL	CTL	PID/ INFO	FCS	FLAG2

where:

FLAG1	Standard opening HDLC flag byte (01111110)
TOCALL	The destination call-sign (6 characters plus sub-station i-d code)
FMCALL	The source call sign of (6 characters plus sub-station i-d code)
CTL	Standard HDLC control byte
PID	Protocol Identification byte for information frames.
INFO	Information field in information frames
FCS	Frame CRC check sequence
FLAG2	Standard closing HDLC flag byte

Frames to be repeated by a local-area network simplex packet repeater also contain a third address field following the FMCALL field. This third field is the call sign of the repeater. More details on this protocol will be published in the revised AX.25 specificiation document.

Collectively, the group considered that nearly every link design starts out with a statement something like this: "Holy 807's, look at all the overhead bytes you have in using call signs as addresses. I can do it with just 4 bits." We have found that these other schemes have their own defects and that the penalty for the call sign overhead is relatively small in comparison to other delays on the link and in view of the other benefits. In addition, both amateurs and their regulatory authorities are particularly defensive that the individual's call sign is sacrosanct and tantamount to being a personal name.

The AMICON session ended with promises from various representatives to try to implement the required versions of this new protocol. In the interim, LIPM.04/TIPM.04 will be available for use by AMICON ground stations until the new software is ready.

PACSAT -- A New AMSAT Satellite Project

By Den Connors, KD2S and Tom Clark, W3IWI

A new type of amateur satellite was proposed by Tom Clark, W3IWI, at the packet radio working group meetings held October 8-11, 1982 at the AMSAT laboratory in conjunction with AMSAT's annual general meeting. The working group meeting was also noteworthy in that it provided a focus for the various packet radio groups to coordinate their activities and resulted in a new unifed protocol which is described by Hank Magnuski, KA6M, in a companion document. The new satellite project has been tentatively dubbed PACSAT -- a final name is yet to be chosen, pending resolution of some potential trademark conflicts. This satellite would build upon AMSAT's experience in low-cost spacecraft development, the current upsurge of interest in digital and computer techniques, and the technology being developed for amateur packet radio applications. The basic idea is to implement an orbiting digital packet radio repeater with store-and-forward capabilites. This satellite would allow amateur "electronic mail" service with a few-hour-delivery time to anywhere in the world -- a virtual "flying mailbox" for amateur radio and computer enthusiasts.

The "straw man" system proposed by Tom and discussed during the three days of meetings, would have one or more high-speed packet radio channels, and possibly other ASCII or Baudot RTTY input/output channels. An on-board computer system would control a large amount of memory storage -- perhaps as much as one megabyte for messages. Access to the message system would be somewhat like using a more-traditional computer-based message system (CBMS) using landline dial-up capability, such as the Computerized Bulletin Board System (CBBS)(tm Ward Christensen). Using a Phase II type of low-earth orbit ("LEO"), the satellite would be available several times a day for up to 15 minutes worth of message reading and writing. Although the LEO satellites are limited in their coverage, the store-and-forward capability could extend an AMSAT-OSCAR-8 type satellite to provide global coverage.

One of the major problems with such a concept is that packet radio represented new technology to most amateurs, although we see a marked rise in amateur interest in computers. In order to make a PACSAT be a viable concept, the current packet radio "experts" will have to devote considerable efforts to making reliable ground-station hardware and software available to AMSAT's user community, and they will have to embark on a concentrated educational program to explain these new concepts -- some of the attendees at the working group meeting noted that they were around when the ssb vs. a-m "wars" were raging in the early 1950's.

One of the major technical problems that will have to be solved before a PACSAT (or the AMICON channel for Phase IIIB) is viable involves modems. None of the standard commercial modems seem suitable for noisy channels with doppler shift. Several alternatives were discussed during the meetings. The modulation techniques mentioned included phase-shift keying (psk) and minimum-shift keying (msk). Discussions of data rates for up- and down-links ranged from 400 baud up to 56 kilobaud; the technical constraints associated with accptable bit error rates and practical constraints of implementation cost and difficulty plus available spectrum space led to a consensus that likely rates were in the 400-2400 baud range. Although the Phase IIIB telecommand group have implemented state-of-the-art 400 baud psk modems, and W4RI has been working on msk designs, the use of either technique will require considerable work in order to develop high reliability modems usable by the amateur community. For any digital usage of amateur satellites, it is clear that modems will be more complicated that the traditional frequency-shift-keyed systems currently used for RTTY.

The straw man design that Tom presented involved multiple uplinks and a single downlink (e.g., one calling uplink channel and per-

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haps four working channels). This built upon typical amateur net experience with the satellite acting as "NCS" on a calling-and-answering frequency. After the user calls in and establishes that he has uplink traffic (or that the satellite has a message for him), he would directed to QSY to a working message channel where the spacecraft's computer would "poll" the user until both he and the spacecraft are QRU. This design is based on the use of ALOHA-type protocols where the multiple users cannot hear each other, leading to possible collisions on the uplink channels; this, combined with Tom's assumption that "what goes up must come down" (i.e. the total message traffic up and down are about equal), led to the multiple uplink, single downlink proposal. Tom's proposal was that the uplink and downlink were full duplex (simultaneous transmission and reception) involving two bands (probably a 435-MHz uplink and a 145-MHz downlink). The design assumed that 0.5-1.0 megabyte of storage was available on board which could be treated as a "virtual disk" for planning. All messages would be "bit regenerated" (i.e., no "direct" channel exists between the users except through the satellite), and control of the communications would be by an active, on-board computer. Other functions to be performed by this computer would include the access mechanism to manage the "virtual disk" storage, handling of the protocols to allow multiple users to get their messages up and down during a single pass, and possibly interspersing of "QST" bulletins in the downlink data stream during moments of inactivity.

On Saturday, the AMSAT members attending the technical forum were allowed to hear packet radio in action on AMSAT's W3ZM (146.235/.835 MHz) repeater. W3IWI brought a microprocessor-based Terminal Node Contoller (TNC) developed by the Vancouver Amateur Digital Communications Group (VADCG), a "202A-type" afsk modem, and a standard 2-meter fm transceiver. Some 50 miles away in Sterling, VA, Dave Borden, K8MMO had his Z80 CP/M (tm's, Zilog and Digital Research, respectively) computer hooked to a similar TNC and modem. Amidst normal talk-in activities, the two packet radio terminals were sending brief data packets through the repeater so that those attending the meeting saw a game of "Adventure" being played in the squelch tails. This impressive demonstration was the first exposure for many AMSAT members of the capabilities of digital techniques in amateur radio.

As the weekend proceeded, a number of informal discussions on packet radio continued. Among the experts there grew a general agreement on the data link protocol, with the AMSAT AMICON ADDCP-HDLC definition emerging as being the best for the "LEO" PACSAT too. Arguments for and against Tom's proposal for multiple uplinks (supporting a single downlink) centered on the estimated relative traffic loading on satellite uplink and downlink. These discussions included the observations:

-- CBMS experience shows that users "browse" through stored information much more than generating new information. If the PACSAT is to be operated as a flying CBMS, then the design should be reconsidered.

-- The "QST" bulletin transmissions will be a very important PACSAT function for the users.

On Sunday, a proposal was made by Den Connors and Lyle Johnson which included a number of the above concepts. Different mechanisms for access using full-duplex uplink/downlink pairs were presented. The AMSAT AMICON (AX.25) HDLC logical link protocol was discussed in as a PACSAT standard and a number of network-related issues, including message classifications and buffer allocation/deallocation mechanisms were raised. Lyle presented another possible system block diagram, showing different input/output channels, including command, multiple CPU's and different memories for program store, file directories, buffers and message mass storage. The tasks of the CPU were further detailed, and the different algorithms needed were identified.

During this discussion, Tom Clark outlined the possibility of a truly international implementation stategy. Tom described one scenario with the system design and user education/interfacing being the prime U.S. responsibility, on-board hardware constructed in South Africa, satellite integration performed in the United Kingdom and actual launch handled by the commercial group in Texas which has recently flown a successful test mission (see AMSAT Satellite Report No. 41, September 13, 1982). A part of the discussion involved the possibility that part of the US role might also include a new role for AMSAT in being responsible for the distribution of the hardware unique to packet radio unless commercial interest is seen soon; this could serve as a method for generating much-needed revenues to support all of AMSAT's activities. To help get this activity moving, Den Connors agreed to act as interim PACSAT coordinator.

The general PACSAT concept was presented at the AMSAT general meeting, and the AMSAT membership welcomed the idea, with the only caveats being expressed as "Can we afford it? Are we stretching ourselves too thin?" Tom indicated that these were AMSAT management concerns too but that the key individuals were very enthusiastic about the concept. He stated that without a dedicated "hard core" of technical volunteers, AMSAT loses its vitality.

Since no further opposition was raised, Tom indicated that further development of the PACSAT concept can be expected.

Since the meetings at Goddard, Den has accepted the position of Project Manager for the U.S. part of the PACSAT project, and several developmental efforts are in the formative stages. ZS1FE has confirmed the South African interest in pursuing the project, and G3YJO has begun "selling" the rest of the payload (which may well be called UoSAT-2). Key developments in the next few months will include ground station design, technology investigations to identify large flyable memories and modem (both msk and psk) design, planning for maximum utilization of the Phase IIIB designs, conceptual designs of the on-board communications and processing hardware and software and coordination of the roles between the various groups that can contribute to this project.

It is hoped that this satellite will not only give the packet radio experimenters a much-awaited international linking capability, but also provide a new, challenging and unique outlet to the many thousands of new hams who are quite savvy in computer techniques and utilization. The AMSAT team solicits your indications of interest and assistance. This, as with all AMSAT projects, is a volunteer effort -- can we serve as a focus for your creative ideas?

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