AN EXPANDABLE MICROWAVE NETWORK FOR MULTIMODE COMMUNICATIONS

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The projected network described in this paper was originally conceived with the purpose of interlinking communities and cities on a broadband basis. Numerous other capabilities, however, were soon included to permit almost direct compatibility with future communication expansions. The resultant network is highly flexible: it may be instigated between adjoining communities and/or cities, with additional networks being implemented in other areas and interlinked as desired. Communication modes which can be handled by the network are limited only by users desires and their respective modes. A basic outline of the microwave network shown in Figure I, and an overview of its operations follow.

Network Philosophy

The primary purpose of the microwave network is providing emergency communications between areas or cities normally separated by a distance greater than their normal 2 meter communications range. Secondary communications capabilities should be considered at installation time, however, since path losses and overall network bandwidth are directly related. The number of "dumb" or "passive" microwave repeaters will be determined by distance and terrain between associated cities, each accepting responsibility for their part of the link. Existing 2 meter repeater groups and councils can respectively provide finances and frequency/code coordinations. Two transceivers are shown connected to each microwave port: one preset on the "primary" frequency and the other scanning an approximate I mHz range of the 2 meter band (Exception : all secondary transceivers realize primary-frequency lockout). "Secondary" transceivers are under microprocessor control ; permitting frequency scanning, spread spectrum operation, tone control of transceiver functions (enable/disable, lockout, connect to mailbox, etc.). The network could initially develop between any two mutually-agreeable areas (each preferably with at least two local 2 meter repeaters, since this would confine costs of microwave link additions). Additional areas could join the existing network by financing their respective part while exhibiting their benefits to existing network users. Assuming a similar network is also instigated in other and more systems may "grow" until an overall network merge is warranted and instigated. Additional networks may, likewise, grow and merge with the existing system as desired. Further expansions may include "spurs" and subnetworks as desired.

Satellite Interlinking

Continuing the network a step further, interlinking with the OSCAR Phase IV geostationary satellites could provide full hemisphere to complete world coverage for compatible mode users (projected date: 1986). The outline for this concept is shown in Figure 2. OSCAR Phase IV is slated to include several concepts applicable for data communications. Some of these features are dedicated channels , tone controlling and mailboxing. In some instances, a microwave network port may interface with an OSCAR earthbased transponder. Other times, a separate network-to-satellite earth based station will be required. The criteria will, naturally, be determined by geographic locations of microwave links.

OSCAR satellites necessarily utilize narrowband modes such as SSB or CW, however a microwave network should utilize a constant carrier mode such as FM. The key to compatibility between these modes is Constant Amplitude Single Sideband, or merely PLL-SSB. This concept, which was developed in Europe 4 or 5 years ago, employs a variable amplitude in the normally suppressed carrier. Carrier amplitude is miniscule during modulation, but increases to full power during breaks of speech (after passing through the microwave network, the carrier may be fully removed - resulting in conventional SSB). Finally, total microprocessor control is employed for the link; its preprogrammed functions being available for call-up by coded tones.

Technical Aspects

The concepts associated with microwave links are, in several respects, unlike those employed in conventional VHF repeater links. Bandwidths of microwave systems, for example, are typically .5 to 4 mHz. Output power levels are noticeably lower, with large parabolic dishes providing signal gain capabilities. Conventional superhetrodyne techniques are also altered: each microwave transmitter runs continuously,, with a small portion of its output power being directed to its receiver's "front end" to provide a local oscillator signal. Transmit frequencies of communicating units are then offset by a difference equal to the desired I F (center frequency). This arrangement may be visualized with the aid of Figure 3. All microwave units are originally transmitting on their hypothetical resting frequency. An incoming signal on 146.00 mHz shifts the transmitting unit l46 mHz (a second signal on 146.50 and a third signal on 146.80 would appear as subcarriers

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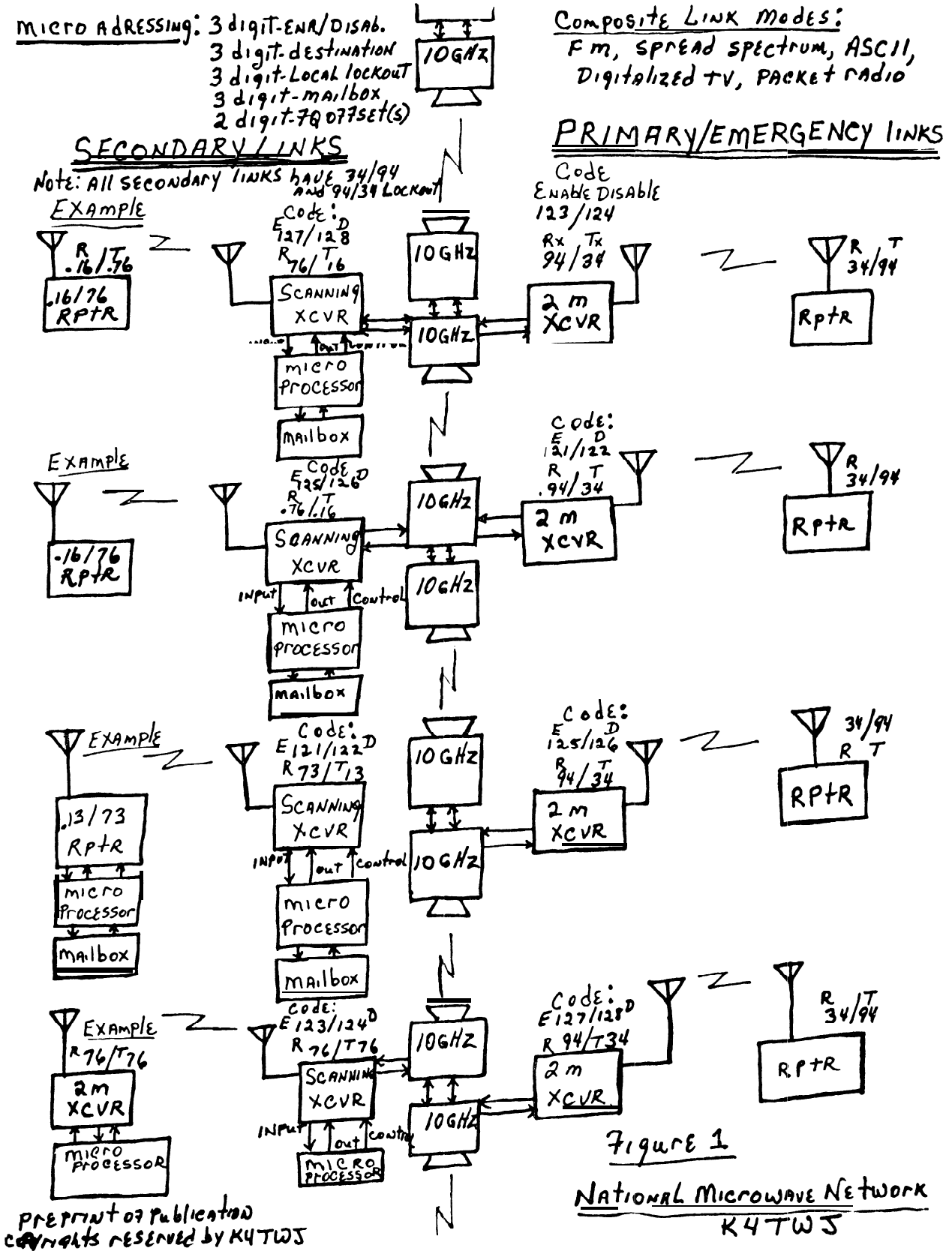

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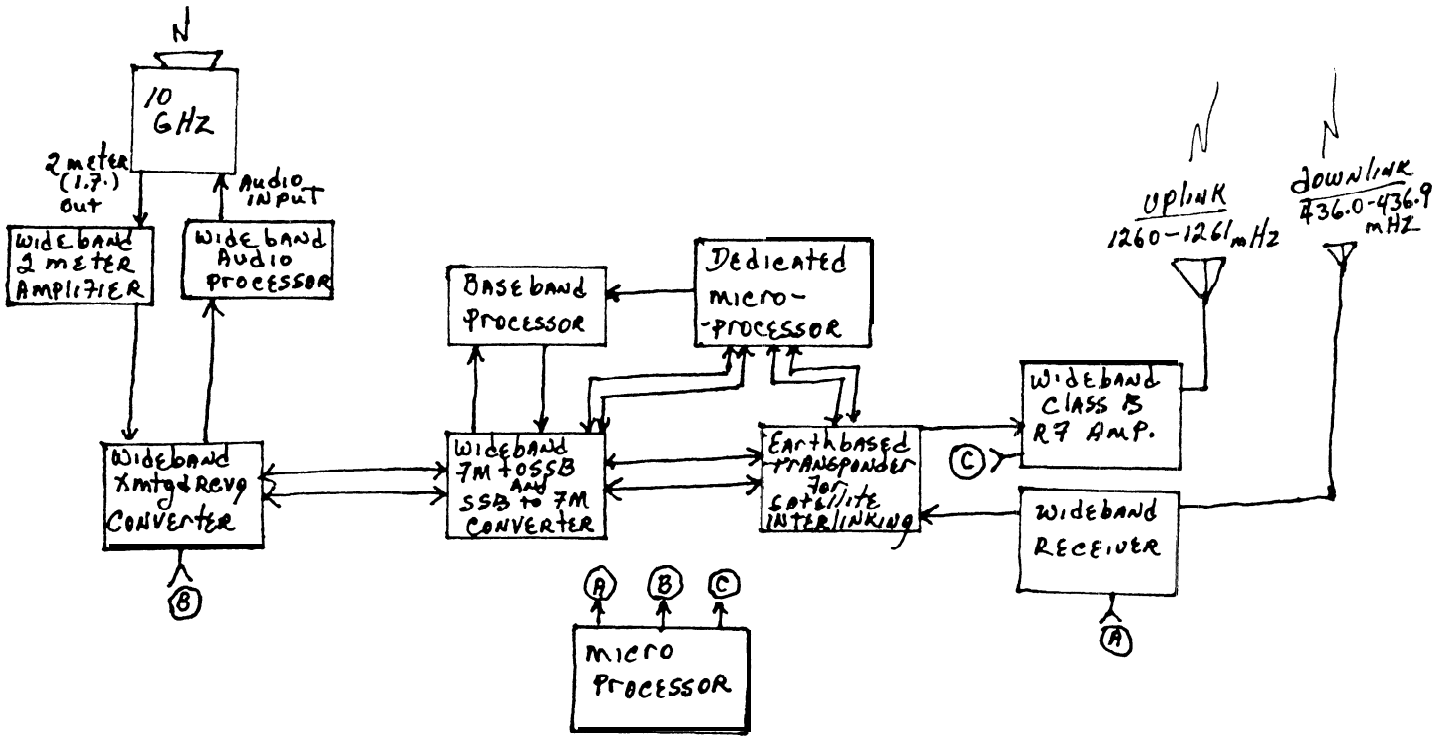

Figure 2 OSCAR PHASE IV INTERLINK for NATIONAL MICROWAVE NETWORK. COMPATABILITY IS ACCREDITED to PLL-SSB CONCEPTS.
MASTER MICROPROCESSOR MONITORS "CONTROL FREQUENCY" OF 2 M. AND ACTIVITY ON 2 M. BANDPASS TO ENABLE SATELLITE LINK IF: A PREESTABLISHED COUNT OF SIGNALS ON 1) DOWNLINK 2) UPLINK 3) 2 M. BANDPASS ARE'NT EXCEEDED.
IF JUSTIFIED, THEN PROPER "FOLLOWUP SEQUENCE" OF 2 M. "CONTROL SIGNALS" ON SPECIFIC FREQUENCY WILL ACCESS SATELLITE LINK.

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of the original signal, until the 146.00 disappeared. The 146.80 signal would then be a subcarrier of the 146.50 signal would then be a subcarrier of the 146.50 signal). Assuming a "dumb" relay is required between ports, it would receive the 2.146 gHz signal, hetrodyne to .146 gHz, IF amplify the signal(s) and apply it to the associated transmitter. The 2.146 gHz signal would then be received at the subsequent microwave port, converted to 146 mHz and applied to a (broadband) amplifier. That (I. F.) amplifier's output would feed the "next" 2. I gHz transmitter and the 146 mHz transceiver (while also accepting 146-band input signals from the 146 mHz transceiver). The microwave% overall bandwidth could easily expand to I mHz, as necessary, with all data/tones being moved in a conventional manner. All operations and frequency determinations of network - located 2 meter transceivers are under microprocessor control. This means that port-available signals may be selected or rejected by tone control, as desired. Preprogramming of the microprocessor establishes basic network standards.

Two microwave! bands are prime candidates for network links: 2.1 gHz and IO gHz. Gunnplexers are readily available for 10 gHz systems, however their individual-link range is limited. Similar units for operation on 2.1 gHz will soon be available from Universal Communications, P. 0. Box 339, Arlington, Texas 76010. The 2.1 gHz units are 100 mw or I watt., as required. cost of IO gHz Gunnplexers are approximately 115 dollars each. Cost of 2.1 gHz units are approximately 170 dollars each.

Returning to Figure I and applying previously acquired knowledge, a brief technical discussion will now be presented.

Assume an amateur operating on 146.76 desires to contact a distant repeater on 146.76 mHz. A .76 signal with PL tone is used for connecting the scanning transceiver into the network. Notice the distant '94 transceiver employs "lockout", preventing accidental access. Another 3 digit code "brings up" the desired distant '76 scanning transceiver, with subsequent microprocessor control establishing operating parameters for accessing that area's '76 repeater.

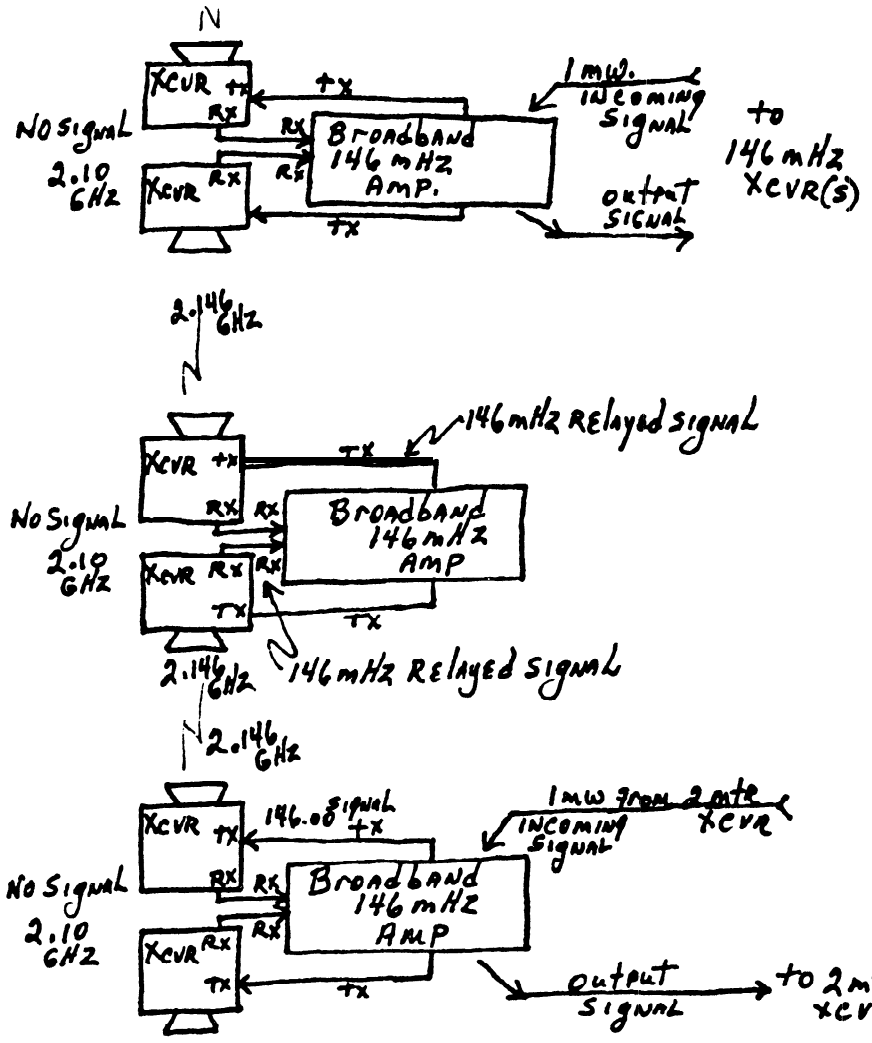

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Figure 3 OPERATIONAL CONCEPTS of the National Microwave Network

Middle unit is considered "dumb" or PASSIVE REPEATER, with intelligent ports being located in large cities.

Assuming the distant amateurs desire disconnection from the link (or the calling station desires distant disconnection) another 3 digit code will "bring down" that transceiver (example: 128). Data packets may be moved either to the distant repeater, or left in the electronic mailbox as required. Continuing overall system capabilities one step further, we can use tone control and port-located microprocessors for handling frequency offsets and Spread Spectrum hopping sequences. This capability would permit an individual amateur operating on 146.52 mHz to "catch" the network's scanning transceiver, establish different network - relayed frequencies, ard proceed in the previously described manner (Example: 146.52/.52 into network, 146.16 out of network. One or two fully microprocessor-controlled transceivers required for this option). A full description of the network would, obviously, encompass numerous pages of discussion. We thus leave those operations open for your investigation and expansion. The network outlined is a coarse system for future communications techniques. We hope this "first basic step" will inspire unlimited expansions.