But What if the Internet Fails?

How Winlink 2000 Will Handle Loss of Internet Forwarding

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Introduction:
The Winlink 2000 Ham radio message system (WL2K) makes extensive use of Internet forwarding. All messages to and from Internet users and all messages from the central server to the participating PMBOs and Telpac nodes are forwarded via Internet. This has proven fast, efficient, reliable and frees up valuable radio spectrum for mobile or emergency stations. But what happens if the Internet *fails*? This document outlines a mechanism that is being implemented to provide continued operation of the WL2K system and message delivery in the presence of multiple localized Internet failures.

What is the Internet and What is an Internet "Failure"?
We all know the Internet is a vast world-wide network of literally millions of interconnected computers. What is not fully understood by some is the actual network is a highly redundant collection of communication media with sophisticated hardware and software controlled routers that dynamically direct connectivity and data transfer between these computers. The Internet is in every sense of the word distributed…there is no one central control function or facility that controls it. What this means is that we should think of an Internet "failure" as most likely a localized loss of connectivity to some of the computers on the Internet network. It would be very difficult (some might argue nearly impossible) to cause a catastrophic loss of all connectivity on the Internet. The many redundant nodes, communication channels, routers and servers on the network provide an extremely large amount of flexibility in detecting network outages and the ability to reroute data between computers on the Internet. Even widespread power outages like the one experienced in the NE US and Canada in Aug 2003 did not bring down a substantial fraction of the Internet. What we as WL2K developers want to provide is a mechanism within the WL2K system to handle the most likely type of failure which is loss of internet connectivity by one or more participants of the WL2K system.

The WL2K system big picture.
Winlink 2000 is a network that uses both Internet and Radio (HF, VHF, UHF) connectivity to forward and deliver messages. Figure 1 shows a simplified diagram of the Winlink 2000 system showing a main and backup Central Mail Box Office (CMBO) three Participating Mail Box Offices (PMBOs) and a Telpac node. The actual system has over 40 PMBOs and over 100 Telpac nodes to provide global HF coverage and selected local area packet coverage. The two CMBOs are identical and exchange synchronization

data to allow either one to be able to take over the central server functions. PMBOs typically have full time Internet connectivity and operate one or more HF radios typically scanning several frequency bands. Some PMBOs also maintain VHF and UHF packet nodes but the majority of packet nodes are supplied by what are called Telpac nodes. These simple Telpac nodes contain no local database and simply bridge (via Internet Telnet) packet connections to the Telnet servers of remote PMBOs. Radio users of the system connect directly to PMBOs or Telpac nodes via HF Pactor or VHF/UHF packet. Users also can use a direct Telnet or Web connection to the system if they have Internet access. Typical message latency….the time from reception of a message from a user to the delivery to another user (radio or Internet) is on the order of 2 minutes or less. All message forwarding (between PMBOs, the active CMBO and the Internet user are normally done via TCP or Telnet connections using the Internet.

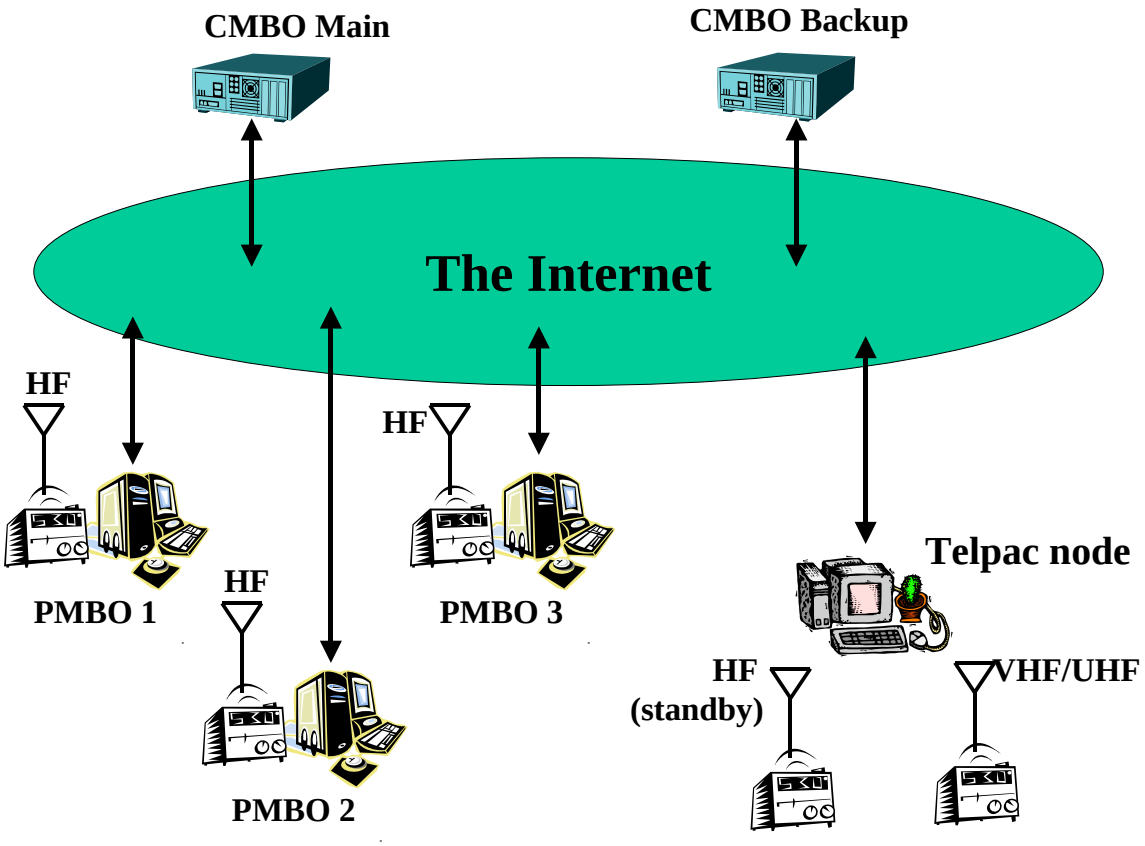

Fig 1. Simplified Diagram of normal WL2K system operation. The actual system may have 40+ HF PMBOs and 100+ Telpac VHF/UHF nodes. All forwarding between system participants is via Internet TCP/IP or Telnet. For simplicity no User connections are shown.

How does WL2K handle an Internet Failure?
Figure 2 graphically shows the system in Figure 1 with three failures resulting in loss of connectivity of a CMBO, a PMBO and a Telpac node shown by the red Xs and black balls on the diagram. It is worth noting this loss of connectivity could be from any one of a number of actual failures such as computer hardware or software, communication media, local ISP or router failure. The diagram shows three mechanisms where by the system recovers and continues delivering messages to users.

If the Primary CMBO fails or looses Internet connectivity the backup CMBO (with a recently synchronized database) comes on line. The synchronization mechanism insures that inbound E-mail will automatically switch over (no change of external SMTP addresses) as the backup CMBO assumes the primary CMBO function. Only messages received from the Internet but not yet forwarded to the PMBOs (typically about a 1-2 minute interval) are at risk of being lost in the startup of the new master CMBO. PMBOs are set up to automatically switch CMBOs if they are unable to connect.

A failure in a PMBOs Internet connectivity (PMBO 2 in the figure 2) will trigger an emergency connection attempt from PMBO 2 where a high speed HF Pactor III link will be established to one of several (prioritized based on location and time of day) remote PMBOs. If one of those PMBOs has Internet connectivity to the CMBO it will accept and maintain the emergency RF link allowing PMBO 2 to communicate to the CMBO by way of the RF link and the working Internet connection of that PMBO. The establishment of the emergency RF link is automatic but the maintenance and optimization of emergency RF links (including frequency re assignment) would then normally be controlled by the Sysops to insure maximum flexibility and reliability throughout the emergency.

If a Telpac node looses its Internet (Telnet) connectivity to a remote PBMOs Telnet server it first tries an alternate PMBO server and if still no Telnet connectivity it can initiate a HF Pactor II or III bridge to a PMBO that has internet connectivity as PMBO 3 does in the diagram. Not all Telpac nodes have this HF bridge capability but for applications where “last mile” connectivity needs to be guaranteed during loss of Internet connectivity this provides a relatively simple, moderate cost robust solution. This would allow for example local packet network emergency traffic served by the Telpac node to bridge out via long-haul HF to reach the Internet in cases when there was a local disruption in Internet connectivity as might happen in a localized disaster.

Because of the limited bandwidth available on the HF emergency channel (typically 800 bits per second for Pactor II and up to 2800 bits per second for Pactor III) forwarding on the emergency channel can be restricted (for example limiting attachments) if required.

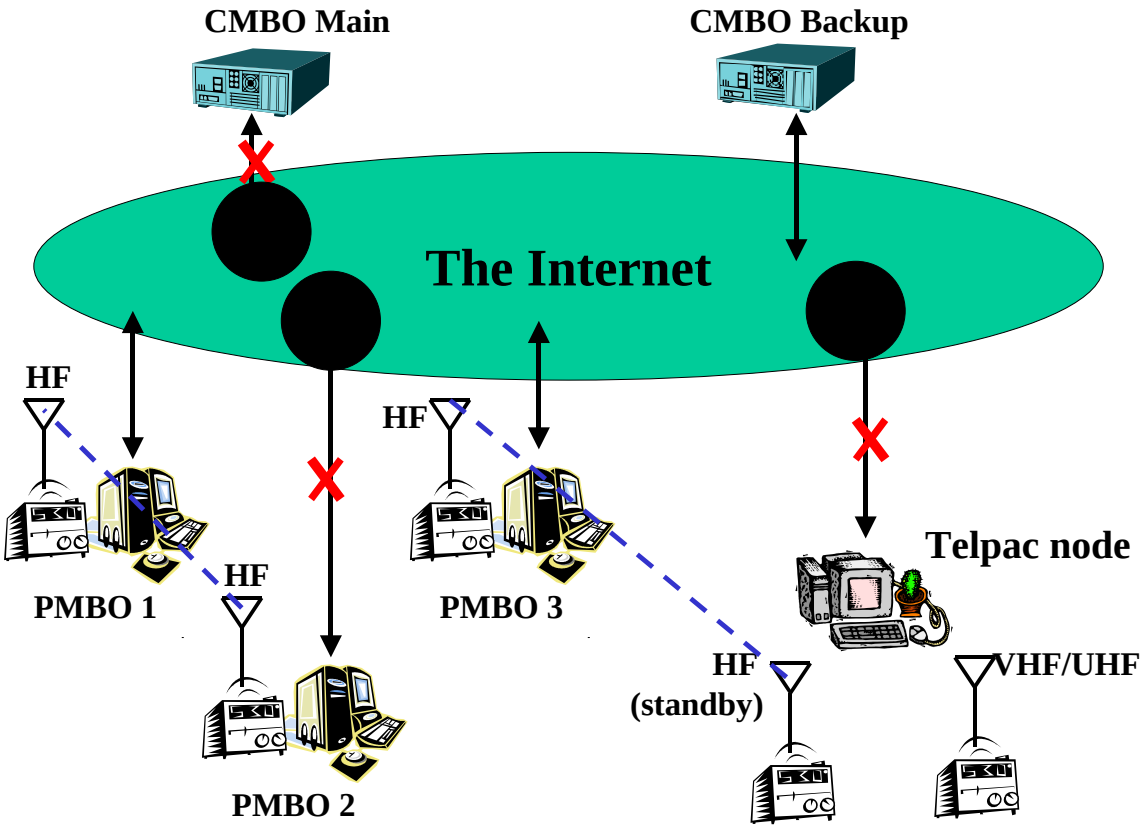

Fig 2. The WL2K system of figure 1 with loss of 3 Internet connections. Backup CMBO has come on line to assume primary CMBO functions. PMBO2 has established an emergency Pactor III link to PMOB1 to reach the CMBO. The Telpac node has established an emergency Pactor II connection to PMBO3 to establish Telnet connectivity and forward local packet traffic. For simplicity user connections are not shown.

Summary:
This extension of Winlink 2000 will provide another layer of redundancy to the system and automatically adapt to the most likely types of Internet "failure". The mechanism will include provisions for sysop control, optimization and rationing of HF radio emergency links during periods of Internet outages.

For additional information on Winlink 2000 and Emergency Communications applications and examples see http://winlink.org/Emergency.htm