

Wide-area Environmental Sensing and alerTing Networks (WESTnets) Requirements for Data Radios

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This document summarizes the requirements for data radios for two closely related projects: a next-generation wireless networking solution for hydrologic warning systems (HWS) and a research and development project called Wide-area Environmental Sensing and alerTing networks (WESTnets).

- **Hydrologic Warning Systems** Hydrologic warning systems have been widely deployed to collect hydrologic and meteorological data in near-real-time to support the creation of flood forecasts and warnings. Because many of these systems are located in remote areas where cellular service is unavailable, they often use VHF or UHF radio links. Most of these systems use the ALERT protocol, a simple wireless network protocol developed in the 1970s; some systems use a variant called the IFLOWS protocol. ALERT systems transmit four-byte packets at 300 bits-per-second (bps) and use a pure ALOHA medium access control (MAC) protocol. It is strictly a one-way protocol and many remote nodes even lack any receive capability. A prototype of new, higher-speed modem, the ALERT2 modem, has been developed for use by ALERT systems.
- **Wide-area Environmental Sensing and alerTing network (WESTnet)** WESTnet is a research and development project of Salo IT Solutions, Inc. (SaloITS) that is intended to develop a next-generation wireless networking solution for hydrologic warning systems and other wide-area environmental sensing systems. It includes the development of a suite of Internet-like protocols that are adapted to severely resource-constrained wireless networks.

SaloITS anticipates acquiring in the immediate future at least one pair of radios for on-the-air testing and evaluation. SaloITS may acquire additional pairs, depending on availability and other circumstances. The results of these on-the-air tests will be published in one or more reports that will be made available to the hydrologic warning system community. This analysis is funded by the National Weather Service (NWS) Office of Climate, Water and Weather Services.

This requirements document is intended to guide a search for a commercial off-the-shelf (COTS) data radio that will support both hydrologic warning systems (by providing a replacement for the original ALERT protocol and a possible alternative to the ALERT2 modem prototype) and the WESTnet research and development project.

Data Radio Requirements

The ALERT community (operators of HWS systems that use the ALERT/IFLOWS protocol) has deep, long-held concerns about deploying modem and radio products that might become difficult to obtain in the future. For the last three decades, the community has addressed this concern by using a 300 bps, AFSK standard. This community-unique standard permits vendors to integrate a modem into the main electronics board of remote nodes. (In practice, many remote systems include only a modulator, since ALERT is a one-way protocol.) These modems operate with readily available, voice-grade radios.

The original 300 bps protocol no longer meets the community's needs. Its strong desire for assurances of the long-term availability of the modem/radio products that it uses motivated the community to develop prototypes of an ALERT2 modem. The ALERT2 modem is a 4,800 bps modem that is designed to use the voice-grade radios that are widely deployed in HWS systems. It employs forward error correction (FEC) techniques, with the FEC decoding performed in an off-board processor.

These requirements are part of a project that will determine whether there are any COTS data radio products that could meet the community's needs. However, before adopting any COTS data radio, the ALERT community must be confident that compatible products will be available from multiple vendors for a period of decades. The community's concerns are reflected in these requirements.

Frequency Requirements

- Must operate on the VHF and UHF hydrologic frequencies (169 – 172 MHz and 406 – 416 MHz, respectively); VHF and UHF operation need not be combined in the same radio.
- Should operate on 144 – 148 MHz, in addition to VHF hydrologic frequencies.
- Must support 12.5 kHz channels.
- Should support 6.25 kHz channels.
- Should support multiple, pre-configured channels, preferably at least ten.
- Host should be able to select, from a pre-configured list, the channel to be used.
- Should have host-selectable high and low power settings of approximately 5 watts and 1 watt.

On-the-Air Protocol

- Should have a synchronous, packet-oriented on-the-air protocol.
- Should have a published, on-the-air protocol, unencumbered by patents or copyright.

- Should interoperate with at least one other data radio from another vendor.
- Should support an on-the-air bit rate of at least 4,800 bps

Host Interface

- Must support a host interface of RS-232 or USB; preferably both RS-232 and USB models should be available.
- The RS-232 interface must support asynchronous operation.
- Should permit the host to control precisely the timing of the start of a packet transmission, to enable use with time-division, multiple-access (TDMA) MAC protocols.
- Should permit simultaneous operation of both the host interface and the RF interface (e.g., the radio might be transmitting one packet while the hosts transfers the next packet to the radio).
- Should permit a host to perform FEC encoding and decoding external to the radio.

Packaging

- Must have a small form factor suitable for embedding in remote nodes.
- Must operate over a wide range of ambient temperatures.
- Must be power-efficient, because many remote nodes operate with solar power.