ALERT-2 Protocol Development

A proposal submitted to:

National Oceanic and Atmospheric Administration (NOAA)

In response to:

FY 2007 Small Business Innovation Research (SBIR) Program Solicitation

Submitted by:

Salo IT Solutions, Inc.

Abstract:

Salo IT Solutions, Inc. (SaloITS) will design and implement the ALERT-2 protocol, a next-generation suite of network protocols that will provide enhanced services for Automated Flood Warning Systems (AFWSs). The focus of this Phase I project is to create and develop a consensus within the ALERT community in support of an ALERT-2 Requirements Specification document and an ALERT-2 Protocol Specification document. The Requirements Specification will record the unmet needs that a next-generation protocol for automated flood warning systems should address. Its audience will primarily be users and operators of ALERT systems. Its purpose is to provide a benchmark against which the ALERT-2 Protocol Specification can be evaluated. The Protocol Specification will be a technical document that will be mostly of interest to vendors, and perhaps a few technically sophisticated users and operators.

Awarded:

Contract DG133R07CN0175, July 16, 2007 – January 15, 2008.

1. Identification and Significance of the Problem or Opportunity

Salo IT Solutions, Inc. (SaloITS) will design and implement the ALERT-2 protocol, a next-generation suite of network protocols that will provide enhanced services for Automated Flood Warning Systems (AFWSs). The ALERT-2 protocol is intended to replace the existing ALERT protocol. This new protocol will employ modern network protocol design principles and technologies that have been refined and proven in applications ranging from the Internet to specialized, demanding environments such as low-power, wireless networks. Recent, applicable results from the wireless sensor network research community and other researchers may also be employed, as appropriate. The focus of this Phase I project is to create and develop a consensus within the ALERT community in support of an ALERT-2 Requirements Specification document and an ALERT-2 Protocol Specification document. The Requirements Specification will record the unmet needs that a next-generation protocol for automated flood warning systems should address. Its audience will primarily be users and operators of ALERT systems. Its purpose is to provide a benchmark against which the ALERT-2 Protocol Specification can be evaluated. The Protocol Specification will be a technical document that will be mostly of interest to vendors, and perhaps a few technically sophisticated users and operators.

The ALERT-2 protocol will be open and non-proprietary. The freely available protocol specification will be written with the clarity and level of detail necessary to ensure interoperability between products and vendors: products that conform to the specification will be assured of interoperating with other conforming products. The open, non-proprietary nature of the protocol specification will ensure that the benefits of the technologies developed by this project will be available to all automated flood warning system vendors. Furthermore, the assurance of interoperability between products and vendors will simplify the task of deploying, upgrading, operating, and maintaining ALERT-2 products and networks.

The development of the ALERT-2 specification documents described in this proposal will employ an open protocol design process. Members of the ALERT community, including vendors and users, as well as any other interested parties, will be encouraged to review, discuss, and comment on drafts of the specifications developed by this project. This process is intended to leverage both the technical expertise provide by SaloITS and the operational experience and domain knowledge of the ALERT community. The collaborative efforts of these groups will ensure that the ALERT-2 protocol meets the current and anticipated needs of vendors and users.

The ALERT-2 protocol will be flexible and extensible. It will support a broad range of sensor, reporting station, and network configurations, and will be designed so that new functionality can be added gracefully, without adversely affecting existing products or deployed networks. The protocol will include optional security features to protect networks deployed in unsecured environments, as well as to ensure the integrity of critical sensor data or other information.

1.1 Target Environment

Figure 1 below summarizes the core application for which the ALERT-2 protocol will be designed: to provide a reliable, extensible, secure protocol for transporting hydrology and other sensor data between remote reporting stations and central monitoring stations.
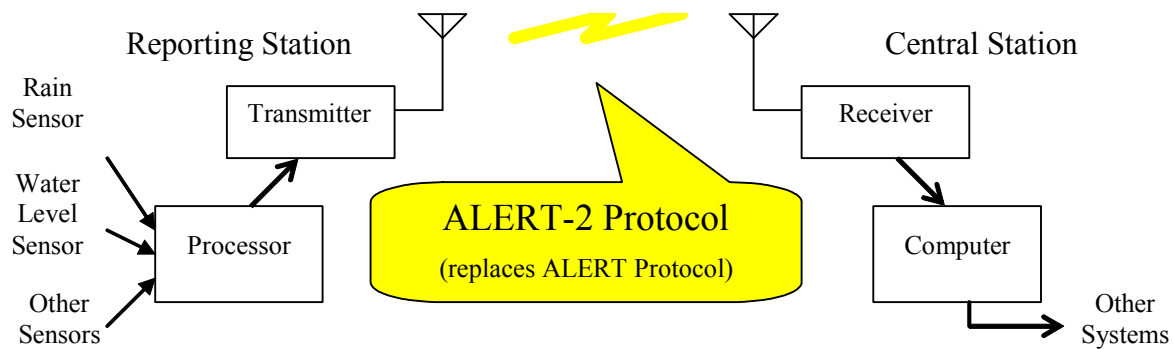
Figure 1. Representative Environment Targeted by the ALERT-2 Protocol.

1.2 Limitations of Existing ALERT Protocol

The Automated Local Evaluation in Real Time (ALERT) protocol, developed in the 1970s, cannot meet, and cannot practically be extended to meet, the demands of today's environments. Some of the limitations of the ALERT protocol, many of which have been documented elsewhere, are summarized below.

1.2.1 Small, Fixed Packet Format

An ALERT frame is transported as four eight-bit bytes (plus start and stop bits), which includes a 13-bit field that identifies the source of the data and 11 bits of sensor data. These fixed-width fields are inadequate to support the number of sensors deployed in some networks or the data resolution provided by some sensors. The error-correcting modem developed by Blue Water Design under a NOAA-funded Phase I SBIR project enables larger packets to be used with the ALERT-2 protocol. The ALERT-2 protocol will support a larger address field and variable-length fields that will allow larger and more diverse remote station configurations.

1.2.2 Monolithic Protocol Specification

The ALERT protocol specification is monolithic, in the sense that it doesn't embody a notion of protocol layering, (e.g., identify the functions that should be performed at each protocol layer and clearly define the interaction between protocol layers). Clean protocol layering has been repeatedly demonstrated to enhance the quality of protocol designs, simplify the implementation of protocols, and facilitate the enhancement and evolution of the protocols. The ALERT-2 protocol specification will include an explicit protocol architecture that will specify the responsibilities of each layer and the interaction between layers. The project will focus on the ALERT-2 application-layer protocol, although the ALERT-2 Requirements Specification may motivate work on a network-layer protocol and perhaps a minimal transport layer protocol.

1.2.3 Un-Extensible Protocol

The ALERT protocol includes no mechanisms that permit the protocol to be gracefully extended or evolved. The ALERT-2 protocol will include explicit mechanisms that will permit new

functionality to be defined and deployed in the future, without requiring that existing remote reporting stations be upgraded.

1.2.4   Narrow Protocol Scope

The ALERT protocol was designed to only transport a few types of sensor data to a central station. In order to create manageable products, vendors developed proprietary, and apparently undocumented, extensions to the ALERT protocol (or, alternative protocols, depending on one's perspective) to provide common management functions. SaloITS will work with the vendor community to identify the functionality that the ALERT-2 protocol ought to provide in order to best help users manage operational networks.

1.2.5   Nonexistent Network Security Mechanisms

The ALERT protocol contains no security mechanisms that ensure the integrity of received data. In an era of heightened concern about homeland security, critical infrastructure such as environmental monitoring networks ought to include features that protect sensitive data, (even if those features aren't universally deployed). SaloITS will propose several security requirements for the ALERT-2 protocol and design protocol features that address those requirements.

1.2.6   Missing Sensor Data Descriptions

In the ALERT protocol, the type of sensor and the units of the data are implicit (e.g., derived from the ID field) or pre-configured, (e.g., the central station is manually configured). The initial draft of the ALERT-2 protocol specification will suggest a method of explicitly associating a type code with sensor data (e.g., temperature or precipitation event). SaloITS will work with ALERT vendors and users to determine the list of sensor types that should be enumerated. Ultimately, however, it is the ALERT community that ought to decide whether the benefits of explicitly identifying sensor data types, (e.g., improved interoperability and reduced manual configuration), are worth the additional costs, (e.g., additional bits transmitted, increased channel utilization, and reduced battery life).

1.2.7   Lack of Explicit Network-Layer Functionality

The original ALERT specification assumes that remote stations communicate directly with a base station. Vendors extended their products to include a repeater functionality, which enables sensor data to be forwarded through one or more intermediate stations before being delivered to the base station. The ALERT-2 protocol specification will most likely include an explicit network layer, which will describe how data can be forwarded through intermediate nodes, thereby permitting larger and more robust network configurations.

1.2.8   Lack of Collision Avoidance and Congestion Control

The ALERT protocol lacks effective collision avoidance and congestion control mechanisms. Although this topic is arguably beyond the scope of the solicitation, advances in this area could offer significant benefits to automated flood warning system operators.

1.3   Benefits of Proposed Approach

Table 1 summarizes the benefits of the ALERT-2 protocol development process and specifications.

Table 1. Innovations and Benefits of the ALERT-2 Protocol Development Process and Specifications	
Innovation	**Benefits**
Open protocol development process	SaloITS will describe and use an open protocol development process that invites wide-spread participation • Leverages the operational and domain expertise of ALERT vendors, users and operators • Enhances likelihood that ALERT-2 protocol will meet ALERT community's needs and expectations
ALERT-2 Requirements Specification	An ALERT-2 Requirements Specification will record the objectives and unmet needs that the ALERT-2 protocol should address • Offers an accessible (e.g., semi-technical) forum in which vendors', users' and operators' needs can be discussed • Provides a benchmark against which the ALERT-2 Protocol Specification document can be evaluated
ALERT-2 Protocol Specification	An ALERT-2 Protocol Specification will detail the design of the ALERT-2 protocol • Provides sufficient technical detail for a vendor to implement the ALERT-2 protocol • Ensures interoperability between products and vendors
Flexible message format	The ALERT-2 application-layer protocol is likely to contain a fixed header, followed by a variable header • Enables larger networks and more diverse remote station configurations to be more easily supported • Simplifies support for additional functionality (e.g., network management, new software upload, etc.) • Allows additional types of sensors to be easily supported
Extensibility features	The ALERT-2 protocol will be designed so that new features can easily be added • Permits new features to be deployed, without necessarily upgrading existing remote stations • Avoids for the foreseeable future any need for an ALERT-3 protocol to support desired new functionality or technology
Layered protocol specification	The ALERT-2 Protocol Specification will include explicit protocol layering • Simplifies, and limits scope of changes required by, future introductions of new technologies (e.g., new modem)

2. Phase I Technical Objectives

The principal Phase I technical objective is to:

- Develop a detailed technical specification for the ALERT-2 protocol, a suite of network protocols designed for use in automated flood warning systems. This document should contain sufficient technical clarity, detail, and scope to ensure that any product that conforms to the specification will interoperate with any other conforming product. The ALERT-2 protocol should:

  - Address the current objectives and requirements identified by the ALERT vendor and user communities and other interested parties;

  - Support the unique operating environment typical of automated flood warning systems by providing such features as energy-efficient protocols, support for unattended remote operation and management, and minimal administrative requirements;

  - Provide extensibility that will permit the ALERT-2 protocol to support new features and functionality in the future, without adversely affecting interoperability with existing products;

  - Employ the best available protocol design principles and network technologies;

  - Include security features that will permit ALERT-2 devices to operate in moderately hostile environments;

  - Permit vendors to added vendor-specific functionality, while ensuring that these proprietary features don't inhibit interoperability between vendors' products;

  - Avoid proprietary technologies that might inhibit the rapid or wide-spread implementation or adoption of the ALERT-2 protocol;

  - Ensure that existing automated flood warning systems can migrate gracefully to products that use the new ALERT-2 protocols; and

  - Reflect a widely shared vision for the future of automated flood warning systems.

Additional Phase I technical objectives include:

- Create the development plans necessary to ensure the successful implementation of the ALERT protocols; and

- Undertake any modeling or proof-of-concept implementation that may be necessary to demonstrate the technical feasibility of specific aspects of the proposed ALERT-2 protocol.

3. Phase I Work Plan

Timothy J. Salo, the Principal Investigator, will perform the work outlined here at SaloITS facilities located in Minneapolis, Minnesota. The development of the ALERT-2 protocol is intended to be an open, collaborative effort in which SaloITS will provide technical leadership, as well as coordinate activities that will facilitate the participation of any interested party, particularly members of the ALERT community.

3.1 Scope

The Phase I activities will include:

- Writing an ALERT-2 Requirements Specification document;
- Creating an ALERT-2 Protocol Specification document; and
- Developing an ALERT-2 Implementation Plan document.

3.2 Provisional ALERT-2 Protocol Development Process

The process by which SaloITS intends to develop the ALERT-2 specification documents is based on that used by the Internet Engineering Task Force (IETF) to create new standards for Internet protocols. The ALERT-2 Requirements Specification document and the ALERT-2 Protocol Specification document will be developed using this process. This process is expected to include the following components:

- **ALERT-2 Working Group** The ALERT-2 Working Group, as this term is used in this document, will be the informal group composed of individuals who are willing to help create the ALERT-2 protocol, primarily by reviewing and commenting on the documents created by SaloITS as part of this project. The initial membership is expected to include those interested individuals who were identified at the October 2005 meeting of the Southwestern Association of ALERT Systems (SAAS) conference in Overland Park, Kansas. It is anticipated that membership in this group will be unrestricted, and may change over time. An early task for this Working Group is to discuss the ALERT-2 protocol development process described here.

- **Working Group Mailing List and Online Document Repository** E-mail lists will be created to support public discussions about the ALERT-2 protocol. Anyone will be able to subscribe to the lists and participate in the online discussions. An archive of all of the messages that have been sent to the list will be available online. Access to this message archive is expected to be unrestricted.

  An online document repository will be created that will contain all of the documents generated by or related to this project. Access to the document archive will be unrestricted, at least for the documents over which SaloITS has control.

The e-mail lists, e-mail archives, and document repository will be similar to the Yahoo!
Floodsystems group, although they will most likely use different technology.

- **Project Overview Document** SaloITS will write a brief (e.g., one- or two-page) summary
  of the ALERT-2 protocol standardization project. It will outline the motivation for and
  objectives of the work. The intent of this document is to inform the ALERT community and
  others about the project and to invite their participation.

- **Draft Specification Documents** SaloITS will write the initial draft of an ALERT-2
  Requirements Specification document and an ALERT-2 Protocol Specification document, as
  described below. These documents will be made available to the ALERT-2 Working Group
  and others for review, discussion, and comment. They are expected to be the basis for
  specifications that are adopted by the ALERT-2 Working Group.

- **Online Discussion and Document Review** SaloITS will invite the ALERT-2 Working
  Group members and other interested parties to review the documents and submit comments,
  questions and suggestions to one of the ALERT-2 e-mail lists. The e-mail archives will
  provide a permanent record of these discussions

- **Face-to-Face Discussions** SaloITS plans to host face-to-face discussions about the ALERT-
  2 protocol at any convenient venues that occur during this Phase I project. Ideally, the initial
  discussions can take place at the National Hydrologic Warning Council (NHWC) conference
  in June 2007 in Savannah Georgia. These face-to-face meetings will be an additional
  opportunity to review and discuss the draft specification documents. The budget includes
  funds for two face-to-face meetings.

- **Document Revision and Consensus Building** SaloITS will respond to the on-line and face-
  to-face discussions and comments, perhaps by revising the language of the documents;
  perhaps by revising the contents of the documents (e.g., the protocol specified in the
  document); or perhaps by clarifying the motivation, justification, or intent of the relevant
  section of the document. The final result of this process should be an ALERT-2 Protocol
  Specification that has wide spread support within the ALERT-2 Working Group and the
  broader ALERT community. In particular, this should be a protocol that ALERT system
  vendors are committed to implementing and that ALERT system users believe will meet their
  needs.

  It is conceivable, although SaloITS believes that it is very unlikely, that the ALERT
  community will be unable to reach a consensus on the future of the ALERT protocol. Should
  this eventuality occur, the ALERT-2 Protocol Specification document produced by this
  project will reflect the best professional judgment of the Principal Investigator, and will
  identify the areas in which the ALERT community was unable to reach agreement.

- **Intellectual Property Issues** SaloITS will work to avoid any intellectual property issues that
  might slow the implementation or adoption of the ALERT-2 protocol. In particular, SaloITS
  will most likely insist that anyone contributing material to the ALERT-2 protocol
  specification disclose any intellectual property interests (e.g., patents) that they have in any

verbiage or technology they offer. This disclosure is expected to be similar to those used by the IETF and the Institute of Electrical and Electronics Engineers (IEEE).

- **"Rough Consensus and Working Code"** The IETF's approach to developing Internet standards is often summarized as "rough consensus and working code". "Rough consensus" means that while Working Groups strive to achieve consensus on technical issues, it is at times necessary to move forward, even in the face of some dissenting views. "Working code" refers to the requirement that two independent implementations of a draft standard must have been demonstrated to interoperate before a document can become a full Internet standard. Two interoperable implementations provide an assurance that the specification is complete and unambiguous. While the "working code" benchmark is likely unachievable for the ALERT-2 protocol, it does provide a valuable model for an open protocol standard.

3.3   Work Task Plan

The following tasks, each of which is detailed below, will comprise this Phase I project.

1. Establish collaborative tools and processes
2. Write ALERT-2 Requirements Specification document
3. Create ALERT-2 Protocol Specification document
4. Undertake necessary modeling or proof-of-concept implementation
5. Develop ALERT-2 Implementation Plan document
6. Write interim and final reports

3.3.1   Establish Collaborative Tools and Processes

The Principal Investigator will configure the e-mail lists, e-mail archives, and a document repository as described in the preceding section. These may hosted on servers provided by SaloITS, or might use an existing server, such as the ALERT System Organization Web pages (http://www.alertsystems.org/). (Actually, after the SAAS meeting in Overland Park, there was some discussion about adding ALERT-2 pages to existing ALERT Web pages, but this apparently hasn't happened yet.)

3.3.2   Write ALERT-2 Requirements Specification Document

The Principal Investigator will write a draft ALERT-2 Requirements Specification document. The purpose of this document is to record, in one accessible location, the objectives of and the requirements for the ALERT-2 protocol. Initially, the contents of this document will be based on the needs identified by ALERT system users at a session held at the end of the October 2004 SAAS conference, as well as informal discussions the Principal Investigator had with the major ALERT system vendors at the same conference. This document will be made available for review and comment to the ALERT-2 Working Group and anyone else who might be interested in reading and preferably even commenting on it. This document will be revised as many times over the course of the project as is necessary to fully capture the users' requirements for the ALERT-2 protocol. The latest version and all interim versions of this document will be freely available in the online ALERT-2 document archives.

3.3.3 Create Draft ALERT-2 Protocol Specification Document

The Principal Investigator will create a draft ALERT-2 Protocol Specification document. This document is expected to be similar in detail and style to the Internet standards developed by the IETF. Like the ALERT-2 Requirements Specification, this document will be circulated throughout the ALERT community for review and comment, and will be revised in response to those comments. This document will also be freely available in the online ALERT-2 document archives.

The ALERT-2 Requirements Specification document is expected to be a complete specification, in the sense that it (and any documents it adopts by reference) will contain all of the information necessary to construct an ALERT-2 implementation that is assured to interoperate with other implementations. The following is expected to be covered in the ALERT-2 Requirements Specification:

- **ALERT-2 Application-Layer Protocol** The ALERT-2 application-layer protocol will be the primary focus of this project. Important objectives for this protocol include adaptability (e.g., support remote stations with different configurations of sensors), and extensibility (e.g., permit new sensors to be easily supported). It is likely that the ALERT-2 application layer protocol will have a fixed-length header followed by an optional, variable-length section. The fixed-length header will identify the originating station and may contain other information such as the ALERT-2 protocol version number. The variable-length portion of the packet will contain, for example, data from one or more sensors or optional protocol elements, such as data that cryptographically verifies the identity of the transmitting station. The variable-length section of the packet is likely to be composed of type/length/value tuples (TLVs). TLVs are a common protocol construct that include:

  - A type field that will identify the type of data that is contained within the TLV (e.g., a temperature reading, or a 32-bit value);
  - A length field that specifies the length of the TLV; and
  - A value field that is a transparent string of bytes

  A TLV structure provides a highly extensible protocol, because receivers can ignore TLVs that they don't understand. On the other hand, this extensibility comes at the cost of transmitting extra bits (and consuming additional electrical energy, which is sometimes limited). This and other design decisions will be articulated in the draft protocol specification, so that members of the ALERT community can collectively decide whether the appropriate tradeoff between flexibility and energy conservation has been achieved.

  SaloITS will explore including some elements of the "National Transportation Communications for ITS Protocol" (NTCIP) in the ALERT-2 protocol specification. An important motivation for this, as explained in the Commercialization section of this proposal, is to try to spread the development cost of ALERT-2 software over more than just the automated flood warning system market.

- **ALERT-2 Transport Protocol** The ALERT-2 transport protocol is responsible for the end-to-end delivery of application data. It is not clear at this time whether the initial ALERT-2 Protocol Specification will include a transport protocol, (i.e., the ALERT-2 transport protocol may be null). If a transport protocol is included, it might be motivated by a desire to ensure that application-layer data is transmitted reliably between the source and the destination, (e.g., to ensure that all of a new software image is actually delivered to the remote station).

- **ALERT-2 Network Layer Protocol** The ALERT-2 network layer protocol is responsible for routing packets between the originating node and the destination node. The existing ALERT protocol does not really have a network-layer protocol, although vendors have developed repeaters that provide a similar service. SaloITS believes that the ALERT-2 protocol would benefit from an explicit network protocol that could, when desirable, route packets through intermediate nodes, without the need for manual configuration. At this time, SaloITS anticipates including a network protocol in the initial draft of the ALERT-2 Protocol Specification. This network protocol may be revised, or even omitted, based on discussions with the ALERT community.

- **ALERT-2 Link-Layer Protocol** The ALERT-2 link-layer protocol manages the transfer of frames between adjacent nodes. Again, it appears desirable for the ALERT-2 Protocol Specification to also specify the details of the ALERT-2 link-layer protocol, perhaps by adopting another document by reference. Unfortunately, the Blue Water Design document does not appear to specify a complete link-layer protocol. Furthermore, the specification of a link-layer protocol is beyond the scope of the current solicitation. This topic will undoubtedly be discussed within the ALERT-2 Working Group.

- **ALERT-2 Physical-Layer Protocol** The ALERT-2 physical-layer protocol controls how bits are transmitted on the air. The current objective, subject to discussion within the ALERT-2 Working Group and possible revision, is to include a specification of the ALERT-2 physical-layer protocol in this document. This will most likely be done by referring to an existing document, such as Blue Water Design's Phase I Final report, "Forward Error Correction Enabled Open-Source Packet Modem Development". The ALERT-2 Protocol Specification may provide a convenient place to record any additional information that is necessary to ensure full interoperability between implementations of the ALERT-2 physical-layer protocol.

- **Optional or Enhanced Functionality** The ALERT-2 Protocol Specification will include additional functionality that has been found to be useful in similar environments. The following topics are likely to be included:

  - Features that support the enhancement and evolution of the ALERT-2 protocol. Numerous techniques have been used in the Internet protocol to enable new functionality to be added to protocols and new versions of protocols to be deployed without requiring that all existing implementations be upgraded. Clearly, ALERT system operators, like Internet operations, do not relish the idea of having to upgrade difficult-to-access systems just to run new protocol versions in other parts of the network.

- The Internet community has high expectations that any two devices that claim to implement a standard will actually interoperate without the need for human configuration or manual intervention. This high standard of interoperability will be present in the ALERT-2 Protocol Specification and will prove beneficial to the ALERT community.

- Internet operators have an understandable aversion to performing any manual configurations that could have been negotiated by a protocol. The ALERT-2 protocol will make every reasonable effort to minimize the amount of manual configuration that is required, particularly at the central stations.

- **Tamper Alarm** The ALERT-2 protocol could include a standard way to transmit an alarm when, for example, the case of a remote monitoring station is opened.

- **Remote Reporting Station Authentication** The current ALERT protocol provides no means of determining whether a packet was actually transmitted by the reporting station that claims to have sent it. While the chances than an attacker will pretend to be a legitimate reporting station, the technical sophistication required for such an attack is relatively low, the opportunity for disruption is moderate, and the potential for embarrassment could be moderately high. The ALERT-2 protocol will contain optional features that will use strong, modern, cryptographically based techniques to authenticate the originator of a message.

- **Replay and Other Attacks** The Phase I security analysis will enumerate the traditional attacks against which network security technologies are expected to guard, identify the attacks that may be relevant to ALERT-2 operators, (e.g., the utility of encrypting sensor data may be small), and suggest solutions that should be included in the ALERT-2 protocol.

These security features will be optional, and are primarily intended to stimulate discussions with the ALERT community about the most appropriate security requirements for future iterations of the ALERT-2 protocol.

3.3.4   Undertake Necessary Modeling or Proof-of-Concept Implementation

If necessary, SaloITS will model or implement specific components of the ALERT-2 protocol. This may be done to demonstrate the technical feasibility of a particular feature, or to compare two alternative solutions.

If no other need is identified for modeling or proof-of-concept implementation, SaloITS plans to model a slotted media access control (MAC) protocol. (A MAC protocol is the part of a link-layer protocol that controls when a station can transmit and perhaps how contention is avoided.) A slotted MAC protocol appears likely to provide substantial benefits compared to the current ALERT protocol, in which stations make essentially no effort to avoid transmitting at the same time as another station. A slotted MAC protocol might avoid the loss of sensor data when a network is heavily loaded (e.g., during periods of heavy precipitation) and may permit the available bandwidth to be used more efficiently (or permit more stations to use a particular frequency without loss of sensor data).

3.3.5   Develop ALERT-2 Implementation Plan Document

The Principal Investigator will create an Implementation Plan document. This document will be a detailed plan for the development of a prototype of the ALERT-2 Protocol Specification developed by this project. Resource requirements, such as personnel and equipment, will be identified, the major development tasks will be enumerated, and a development schedule will be documented.

3.3.6   Write Interim and Final Reports

The Principal Investigator will write interim and final technical and financial reports and other reports as specified in the contract.

3.4   Milestone Schedule

SaloITS will complete the work outlined above during a six-month contract. The following chart graphically summarizes the Phase I schedule, while Table 3 below summarizes the labor hours allocated to each task.

Table 2. Phase I Schedule						
Task	**Schedule (months after contract)**					
	1	2	3	4	5	6
1. Establish collaborative tools and processes 2. Write ALERT-2 Requirements Specification 3. Create ALERT-2 Protocol Specification 4. Undertake modeling or PoC implementation 5. Develop ALERT-2 Implementation Plan 6. Write interim and final reports	▬	▬	▬	▬	▬	▬

3.5   Deliverables

This project will generate the following deliverables:

- ALERT-2 Project Web pages, including e-mail archive and document repository
- ALERT-2 Requirements Specification document
- ALERT-2 Protocol Specification document
- ALERT-2 Implementation Plan document
- Phase I final report and other reports as required by the contract