XML and TCP/IP-That's Internet! What does it mean to my PSAP?

By Larry Ciesla and Eileen Boroski

Before we attempt to answer this question, let's define XML and TCP/IP. Once we have established this foundation, we will have a context for going forward to reply to this question.
What is XML?

XML stands for eXtensible Markup Language. It is a new markup language, developed by the World Wide Web Consortium (W3C), mainly to overcome limitations in HTML. XML is an outgrowth of the World Wide Web and the Internet. The popularity of XML has been exploding and is finding its way into thousands of Web based applications. (For more information on the W3C, visit their web site at www.w3.org.)

XML provides a standard to make information self-describing but still extremely flexible. It is also designed to be a generic protocol for the interchange of information across dissimilar systems. XML provides an easy way for computer systems to communicate. It is particularly useful for communications between systems dedicated to very different tasks, yet having a need to communicate certain data elements.

XML data elements are encapsulated into paired tags: <CTN>6305551212</CTN>. The receiving system reads the tag <CTN> and decides if it has knowledge of that tag. If so, it reads and stores the data up to the ending tag </CTN>. If the receiving system has no knowledge or interest in the data provided by this tag, it simply ignores it and looks for the start of the next tag. Tags can be nested within tags similar to quotation marks. Here is an example of an Automatic Location Information (ALI) query from a PSAP (Public Safety Answering Point):

<QYT TYPE="L"><CTN>6305551212</CTN><TRK>003</TRK><POS>011</POS></QYT>

In this example, the tags CTN, TRK and POS are nested within QYT. Thus illustrating how XML supports a tree structure within the protocol.

What is TCP/IP?
Transmission Control Protocol (TCP) and Internet Protocol (IP), together TCP/IP, have become the most widely used network protocols in the computer industry. Virtually every combination of computer and operating system can be configured to support TCP/IP. TCP/IP protocols provide outstanding reliability and performance. In the TCP/IP protocols suite, error detection and recovery on TCP/IP networks is the responsibility of the TCP and inter-network delivery is the responsibility of the IP. The primary disadvantage to TCP/IP protocols is that it requires considerable configuration and management, and a fair amount of knowledge concerning how the TCP/IP protocols function.

Several factors contribute to the popularity of TCP/IP:
* Maturity. Definition of the TCP/IP protocols began in the 1970s to satisfy a requirement of the Department of Defense for a robust wide-area-networking protocol.
* Openness. TCP/IP protocols are the only protocol suite with an open standards definition process using an open discussion process for updating the protocols.

* Non-proprietary ownership. The user community owns TCP/IP protocols.
* Richness. TCP/IP protocols are actually a suite of protocols that provide a vast set of capabilities.
* Compatibility. TCP/IP protocols are the only protocol suite that runs on almost anything.

Computer system manufacturers now regard TCP/IP as a requirement. Name the hardware, and you will probably find a least one TCP/IP implementation for it.

Why use XML and TCP/IP in the PSAP?
NENA Technical Committees have embraced the Internet XML protocol as the mechanism by which data will be exchanged between the ALI and the PSAP. The XML protocol is widely deployed throughout the Internet. NENA has produced preliminary documents describing XML's use. The use of XML introduces the concept of a bi-directional protocol; i.e., it supports communication both ways for both data and requests. XML is based on using text, so it allows for creating simple viewers to display the exchange of messages.

XML is a generic protocol designed to allow dissimilar systems to communicate. This approach has quickly garnered the interest of PSAPs committed to improving their centers. Several ALI and PSAP providers are strongly recommending this protocol.

The biggest advantage the XML brings to public safety is that it delegates control over what the PSAP does with the data being sent to the PSAP administrator. This is completely different from the way things are done today, where the ALI system controls the format of the ALI message sent. This would allow the PSAP to configure the PSAP; for example, to directly supply the X and Y (longitude and latitude) to the map for displaying a wireless call.

XML over dedicated point-to-point circuits requires at least 9600 bits per second (bps) data rates. But this does not go far enough! With the addition of XML, there is a need to move the PSAP link network to the ALI system forward to a modern network technology, specifically TCP/IP. This needs to be done over a secured network.

TCP/IP protocols are widely accepted communications protocols that are pervasive throughout the computer industry. It's extensively deployed throughout the United States and the rest of the world. It guarantees error-free delivery of data, eliminating the need to include checksums or CRCs in data messages. With the use for firewalls, gateways, and intelligent network design it is possible to build "secure" virtual private networks. Extremely high speeds can be achieved using standard transport mechanisms like Frame Relay or ATM. The high levels of reliability can be engineered into the PSAP data networks by using common strategies (e.g., multiple routes).

What is current state of PSAP/ALI Data Links?
The data network between the ALI and the PSAP has not changed since the initial introduction of Enhanced 9-1-1 service. The serial protocol used was developed in the late 1970s. The data network, used for 9-1-1, uses very slow communications speeds, with 1200 bps data rate 202T modems still common in many parts of the United States. Data rates of 9600 bps are becoming more common.

The PSAP/ALI protocol is Uni-Directional. It is extremely limited and rigid in that there has to be agreement on exact details on transmission formats between PSAP and ALI. This is also very inflexible. However, a reasonable level of reliability is inherent in the current design of the

PSAP/ALI communications network, but many installations do not take full advantage of the dual-link architecture. The current PSAP/ALI protocol is limited to three messages: ALI Query messages from the PSAP to the ALI, ALI response message from the ALI to the PSAP and Heartbeat messages from either side.

What improvements could be realized by the PSAP by using XML and TCP/IP?
In the current technology the ALI system formats the ALI display for the PSAP. Serial streams of bytes packaged by the ALI are sent to the PSAP. Other PSAP equipment (e.g. CAD, RMS and mapping) must snoop the ALI data stream and be trained on where to find data elements of interest.

PSAP ALI formats with XML allow the entire ALI record to be encapsulated into XML tags and transmitted to the PSAP, as shown in Figure 1, a screen shot of a proof-of-concept example displaying an ALI response to a PSAP manual query.

<<Figure 1; Insert image Boroski3.jpg>>

Then, the PSAP call handling equipment could accept tags it has knowledge of or interest in and reject or ignore the others. Control over what the PSAP call-taker display presents is now in the control of PSAP management as shown by Figure 2, the proof-of-concept call handling ALI display configurator for XML.

<<Figure 2; Insert image Boroski1.jpg>>

In the Figure 3 screen shot, the PSAP administrator configures the XML tags to be displayed along with the location, length and label. Also, PSAP call handling equipment could automatically route certain tags to other equipment like CAD, RMS or mapping. Such an arrangement makes it extremely simple for PSAPs to change out one vendor's equipment for another. The PSAP could easily control how the ALI information will be displayed to the call-taker, as shown in Figure 3, a proof-of-concept screen shot of a Call Handling ALI display.

<<Figure 3; Insert Boroski2.jpg>>

Beyond controlling the display, special Call Handling tags could indicate to the call handling equipment certain key differences between calls. Intelligent call handling equipment could differentiate a wireline 9-1-1 call from a wireless 9-1-1 call. Intelligent call handling equipment could be taught to trigger special handling for certain type of calls like OPX, RCF, Pilot/subline, or calls originating behind a PBX. In addition, this equipment could be "rules based" allowing the PSAP administrator new flexibility for managing how call-takers manage their 9-1-1 calls.

A list of additional possible enhancements that could be implemented due to using the bi-directional communications is: misroute or incorrect ALI report automation, health and status monitoring, common Call Detail Record (CDR) reporting, intra-PSAP communication, inter-PSAP communication, and on-line access to the MSAG and other service provider generated reports and data.

The on-line entry of misroute or incorrect ALI reporting could be automated. The call taker could automatically generate a report to the ALI service provider during or after the call, greatly speeding up the resolution of these types of errors. Misroute or incorrect address reports could be

automatically encapsulated into an XML message and transmitted over the same network connection that supports the ALI links to the ALI service provider's E9-1-1 Database Management System (DBMS).

Health and status monitoring of PSAP equipment by RBOC, ALI service provider, or state agency could be implemented. PSAP equipment could alert the service provider of health problems using XML messages. The service provider could remotely monitor and/or administer equipment.

Common Call Detail Record (CDR) reporting to RBOC in real-time allows for improved and easier 9-1-1 reporting to the state. State agencies or other large agencies can combine reporting statistics on an area wide basis. Alternate routing decisions could be made in real-time based on a real-time analysis of traffic patterns.

Intra-PSAP communication possibilities could include call handling to CAD, call handling to RMS and call handling to mapping.

Inter-PSAP communication possibilities could include transmittal of ALI records, auxiliary data and real-time call comments.

Using on-line access to MSAG and/or other ALI service provider generated reports, the same network connection used for ALI queries and responses can also be used for MSAG management. This could eliminate the need for slow dial-up connections.

The introduction of XML over TCP/IP opens the door for other improvements in other public safety areas. Today, ALI to ALI steering is done using the inflexible PAM protocol. XML protocol is inherently flexible and could easily be adopted, as our industry's needs change. ALI to Wireless E9-1-1 Application (NCAS) PN3890 defines elements but does not define a protocol. Using XML is a fast and simple way for all vendors to meet this standard.

What could be preventing implementation of XML and TCP/IP?
NENA is in the process of standardizing on XML-this needs to happen quickly. XML is really a "framework" in which data can be encapsulated and exchanged between computer systems. The most important thing is not necessarily to agree on tag definitions or field lengths, but rather, to establish a set of rules that allow systems from different vendors to "agree to disagree." In addition, for TCP/IP, in most parts of the country the 1200 bps 202T modem is still all that is tariffed. There is the issue of funding network infrastructure improvements to replace these modems. The network design must provide security of transmission and facilities.

Experiences from implementing XML and TCP/IP for ALI and PSAP interchange
Lucent Technologies developed a proof-of-concept to show these concepts regarding XML over TCP/IP including a demonstration of real-time misroute report generation. The list of data tags in NENA Version 3 were used for the XML tags implemented in the proof-of-concept demonstration.

To demonstrate the configuration ability of the PSAP, a simple configurator was built that allowed the PSAP administrator to define the tags to be displayed, their location and apply any labeling. The configuration changes could be done real-time and would take effect on the next ALI response received.

To illustrate the extendibility of using XML and TCP/IP, real-time misroute report generation was implemented. The current mechanism a PSAP uses to report an incorrect ALI address within an ALI response is to send manually a "misroute report" back to the ALI service provider. The "misroute report" can be either a paper report that is completed by someone at the PSAP (and then faxed into the ALI service provider), or it can be entered on-line via our Palladium(r) MSAG Mail product, for example. Both of these are somewhat inefficient, the former more than the latter. The demonstration allowed for the 9-1-1 call-taker to enter the correct address in a screen from call handling, which is pre-populated with the information from the ALI response. The "misroute report" information is then transmitted to the ALISA all via XML over TCP/IP.

To complete the process and to demonstrate the processing of XML outside the PSAP, the ALISA, upon receiving an XML misroute report, would translate the data and load it into the DBMS misroute table.

Conclusion

The initial question was "What does XML and TCP/IP mean to my PSAP?" The response to this, as shown, includes higher speeds, greater PSAP control, increased flexibility, and opportunity for a long list of PSAP enhanced functionality.

NENA member Larry Ciesla is the Chief Architect for Lucent Technologies' Public Safety Systems. Mr. Ciesla's Lucent team is currently participating on the DATA Committee and the LNP Study Group, and he is a former member of both groups. He has contributed non-call associated signaling paper to the TIA Joint Experts Meetings in Chicago and Washington. This paper was adopted by the TIA and standardized and the method described therein implemented in various parts of the United States. NENA member Eileen Boroski is a Development Systems Engineer for Lucent Technologies' Public Safety Systems. Ms. Boroski is a member of the NENA PSAP/CPE Technical Committee and ALI Response Format Joint Study Group. You can ask questions or contact Larry at lciesla@lucent.com or Eileen at boroski@lucent.com.