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911 Service Down for Six Hours Due to Software Bug November 2014

On Thursday, April 10, 2014, the entire state of Washington lost 911 service for all of its residents for six hours. Some residents in six other states also suffered 911 outages. The problem was caused by a software bug in a centralized site that handles over half of 911 calls for the United States.



Centralization of 911 services is made possible by the move to Next Generation 911 (NG911), which will be IP-based rather than based on land-line direct trunks. Consolidation of services may portend further massive outages should concentration points fail.

The Outage

At about 1 AM PDT on April 10th, call dispatchers in 911 call centers around the state of Washington began to notice that no 911 calls were coming through. 911 call centers are called Public Safety Access Points (PSAPs). Call dispatchers attempted to reroute incoming 911 calls to neighboring PSAPs but found that these jurisdictions had no service either.

Frantic calls to CenturyLink, the 911 service provider for the state of Washington, provided no relief. It took six hours to restore service. During that time, 4,500 911 calls in Washington state went unanswered. Only 770 were completed.

Washington was not the only state affected, but it was the only state to lose 911 calls to all of its PSAPs. In total, 11 million people in seven states were affected. Other states that lost partial service included North Carolina, South Carolina, California, Florida, Michigan, and Pennsylvania. In total, 6,600 911 calls were lost among all of the affected states.



The Olympian

The number of affected counties in each state were as follows:

Washington	39 of 39 counties
North Carolina	2 of 100 counties
South Carolina	1 of 46 counties
California	8 of 58 counties
Florida	3 of 67 counties
Michigan	6 of 87 counties
Pennsylvania	1 of 67 counties

Though Pennsylvania lost only one county, it was unfortunately its most populous, Philadelphia county.

Next Generation 911 (NG911)

A little background will set the stage for the description of the problem. In the early days of 911 service, before the Internet became pervasive, 911 calls were made by land-line telephones. A 911 call was received by the local central office that served the telephone. The central office knew the location of the telephone and routed the 911 call to the PSAP that served that location.

Then came the Next Generation 911 service – NG911. The intent of NG911 is to take advantage of the Internet to make 911 call servicing more efficient and flexible. Rather than the local central office directly routing 911 calls to the local PSAP, it now routed the calls to a central site for rerouting to the PSAPs. Communication links between the central offices and the central sites were initially land-line trunks, specifically time-division multiplexing (TDM) trunks that can handle multiple calls over a single land line.

These lines are slowly being replaced with IP (Internet Protocol) communication links. One of the advantages of NG911 is that voice is no longer the only means of communication. 911 messages can now be sent over IP links by text, and even video can be relayed to a PSAP. NG911 implementation is currently in progress nationwide and will not be complete for several years.

A potential Achilles's heal in NG911 is the concentration of services in central computers. A failure of one of these central sites can have a major impact on 911 services. This is what happened on April 10th. The problem was caused by a simple, easily correctable software bug. Even worse, there was redundancy in the system; and if the problem had been correctly identified, service could have been restored in minutes.

The Software Bug

A major 911-services provider is a company by the name of Intrado Inc. Intrado provides some level of 911 function for over 3,000 of the nation's 6,000 PSAPs. 260 million 911 calls per year, over half of all nationwide 911 calls, are handled in some way or another by Intrado.

One of the services that Intrado provides is 911 call routing to the appropriate PSAPs. It maintains two major data centers to do this, one in Englewood, Colorado, and one in Miami, Florida. Massive databases relate the location of land-line telephones and cell-phone locations to the nearest PSAP. When a 911 call comes in to one of Intrado's routing systems, it reroutes the call to the nearest PSAP according to its database. These two call centers are called Emergency Call Management Centers (ECMCs).

Washington state had turned to CenturyLink to manage its 911 service. By agreement, CenturyLink routed Washington's 911 calls to Intrado's Colorado ECMC.

For incoming calls over TDM trunks, an Intrado ECMC assigns a unique identifying key to each call to help it process the call. The system had a maximum capacity of forty million keys. Keys were periodically purged to ensure that there were always a sufficient number of keys to handle incoming calls.

However, the last key purge for the Colorado ECMC had occurred the previous year in September. At 11:54 PM PDT on April 9, 2014, the Colorado system ran out of keys. Incoming calls could no longer be assigned keys and could not be handled. Calls timed out, and callers were greeted with a busy signal.

Why did it take six hours to correct the problem? There were two factors that delayed the identification of the outage. One was that there was a simultaneous outage in Oregon. The Intrado staff and CenturyLink reasonably assumed that the problems in Washington and Oregon were caused by the same fault. Eventually, the Oregon problem was solved, and it then became apparent that Washington was suffering a different problem.

The other challenge was that a full-key condition was deemed to be not important, and this event was assigned a low-priority alarm. All that happened was that thousands of alarms were logged, one for each incompleting call. But no human being was ever notified, and no one noticed the alarms.

Once the Intrado staff recognized the problem – six hours after it occurred – incoming 911 calls were rerouted to the Miami ECMC and service was restored.

All in all, 81 PSAPs were affected in sixty counties located in seven states. The outage affected only those PSAPs that communicated with the Colorado ECMC over TDM trunks. Those communicating over IP links or communicating to the Miami system were unaffected.

System Enhancements

In October, 2014, the FCC (the U.S. Federal Communications Commission) issued a forty-page report¹ analyzing the outage. It concluded that the 911 outage was the result of a preventable software error, and that the outage could have been immediately corrected by rerouting 911 calls that could not be completed by the Colorado ECMC to the Miami ECMC.

Intrado issued a statement saying:

“Intrado has partnered with CenturyLink in the State of Washington for nearly 20 years to provide 911 services. Public and personal safety are at the heart of Intrado’s business and we take any service disruption very seriously. The service disruption on April 10th was caused by an isolated system issue that was promptly resolved after root cause identification. The system is stable and continues to process 911 calls normally.”

Intrado implemented a number of new features to fix the problem and to prevent future recurrences of the same problem:

- It increased the key limit from forty million keys to six billion keys.
- It upgraded the key count alarm to a major alarm.
- It assigned a staff member to monitor the key count weekly to ensure that it is not nearing its maximum threshold.
- It created an alarm based on the percentage of successful calls processed in an ECMC over a 15-minute period. If an ECMC stops processing calls, an immediate alarm is generated.
- 911 calls that cannot be processed by an ECMC are rerouted to the other ECMC.

Summary

Fortunately, it appears that no one died as a result of this 911 outage. Unfortunately, this outage is not an isolated event. 911 services have had an unrespectable availability record.²

¹ April 2014 Multistate 911 Outage Cause and Impact, *Federal Communications Commission*; October 2014.

² Northern Virginia’s 911 Service Down for Four Days, *Availability Digest*, December 2012.
http://www.availabilitydigest.com/public_articles/0712/911_outage.pdf
New York City’s New 911 System Goes Down Four Times, *Availability Digest*, June 2013.
http://www.availabilitydigest.com/public_articles/0806/nyc_911.pdf
911 Systems Experiencing Unacceptable Availability, *Availability Digest*; March 2014.
http://www.availabilitydigest.com/public_articles/0903/911_availability.pdf

It is certain that future failures are bound to occur. Unlike previous outages that were often caused by natural events such as weather, earthquakes, or fires, breakdowns in the future are more likely to be harder to detect. As consolidation of services increases during the phaseover to NG911, outages become more likely to be caused invisibly as computers fail or as software bugs arise. However, these are no excuses. Calls for help must go through.

Highlighting the problem of NG911 consolidation is that during the past three years there have been no outages affecting an entire state or multiple states. Now that NG911 is being implemented, there have been four such incidents in 2014, including those in Hawaii and Vermont.

This outage also provides a lesson for active/active systems. Intrado's ECMC systems represent an active/active architecture. 911 calls are being actively handled by both nodes, and a call can be routed to either node for processing. However, if one node fails and no one notices (or there is not an automatic rerouting of traffic), all users on that node are down until the failure is recognized. It is imperative that effective monitoring be employed on all nodes comprising an active/active system to immediately detect a failure and to either automatically recover to surviving nodes or to alert IT staff so that a manual switchover can be made.

Acknowledgements

In addition to those referenced above, information for this article was obtained from the following sources:

911 emergency backup in Thurston County prevented lost calls during system failure, *The Olympian*; April 10, 2014.

CenturyLink says 4,500 calls failed during Washington's 911 outage, *Oregon Live*; April 15, 2014.

CenturyLink files state report explaining cause of 911 outage, *The News Tribune*; April 29, 2014.

911 Systems Experiencing Unacceptable Availability, *Availability Digest*; March 2014.

How a dumb software glitch kept thousands from reaching 911, *Washington Post*; October 20, 2014.

A preventable coding error knocked out 911 service for millions, *Verge*; October 20, 2014.