EXHIBIT 54 (911-075)

BEFORE THE NEBRASKA PUBLIC SERVICE COMMISSION

In the Matter of the Nebraska Public Service Commission, on its own motion, conducting an investigation into the 911 service outage that began on August 31, 2023 in areas of Nebraska served by Lumen and its affiliates.	)	Application No. 911-075/ PI-248
In the Matter of the Nebraska Public Service Commission, on its own motion, conducting an investigation into 911 service outages occurring in areas of Nebraska served by Lumen and its affiliates.	)	Application No. 911-077/ C-5581/PI-252
	)	ORDER ADOPTING PROCEDURAL SCHEDULE AND SETTING HEARING
	)	Entered: October 22, 2024

BY THE HEARING OFFICER:

On September 12, 2023, the Nebraska Public Service Commission opened Docket No. 911-075/PI-248 to investigate the 911 emergency telecommunications service outage that occurred over a wide area of the Lumen network in Nebraska beginning at approximately 7:00 p.m. on Thursday, August 31, 2023, and lasting until approximately 7:20 a.m. on Friday, September 1, 2023.

Subsequently, on April 17, 2024, 911 service was again disrupted in Lumen service areas, impacting multiple Public Safety Answering Points ("PSAPs") across Nebraska ("April 2024 Lumen Outage") resulting in the Commission opening a second investigation.[1] On July 9, 2024, ("July 2024 Lumen Outage)" a third outage occurred impacting Lumen customers in Nebraska. On August 20, 2024, the Commission entered an Order Expanding Investigation under Docket No. 911-077/C-5581/PI-252 to include both the April and July 2024 outages.[2]

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[1] *See, In the Matter of the Nebraska Public Service Commission, on its own motion, conducting an investigation into the 911 service outage that began on August 31, 2023, in areas of Nebraska served by Lumen and its affiliates,* App. No. 911-075/ PI-248, Order Opening Investigation (September 12, 2023).

[2] *See,* Application No. 911-077/C-5581/PI-252, *In the Matter of the Nebraska Public Service Commission, on its own motion, conducting an investigation into the 911 service outages occurring in areas of Nebraska served by Lumen and its affiliates,* Order Expanding Investigation (August 20, 2024).

On October 16, 2024, a planning conference was held with the parties in this matter. As a result of the planning conference, several issues were decided. Therefore, this Order serves to memorialize those decisions and provide a timeline for proceedings in this docket. I find that the following schedule should be adopted:

Date	Event
Wednesday, October 30, 2024	All pre-filed testimony, exhibits, and final witness lists due.
Monday, November 4, 2024, at 9:00 a.m. CST; and Tuesday, November 5, 2024, at 9:00 a.m. CST (if necessary)	Hearing(s)

Furthermore, hearing on this matter shall be set for **Monday, November 4, 2024, at 9:00 a.m. Central Time**, and if necessary, **Tuesday, November 5, 2024, at 9:00 a.m. Central Time**, in the Commission Hearing Room, 1200 N Street, Suite 300, Lincoln, Nebraska. This Hearing shall be held in person; however, remote access to the hearing will be available via WebEx at the following link: https://psc.nebraska.gov/stream (case sensitive).

If auxiliary aids or reasonable accommodations are needed for attendance at the meeting, please call the Commission at (402) 471-3101. For people with hearing/speech impairments, please call the Nebraska Relay System at (800) 833-7352 (TDD) or (800) 833-0920 (Voice). Advance notice of at least seven days is needed when requesting an interpreter.

O R D E R

IT IS THEREFORE ORDERED by the Hearing Officer that the proposed procedural schedule set forth herein be, and is hereby, adopted.

IT IS FURTHER ORDERED that hearings in the above-captioned matters should be, and are hereby, scheduled for **Monday, November 4, 2024, at 9:00 a.m. Central Time**, and if necessary, **Tuesday, November 5, 2024, at 9:00 a.m. Central Time**, as provided herein.

ENTERED AND MADE EFFECTIVE at Lincoln, Nebraska, this 22nd day of October, 2024.

NEBRASKA PUBLIC SERVICE COMMISSION

By: 

Tim Schram
Hearing Officer

The Daily Record

EXHIBIT
55 (911-075)

Public Notice Placement Confirmation

*Please notify us of any changes ASAP at **legals@omahadailyrecord.com***

Scheduled Publication 10/24

NEBRASKA PUBLIC SERVICE COMMISSION
300 The Atrium, 1200 N Street
P.O. Box 94927
Lincoln, NE 68509-4927

NOTICE OF PUBLIC HEARING

APPLICATION NO. 911-075 PI-248 and
APPLICATION NO. 911-077/C-5581/PI-252:

911-075/PI-248 The Commission, on its own motion, conducting an investigation into the 911 service Outage that began on August 31, 2023, in areas of Nebraska served by Lumen and its affiliates, and;

911-077/C-5581 PI-252 In the Matter of the Nebraska Public Service Commission, on its own Motion, conducting an investigation into the 911 service PI-252 outage on the Lumen network that began on April 3, 2024, in varying areas of Nebraska.

All persons interested in the above-referenced application are hereby notified that this matter has been scheduled for public hearing on **November 4, 2024**, at **9:00 a.m. central time, and if necessary, November 5, 2024, at 9:00 a.m. central time** in the Nebraska Public Service **Commission Hearing Room, 300 The Atrium, 1200 "N" Street, Lincoln, Nebraska.**

Remote access to the hearing will be available via WebEx or by telephone. The Commission WebEx may be accessed by the following link: **https://psc.nebraska.gov/stream**. Those wishing to attend anonymously may use "anonymous" for their name and "**a@b.com**" for their email address. To attend by telephone, dial 408-418-9388, then enter **1462735624** when prompted for an access code. Visit the **PSC Meeting/Hearing information page** for additional details

If auxiliary aids or reasonable accommodations are needed for attendance at a Commission meeting, please call the Commission at 402-471-3101. For people with hearing/speech impairments, please call the Commission at 402-471-0213 (TDD) or the Nebraska Relay System at 800-833-7352 (TDD), or 800-833-0920 (Voice). Advance notice of at least seven days is needed when requesting an interpreter.

10/24 ZNEZ

All notice submissions, changes and cancellations must be made by 12 p.m. two weekdays prior to publication, or by earlier deadlines noted in your confirmation email in advance of court holidays. Please note the The Daily Record reserves the right to delay publication if we are unable to reach you to resolve questions or concerns.

EXHIBIT
56 (911-075)

BEFORE THE NEBRASKA PUBLIC SERVICE COMMISSION

In the Matter of the Nebraska Public Service Commission, on its own motion, conducting an investigation into the 911 service Outage that began on August 31, 2023, in areas of Nebraska served by Lumen and its affiliates.	)))))	Application No. 911-075/PI-248

CENTURYLINK COMMUNICATIONS, LLC d/b/a LUMEN TECHNOLOGIES GROUP'S RESPONSES TO COMMISSION STAFF'S SECOND SET OF DATA REQUESTS

COMES NOW CenturyLink Communications, LLC d/b/a Lumen Technologies Group, (hereafter, "Lumen"), and for its responses to the Nebraska Public Service Commission Staff's Second Set of Data Requests in the above-captioned matter, states as follows:

PRELIMINARY STATEMENT

As stated in Lumen's response to the Commission's First Set of Data Requests, the responses provided herein are based upon information presently available and specifically known by Lumen. Further discovery and investigation may disclose additional facts and add meaning to known facts, all of which may lead to additions to, changes in, and/or variations from, the answers set forth herein. The following answers are given without prejudice to Lumen's right to produce evidence of any subsequently discovered fact or facts. Accordingly, Lumen reserves the right to supplement any and all responses herein if additional information become known.

All responses provided herein are made without waiving any and all objections to relevancy, privilege, confidentiality, and admissibility of evidence at any additional evidentiary hearing or further proceeding.

OBJECTION TO DEFINITIONS:

Lumen objects to the definitions set forth in the Second Set of Data Requests, including but not limited to, the following:

- Definition No. 1: the definition of "Lumen" incorrectly and improperly groups together *all* "parents, subsidiaries, and affiliates" and "former and present officers, directors, employees, representatives, agents, and attorneys"; CenturyLink Communications, LLC d/b/a Lumen Technologies Group is the entity involved in the Outage currently being investigated, and, as noted above, is the entity responding to this Second Set of Data Requests;
- Definition No 8: the definition of "Outage" to the extent it does not comport with E-911 industry standards and/or statutory definitions; and
- Definition No. 9: the definition of "August 31, 2023 Outage" incorrectly assumes the Outage being investigated occurred on the "Lumen 911 System" in Nebraska, because, as defined in the Second Set of Data Requests, the term "Lumen 911 System" means the Legacy 911 System and the NG-911 System. As set forth in prior response to data requests, written testimony, and testimony at the January 4, 2024 hearing in the above-captioned docket, The E911 and NG-911 networks were working and were not impacted by the transport outages being investigated by the Commission under this docket.

LUMEN'S DEFINITIONS

"Outage Period" referred to herein means August 31, 2023, to September 1, 2023.

"Fiber Cut No. 1" referred to herein means the August 30, 2023 cable that was cut by a third party contractor in Minnesota, through no fault of Lumen.

"Fiber Cut No. 2" referred to herein means the August 31, 2023 cable that was cut by a third party contractor in Omaha, Nebraska, through no fault of Lumen.

RESPONSES TO DATA REQUESTS

REQUEST NO. 1: The testimony seems to indicate that the Grand Island equipment was a switch that was operating as a selective router and as an aggregation switch. Please explain what is meant by an "aggregation switch" and how that differs from a selective router with trunk-to-trunk routing to another switch.

RESPONSE TO REQUEST NO. 1: The Grand Island switch referenced was operating as a traditional E-911 Selective router for PSAPs that had not yet migrated to NG-911. In this capacity the originating Office providers provide trunks to the E-911 Selective Router and the E-911 Selective Router then does a routing lookup and sends the call to a dedicated 911 trunk to PSAP's that have not yet cut to the NG-911 Solution.

The Grand Island switch also acts as an aggregation switch for 911 traffic destined for the NG-911 network; for PSAPs migrated to the NG-911 network, the switch does a routing lookup and determines the call is destined to a PSAP served by the NG911 network and forwards the call over TDM ES trunks to the LNG that then converts the traffic to SIP to forward to the NG911 network.

REQUEST NO. 2: The diagram shows Lumen "LNGs". Is this actually an LSRG and just mislabeled? If not, please explain how calls are handled from the origination switch to the LNG and what LNG stands for.

RESPONSE TO REQUEST NO. 2: Lumen objects to this request because it fails to specifically identify what "diagram" is being referred to and the Definitions section of this Second Set of Data Requests does not define "diagram". Subject to and without waiving said objection, Lumen's understanding is that OSP providers will build 911 ES trunks to the LNG and the LNG will convert TDM to SIP, or OSP will build or have ES trunks to the aggregation point and the aggregation point will then forward the traffic to the LNG over ES trunks where the traffic will then be converted to SIP. LNG stands for "Legacy Network Gateways".

REQUEST NO. 3: Were both SS7 signaling and trunk connections lost in the incident? Why or why not?

RESPONSE TO REQUEST NO. 3: Lumen objects to this request because it fails to specifically identify what "trunk connection" is being referred to and the Definitions section of this Second Set of Data Requests does not define "trunk connection". Subject to and without waiving said objection, this incident was two separate fiber cuts along two diverse paths to the NG911 network, referred to by Lumen as Fiber Cut No. 1 and Fiber Cut No. 2. Assuming this request refers to the SS7 signaling network and the trunks between the OSP and the selective router or the selective router and the PSAP, then Lumen's response is no, the trunks were not lost in the incident when the SS7 network was lost. SS7 signaling was impacted due to two diverse A-Links being down due to the separate fiber cuts, No. 1 and No. 2. These are the SS7 "connections" that caused the SS7 impact. The voice or "bearer"

trunks configured as SS7 remained up and in service.

REQUEST NO. 4: Was the network configuration that allowed for the failure in this incident, a transition step, or is this backhauling of TDM calls the final network design?

a. If this was a transition step, when is the final network configuration going to be completed?

b. Does either the current network or the final network configuration include placing legacy network gateways at the arrogation point?

RESPONSE TO REQUEST NO. 4:

The network configuration at the time of the incident was in a transitionary stage.

- **For PSAPs that had not yet transitioned to the NG-911 solution, calls entered the network from the end user to their Carrier and then to the legacy selective router. The selective router uses the SS7 network to retrieve information to complete the 911 calls to the correct PSAP with the caller information.**
- **For PSAPs that had transitioned to the NG-911 solution, calls entered the network from the end user to their Carrier and then to the legacy selective router. For 911 calls destined for the PSAPs that have converted to the NG911 solution, the selective router is now functioning as an aggregation point, passing all 911 traffic to the Lumen Points of Interface (POIs) as a part of the NG911 solution, until the OSPs complete their own connections to the POIs.**
- **Some calls were delivered from the OSP directly to the Lumen POIs as a part of the final NG911 solution.**

a. The State of Nebraska has 61 of 67 PSAPs deployed as well as 2 State Patrols. There are 6 PSAPs left to deploy in the State. Of those 6, there are 5 scheduled in Q2 2024 and one (Thurston County) is pending PSAP readiness for deployment. Originating Service Providers (OSPs) are in various stages of their migration process to move to the final network configuration – 36% have completely deployed, and 26% have completed their connectivity orders and are now working through migration and testing.

b. The i3 solution supports end-to-end IP connectivity. Gateways are used to accommodate legacy wireline and wireless origination networks that are non-IP.

REQUEST NO. 5: Were any Lumen originated 9-1-1 calls affected by this outage? If so, were their alarms raised on those calls? Why or Why not?

RESPONSE TO REQUEST NO. 5: Yes, Lumen originated calls were impacted by this event. Lumen currently does not alarm on an individual call failure at the aggregation point, as it would cause multiple false alarms. Lumen monitors the trunks and trunk groups that carry the 911 services.

REQUEST NO. 6: You indicated that the cut in Minneapolis did not create an automatic alarm, but the cut in Omaha did. If these two cuts were on a ring, then the first one would not have caused a service failure, although it should have created a transport alarm. When you say that the first cut did not create an alarm, was that the transport alarm?

RESPONSE TO REQUEST NO. 6: Lumen did not get Loss of Redundancy (LOR) or SS7 alarming because the com-links failed when Minneapolis fiber was cut. We did receive National Transport alarms for the Minneapolis fiber cut. We have further diversified the local SS7 communications links on September 8, 2023. See also Drew Groff's Written Direct Testimony, Exhibit 51, p. 7.

REQUEST NO. 7: Does Lumen assert that a single OC-192 ring is reliable enough to maintain 99.999% 9-1-1 service? Why or why not?

RESPONSE TO REQUEST NO. 7: Lumen objects to this request because it is vague, calls for speculation, improperly assumes facts and testimony not in evidence in this matter, and is not relevant to the incident that occurred during the Outage Period. Lumen further objects to the extent this request relies upon industry objectives and/or recommendations for 9-1-1 reliability and availability that are inapplicable to the issues at hand. Subject to and without waiving said objection, see the January 4, 2024 testimony of Drew Groff at 264:23 – 265:20.

REQUEST NO. 8: When the Omaha cut happened, the services failed. Testimony indicated that the Omaha cut did generate an automatic alarm. Was that alarm also a transport alarm?

RESPONSE TO REQUEST NO. 8: Yes, transport alarms were received.

REQUEST NO. 9: When the Omaha cut happened, the services failed. Testimony indicated that the Omaha cut did generate an automatic alarm. Was that alarm also a transport alarm?

RESPONSE TO REQUEST NO. 9: This is duplicative of Request No. 8 and does not require a response.

REQUEST NO. 10: Does Lumen assert that two paths are sufficient to achieve 99.999% availability? Why or why not?

RESPONSE TO REQUEST NO. 10: Lumen objects to this request because it is vague, calls for speculation, improperly assumes facts and testimony not in evidence in this matter, and is not relevant to the incident that occurred during the Outage Period. Lumen further objects to the extent this request relies upon industry objectives and/or recommendations for 9-1-1 reliability and availability that are inapplicable to the issues at hand. Subject to and without waiving said objection, see the January 4, 2024 testimony of Drew Groff at 264:23 – 265:20.

REQUEST NO. 11: Does Lumen consider a single selective router reliable enough to maintain a 99.999% service to multiple end offices? Why or why not?

RESPONSE TO REQUEST NO. 11: Lumen objects to this request because it is

vague, calls for speculation, improperly assumes facts and testimony not in evidence in this matter, and is not relevant to the incident that occurred during the Outage Period. Lumen further objects to the extent this request relies upon industry objectives and/or recommendations for 9-1-1 reliability and availability that are inapplicable to the issues at hand. Subject to and without waiving said objection, see the January 4, 2024 testimony of Drew Groff at 264:23 – 265:20.

REQUEST NO. 12: Does Lumen consider a single OC-192 multistate ring reliable enough to maintain a 99.999% 9-1-1 service?

RESPONSE TO REQUEST NO. 12: Lumen objects to this request because it is vague, calls for speculation, improperly assumes facts and testimony not in evidence in this matter, and is not relevant to the incident that occurred during the Outage Period. Lumen further objects to the extent this request relies upon industry objectives and/or recommendations for 9-1-1 reliability and availability that are inapplicable to the issues at hand. Subject to and without waiving said objection, see the January 4, 2024 testimony of Drew Groff at 264:23 – 265:20.

REQUEST NO. 13: When considering redundancy, does Lumen consider a single ring one connection or two?

RESPONSE TO REQUEST NO. 13: Lumen objects to this request because it is vague, calls for speculation and is undefined. Lumen further objects to the extent this request is irrelevant to the instant incident during the Outage Period. Subject to and without waiving said objection, Lumen states that the connection depends on the configuration. There must be two or more faults to lose service. A single fault on a properly diverse ring will not cause an outage. A ring provides two redundant paths for traffic to traverse from the entry point and the exit point on a given ring for a protected circuit or connection. A ring utilized in this configuration provides a single connection or protected circuit for traffic to traverse that portion of the network.

REQUEST NO. 14: In this particular ring, approximately how many nodes were there?

RESPONSE TO REQUEST NO. 14: Lumen objects to this request because this request lacks specificity in order for Lumen to provide any articulate response, is vague and undefined, and irrelevant to the instant incident during the Outage Period.

REQUEST NO. 15: Testimony indicated that there was a delay in notifying PSAPs which testimony seemed to attribute to the lack of an automatic alarm from the first cut that occurred in or around Minneapolis Minnesota. Please explain in more detail why this delay occurred, including what alarms occurred when, why there was confusion and how and when information was given to you that made the scope of the problem clear enough to start notifying PSAPs.

RESPONSE TO REQUEST NO. 15: Fiber Cut No. 1 caused a transport loss of redundancy, but not a 911 outage, and because of that, the 911 trunks that Lumen monitors

were not impacted. Since 911 services were working properly, no alarms were created. The delay for automatic notification for SS7 was due to the com-link failure created during the Minnesota fiber cut (Fiber Cut No. 1), because the SS7 and the alarms were on the same transport fiber. For the Nebraska fiber cut (Fiber Cut No. 2), Lumen started receiving 911 ES Trunk alarms at 7:10 p.m. (CDT), indicating trouble with the ES trunks in the network. However, it took time to correlate the alarms and determine what the exact impact (including which PSAPs were impacted). Lumen received a trouble report from Douglas County, NE reporting calls ringing busy at 7:42 p.m. (CDT) and determined we had an entire NE state impact and sent notifications at 8:37 p.m. (CDT).

REQUEST NO. 16: Was the OC-192 ring that failed marked as a 9-1-1 circuit?

RESPONSE TO REQUEST NO. 16: This OC-192 is not dedicated exclusively to 911 traffic. Lumen labels all 911 at the circuit level as critical. Those circuits that rode this OC-192 were labeled as such.

REQUEST NO. 17: Were the tickets for the two cuts eventually updated to indicate that a 9-1-1 outage was caused by the cuts? If so, when did that occur?

RESPONSE TO REQUEST NO. 17: The outage bridge was actively correlating and coordinating restoration efforts and not all related tickets were noted at the same time; however, all resources were focused on correlating impact, looking at potential reroute options, and determining which cut could be spliced first to restore 911 ingress voice services. The first recorded time that the cuts were related was 8:47 p.m. CDT.

REQUEST NO. 18: Were the repair crews working on the Minneapolis fiber cut, made aware that there was a 911 outage? If so, when?

RESPONSE TO REQUEST NO. 18: Yes, crews working on the Minneapolis fiber cut (Fiber Cut No. 1) were made aware there was 911 impact on 8/31/23 at 11:36 p.m. (CDT). However, even without that information, teams had been working with a sense of urgency. By the time the crews were able to commence splicing at 2:51 a.m. (CDT) on 9/1/23, prioritization had been provided.

REQUEST NO. 19: Were the repair crews working on the Omaha fiber cut made aware that there was a 911 outage? If so, when?

RESPONSE TO REQUEST NO. 19: The first note referencing correlation of the Omaha fiber cut (Fiber Cut No. 2) to the 911 ingress voice outage was made on the outage bridge at 08:50 p.m. CDT. By the time the Omaha team was able to begin splicing, 911 services had been restored.

REQUEST NO. 20: Testimony indicated that there were a number of other emergencies which lengthened response times. How many of the other emergencies affected both sides of an OC-192 or larger ring? How many caused a 9-1-1 failure?

RESPONSE TO REQUEST NO. 20: Lumen objects to this request because it misstates Testimony (which is defined by the Commission as the January 4, 2024 testimony of Drew Groff) by stating that Testimony "indicated that there were a number of other emergencies which lengthened response times". Subject to and without waiving said objection, Testimony regarding this issue is set forth in the hearing transcript at 143:21-144-24. Lumen further states that with respect to Fiber Cut No. 2, any other "emergencies" did not impact the Outage Period. See also Response to Request No. 23, *infra*.

REQUEST NO. 21: Explain Lumen's process for allocating crews to cuts. How does loss of 9-1-1 services affect decisions on crew allocations?

RESPONSE TO REQUEST NO. 21: Splicing/construction crews are third-party contractors. If there is any outage, Lumen will request the contractor to dispatch the closest crew available. There are primary and secondary contractors and Lumen will utilize the contractor that can allocate the crew the soonest. In this case, even though a crew was dispatched to the Nebraska fiber cut (Fiber Cut No. 2), Lumen attempted to contact three other construction crews to try to get a crew on site sooner. See also Response to Request No. 23, *infra*.

REQUEST NO. 22: Testimony indicated that 9-1-1 service loss might affect things like which fiber line was restored first after a cut. Did that occur in this instance?

RESPONSE TO REQUEST NO. 22: When Lumen is aware of any impacts to its 9-1-1 services because of a fiber cut event, Lumen Engineering, Support and Leadership teams collaborate to develop a critical service restoration priority list. This list is based on the following criteria:

- **The severity and extent of the fiber cut event and its impact on 9-1-1 services.**
- **The availability and feasibility of alternative routes or locations for 9-1-1 calls.**
- **The estimated time and resources required to repair the fiber cut and restore the 9-1-1 services.**
- **The potential risks and challenges associated with the repair and restoration process.**

In this instance, once the protect outage began, the protect circuits (which contained the 911 circuits) were prioritized.

REQUEST NO. 23: Please list the emergencies that occurred prior to the two cuts that affected 9-1-1 service for which crews that could potentially respond to one of the cuts that were part of this incident. For each emergency, please list the time you were made aware of the emergency, the nature of the emergency, the time a repair crew arrived and whether 9-1-1 (or another higher priority service) was obstructed by that emergency.

RESPONSE TO REQUEST NO. 23: Lumen maintains Service Level Agreements (SLA's) with its third-party contractors; however, Lumen is typically unaware of any third-party contractor's locations prior to contacting them directly. Lumen is not aware of any

prior emergencies in the Minnesota outage (Fiber Cut No. 1). And for this outage, the Nebraska fiber repair provided diversity to the network that was already back in service based on the repair completed in Minnesota. Lumen recognizes its third-party contractors have multiple customers and operate to provide service to all contracted customers.

REQUEST NO. 24: Please provide a detailed timeline of the repair for the Minneapolis fiber cut including :

(a) when technicians were dispatched,
(b) when technicians arrived,
(c) when repairs were started,
(d) when the first splice was completed,
(e) when the splice that restored 9-1-1 service was completed,
(f) If work was halted for train passage, please list stop time and resume time for each such stoppage.

RESPONSE TO REQUEST NO. 24: Minnesota fiber cut (Fiber Cut No. 1) (all times Central Daylight Time):

(a) Technicians were dispatched on 8/30/23 at 2:07 p.m.
(b) Technicians arrived on 8/30/23 at 3:01 p.m.
(c) Following prep work and substantial delays by the railroad and locate providers, excavation began on 8/31/23 at 4:32 a.m. and splicing commenced on 9/1/23 at 2:51 a.m. Between 8/30/23 at 3 p.m. and 8/31/23 at 4:32 a.m., Lumen personnel spoke with railroad personnel, who initially would not allow work to begin until the morning of 8/31/23, escalated with railroad personnel and received clearance to begin work immediately, confirmed there were twelve (12) buried utilities and sent Emergency Locate tickets, marked the repair area and then waited for the all the emergency locates to be completed. Once locates were completed and railroad flaggers were in place, Lumen contractors began exposing hand holes and preparing for the boring efforts that were needed. The boring rig was staged and boring was completed by about 2:00 a.m. on 9/1/23.
(d) There were five splicing crews onsite working to splice the fibers on both ends simultaneously. While Lumen doesn't have a precise time the initial splice was completed, the company believes the first splice for one side of the work effort was completed on 9/1/23 at 3:27 a.m. Splices on both sides would have to be complete prior to any circuit being cleared. Lumen doesn't have any documentation on when individual circuits were restored, other than the 911 circuit (see response to (e) below).
(e) 911 service was restored on 9/1/23 at 5:32 a.m.
(f) Lumen does not have that information and would not track the information during a repair as the focus is restoring customers to service.

REQUEST NO. 25: Please provide a detailed timeline of the repair for the Omaha fiber cut including:

(a) when technicians were dispatched,
(b) when technicians arrived,
(c) when repairs were started,
(d) when the first splice was completed,

(e) If work was halted for train passage, please list stop time and resume time for each such stoppage.

RESPONSE TO REQUEST NO. 25: Nebraska fiber cut (Fiber Cut No. 2) (all times Central Daylight Time):

(a) Technicians were dispatched on 8/31/23 at 7:17 p.m.

(b) Lumen does not have a precise time of arrival, but technicians had already arrived and provided pictures of damage location and construction equipment in the area on 8/31/23 at 9:54 p.m,

(c) Lumen does not have a precise time of repairs beginning, but has a picture of digging on 9/1/23 at 7:35 a.m. Between 10 p.m. and 7:35 a.m. crews identified the issues, obtained approval from the railroad to begin repairs immediately, issued Emergency Locate tickets, marked the repair area and waited for railroad flaggers, who arrived after 7:00 a.m.

(d) The first splice was completed on 9/1/23 at 6:19 p.m.

(e) Lumen does not have that information and would not track the information during a repair as the focus is restoring customers to service.

REQUEST NO. 26: If a repair crew arrives at the location of a cut, under what circumstances, if any, would that crew be redirected to another, higher priority cut before completing repairs at the site they began working?

RESPONSE TO REQUEST NO. 26: It is not Lumen policy to redirect a crew from one repair to another repair. Most fiber cuts are not close to each other, and redirecting a crew would further delay repairs on the first cut, potentially without speeding repairs on the cut where the crew is redirected. See also the Response to Request No. 23.

REQUEST NO. 27: How are fiber cut priorities identified and who makes that decision?

RESPONSE TO REQUEST NO. 27: Fiber cut prioritization plans, when applicable, are established by Network Implementation Managers with data provided by NOC and Field Management. Fiber cut prioritization plans are designed to optimize the use of resources and minimize the impact of service outages. The prioritization plans are based on the some of the following guidelines:

- **The priority of a fiber cut is determined by the number and type of services affected, the duration of the outage, and the availability of alternative routes or backup systems.**
- **The priority of a fiber cut may change over time, depending on the progress of the restoration, the status of the affected services, and the feedback from the customers.**
- **The priority of a fiber cut may vary in each instance, depending on the specific circumstances and challenges of the situation.**

REQUEST NO. 28: Please supply more details on why the automated alarm did not occur. It appears from the testimony that the alarm may have been at least partially provisioned on the network that failed. Is it Lumen policy that alarm mechanisms are allowed to ride on the network

they are monitoring? If not, please detail how this alarm was "inhibited"?

RESPONSE TO REQUEST NO. 28: Lumen objects to this request because the request to "supply more details" is overbroad, vague, improperly calls for a narrative response, and seeks information that is already in this record. Subject to and without waiving said objection, Lumen states that this request appears to be related to the Minnesota fiber cut (Fiber Cut No. 1); subject to that assumption, Lumen states as follows: in this case the only alarms not received were related to the SS7 network, because the SS7 alarms and the SS7 traffic were on the same fiber. Lumen attempts to maximize diversity wherever possible, and Lumen diversified the SS7 alarms away from the SS7 traffic shortly after this outage. See also Response to Request No. 6, *supra*.

REQUEST NO. 29: When the Grand Island SR could not complete 9-1-1 calls, did that not generate an alarm automatically? Why or why not?

RESPONSE TO REQUEST NO. 29: The Grand Island SR does not alarm on single call failures as Lumen does not monitor at that level. Lumen monitors the 911 ES trunks and trunk groups. The trunks are set to alarm at 25% out of service condition so the technicians in the center need to review all the alarms to see the percentage of trunk impact. The center received 443 alarms total for this event within a 1-hour time frame.

REQUEST NO. 30: Lumen designed part of the NG9-1-1 system to utilize the OC-192 ring that failed. It knew, or should have known, which PSAPs would be affected by a failure of the Grand Island SR, and it knew that the Grand Island SR was connected to the LNG by this ring. Why did it take an hour from when the ring failure occurred to determining that the Grand Island SR could not pass traffic to the LNG, and thus all PSAPs with originating service providers connected to the Grand Island SR would be affected?

RESPONSE TO REQUEST NO. 30: It took time to correlate all the alarms and the amount of impact to determine all the PSAP's that were impacted. The PSAP's in the E911 network were still receiving calls which caused confusion on determining the exact cause and to identify the impacted PSAP's or offices.

REQUEST NO. 31: Is the aggregation switch in Grand Island, and the Lumen LNG connected to part of the NG9-1-1 service or is it a separate service provided under a different contract or tariff?

RESPONSE TO REQUEST NO. 31: Yes, the Grand Island selective router also currently functions as an aggregation point to the NG-911 solution so that conversions to the NG-911 system can be completed more quickly. The agreement between the State of Nebraska and Lumen for NG-911 service references integration with the legacy selective routers (serving as an aggregation point) as a part of the transitional solution. However, the Grand Island aggregation point is managed under a different agreement between Lumen and the OSPs. The Lumen LNG is included as a part of the NG-911 solution.

REQUEST NO. 32: Please provide a list of incidents for the immediately preceding 10 years to this outage of two fiber cuts on the same Lumen SONET ring and an estimate of the number of SONET rings Lumen maintains.

RESPONSE TO REQUEST NO. 32: Lumen objects to this request because the request for a "list of incidents" for the preceding 10 years is vague, irrelevant, overly broad in temporal scope, is unduly burdensome, and seeks information that is beyond the scope of the Nebraska Discovery Rules, which are applicable to these responses.

REQUEST NO. 33: Based on review of the reports the Next Generation Core Services (NGCS) was operational, but 911 calls could not be routed to the NGCS by the Lumen infrastructure to a PSAP. What process is in place to ensure that 911 calls be delivered to a default route if routing to the NGCS is unavailable?

RESPONSE TO REQUEST NO. 33: Currently there is no automated way to reroute calls in this type of outage. We would need One single PSAP accept responsibility to answer all calls for the 911 Selective Router/Aggregation Point via admin lines with no ALI. The other option is every OSP provider would need to do a reroute to an admin line to the PSAP that answers calls for their office. That is a manual endeavor and takes a long time to implement.

REQUEST NO. 34: How many 911 calls were not delivered during the outage?

RESPONSE TO REQUEST NO. 34: There were 639 failed calls from the Council Bluff aggregation point. Grand Island showed 4 failed calls between the aggregation point and the LNG but since that office was isolated, Lumen had no visibility to calls that were sent to the aggregation point and did not make it due to the SS7 isolation. Lumen does not have any data on the Norfolk Aggregation point and the data is too old to pull those numbers at this time.

REQUEST NO. 35: Documents show the ESInet remained operational. Are traffic statistics available that show the traffic processed by the NGCS during this event? If so, please provide the statistics. If not, please explain why they are not available.

RESPONSE TO REQUEST NO. 35: The ESINet remained operational. Probe calls that traverse through the LNG and the NG-911 network completed successfully during the event and Lumen's NG-911 vendor confirmed ESINet links remained up to all PSAPs over the NG-911 network and completed test calls to the PSAPs. This data is no longer available.

REQUEST NO. 36: Realizing that the SS7 network failure resulted in calls not getting to the Lumen system what options are available to assist the OSPs in having diversity to the aggregation point?

RESPONSE TO REQUEST NO. 36: The Lumen NG-911 solution provides for two diverse TDM POIs per LATA. OSPs are expected to connect to both POIs for each of the LATAs in which they provide services. Additionally, there are two geographically diverse

SIP POIs available to OSPs that wish to connect via that method. If the OSPs are unable to build their own network to the POIs, they can order facilities from Lumen or other providers to reach the POIs.

Dated this 4th day of June 2024.

Respectfully Submitted,

BY: /s/ *Katherine A. McNamara*

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CERTIFICATE OF SERVICE

The undersigned hereby certifies that on this 4th day of June 2024, the foregoing was filed electronically with the Nebraska Public Service Commission via e-mail to the following:

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EXHIBIT
57 (911-075)

NEBRASKA
Public Service Commission

Lumen 2023-2024 911 Outage Report and Analysis

10/22/2024

Prepared by:

911 Authority
Connecting Public Safety with Technology

Table of Contents

Executive Summary

911 Authority, consultants to the State of Nebraska Public Service Commission (PSC), were commissioned to begin an independent review and assessment of an outage on the Lumen Technologies Group (Lumen) NG911 service and the actions of Lumen leading up; and subsequent to the outage under review.

This report investigates the causes and contributing factors related to the outage, the actions of Lumen before, during and after the failure of their NG911 service; and provides recommendations for next steps and actions that may minimize or eliminate the factors identified as contributing to the outage.

911 Authority reviewed the Lumen testimony documents and worked with the State team to identify immediate, near and long-term remediation plans specific to the factors that contributed to the outages.

Outage Reviewed:

A. 8/30/2023 – Fiber cut in Minneapolis, MN, and damaged one path serving the NG911 system
B. 8/31/2023 – Fiber Cut in Omaha, NE, and failure of the NG911 service

Section 1 of the report documents what happened in the outage from the State of Nebraska perspective.

Section 2 identifies contributing factors and analysis from an independent NG911 service perspective.

Section 3 provides recommended actions and remedies.

This report reveals that Lumen Communications:

- **Does not fully implement NG911 industry standards:** The company's statewide 911 service is bifurcated in the sense that Legacy 911 is provided by one business unit of Lumen and the NG911 service is provided by another. The Legacy 911 service is based upon Tariff offerings and can conflict with the NG911 service standards and complicate the Service Level Agreement (SLA) negotiated with Lumen during the NG911 contract process. Lumen has testified that the ESInet and NG911 service were not affected in the outage, but Legacy 911 service including their own aggregation point of interconnection at a single Selective Router failed. The conclusion is that the separation of business units' responsibility for 911 creates a gap within the NG911 service, and within Lumen as far as meeting an end-to-end 911 and NG911 standard.
- **Neglects risk mitigation:** The company has not adequately planned for contingencies or addressed the risks associated with implementing a public safety-grade system.[1] Lumen is responsible (under the NG911 contract) for Ingress, Core and Egress (end-to-end) service. Lumen implemented the configuration to use Grand Island, NE Selective Router as the aggregation point to deliver calls to the NGCS. Lumen should have recognized the risk that their design presented and prepared for contingencies to avoid a widespread outage.

[1] The term "Public Safety Grade" is a conceptual term that refers to the expectation of emergency response providers and practitioners that their equipment and systems will remain operational during and immediately following a major natural or manmade disaster on a local, regional, and nationwide basis.

- **Operates a vulnerable 911 system:** The manner that Lumen has designed and deployed the NG911 service demonstrates a lack of diversity and redundancy required to reliably deliver expected 911 call delivery results.
- **Fails to conduct adequate audits and assessments:** Regular audits and assessments of the entire service, including the internal processes, business operations boundaries, and aggregation points used for NG911 service only reflect that Lumen has created some variables with respect to delivering a complete diverse and redundant NG911 service. Had a full audit and assessment been completed, per the FCC requirements all risks (including the internal boundaries) would have identified the gaps before they occurred, and contingencies may have been in place before risks were exposed. [2]

Conclusions:

All 911 systems are vulnerable to outages. The crucial distinction lies in preparedness. The failure of Lumen's NG911 service on August 30 and 31, 2023, underscores this critical need for proactive measures. The August 30, 2023, fiber cut in Minneapolis impacted one side of the OC192 transport network that connected the State of Nebraska ESInet to the NGCS core. On August 31, a second fiber cut in Omaha damaged the remaining path from the ESInet to the NGCS core. Lumen must thoroughly analyze this incident, extract valuable lessons, and implement comprehensive changes to prevent future disruptions. Lumen has stated in the Root Cause Analysis that these changes are already underway. Additionally, these changes must encompass personnel training and expertise, operational processes, and reviewing the underlying network architecture, configuration, and facilities to ensure a reliable and resilient NG911 service for Nebraska residents and visitors.

Section 1 Lumen Outage – What Happened?

Lumen Technologies Group provides E911 service and NG911 service to 68 PSAPs in Nebraska. The events documented below highlight the incidents that occurred.

1.1 Incident 1 – 8/31/2023

An outage of 911 service in the State of Nebraska was experienced on August 31, 2023, which lasted for 10 hours and 27 minutes (10:27). This outage was due to multiple fiber cuts in the transport network that Lumen uses for E911 and NG911 service.

Lumen provided testimony that describes their services within the State of Nebraska. Lumen provides E911 service to PSAPs and has been contracted to provide an NG911 service for the entire State. The testimony also indicates that the outage was with the "ingress" platform which transports 911 calls from an aggregation point to the NG911 core (sub-contracted to Intrado). Because of an ingress disruption calls were unable to reach the Intrado core so the NG911 service did not have 911 call traffic to relay back to the connected PSAPs. Hence, Lumen is correct in saying the ESInet and NG911 system and core did not fail. However, Lumen is responsible under the contract provisions for a statewide NG911 system which includes Ingress, Core and Egress, (in other words) end-to-end service. The NG911 contract with the State

[2] 47 CFR § 9.19 - covered 911 service providers must annually file a certification with the Commission attesting whether they have taken measures to ensure the reliability of their network with respect to circuit diversity, backup power, and network monitoring

of Nebraska also does not make a distinction between Ingress, Core and Egress and that the expectation is end-to-end service.

Lumen indicates that an SS7 outage at the Grand Island NE aggregation point prevented some OSP's from completing calls from the aggregation point. If calls reached the NG911 core, or individual service providers used their own SS7 network in response to the outage, calls were still delivered to the PSAP. 39 PSAPs were unable to receive 911 calls during the outage.

While Lumen explains that the outage was a series of unlikely events that all conspired at once to cause the ingress side to fail, it raises the question why Lumen was unprepared for the risk exposure of multiple fiber cuts. Lumen must evaluate all facets of their 911 service to address the critical lack of risk assessment and management that caused the outage.

1.2 Summary and Conclusions:

Incident 1:

911 service is commonly delivered in terms of Availability. The expectations on the industry are that all 911 communications are built with "High Availability". In the table below, the communications industry quantifies high availability as five-nines (99.999%).

Availability %	Downtime per year
90% - "one nine"	36.5 days
99% - "two nines"	3.65 days
99.9% - "three nines"	8.76 hours
99.99% - "four nines"	52.56 minutes
99.999% - "five nines"	5.26 minutes

Availability Reference table

1 Lumen's perspective regarding the E911, NG911 and particularly the Aggregation points of interconnection indicate a lack of attention to critical communications as a service and a limit on their measure of "high availability". When questioned, Lumen was forthright in suggesting if carriers had not connected an ESInet (which includes Aggregation points) PSAPs would not have had an outage, and 911 calls would not have failed. But they also should clarify their perspective of the aggregation points. They suggest the aggregation points are separate from the NG911 contract. Per the NG911 contract, Lumen is responsible for the NG911 service end-to-end (Ingress, Core and Egress) which Lumen designed and implemented.

2 During the time period the PSAPs experienced three separate issues that caused a catastrophic failure of the 911 system.

- The OC192 transport fiber cuts caused the NG911 system to be unavailable to receive traffic from the Grand Island, NE POI.
- Any OSP connected to the Grand Island, NE Selective Router, which did not have direct trunks to the PSAP caused that OSP's 911 calls to fail.
- Another Selective Router, Council Bluffs, IA which serves Omaha and other surrounding PSAPs also experienced failures of the NG911 system due to the OC192 outage.

3 The Lumen system design exhibits a lack of redundancy. Industry best practices for achieving high availability (and to meet the five-nines SLA in the NG911 contract) typically involve multiple geographically dispersed sites, each housing multiple instances of each component, interconnected by redundant communication links. Lumen has made modifications to their diversity and is working to enhance the redundancy.

a) **Redundancy:** The aggregation point of interconnect (Grand Island, NE Selective Router) was a single site for aggregating originating service provider (OSP) traffic. Lumen chose this site and configured multiple paths from the site to the OC192 transport ring. Lumen did not have multiple aggregation points, nor did they have multiple LNG's. When the fiber cuts happened in succession the Grand Island POI was unable to connect to the OC192 and any calls that terminated in the POI were not able to pass to the NG911 system. A risk assessment may be useful for uncovering any potential gaps that could impact the service including cross boundary issues between providers.

b) **Notification:** During the failure and subsequent outage, two fiber cuts caused 911 to fail. When the first fiber cut occurred, Lumen began efforts to repair and restore the system, but calls were not impacted since (at least initially) the diversity and redundancy to the NG911 core was not impacted. Lumen did not alert the State of Nebraska that a key transport route to their NG911 system was damaged and may cause a vulnerability. If Lumen had made such a notification the PSC may have been able to prepare the PSAPs to enable contingency plans sooner. Furthermore, decisions to reroute and alternatively route 911 traffic to increase redundancy could have been coordinated with the PSC.

c) **Network Management System Issues:** Compounding problems within the network management system hindered the timely diagnosis of the issue, a failure that could have been averted with proper testing and monitoring.

d) **Lack of Path Audits:** The failed network paths could have been minimized if Lumen audited the diversity. This includes the fiber paths in Minnesota and Omaha and furthermore the paths at the Aggregation points of interconnection. All paths within a 911 service should undergo regular diversity audits to ensure redundancy and resilience. Shared services do not excuse the need to audit, in particular if they are used to deliver 911.

This incident underscores a failure in risk management, contingency planning, diversity and redundancy modeling, and operational decision-making, which jeopardized public safety.

Conclusions:

The root cause of the failure is a lack of diversity and redundancy in the Lumen network. This deficiency encompasses insufficient diversity in physical locations and equipment, the absence of rigorous reliability engineering analysis including risk assessment, analysis and mitigation, and inadequate auditing of the entire 911 service from end-to-end. The State of Nebraska expects that as the NG911 provider for the state that Lumen will operate a reliable, resilient 911 system which will not be impacted by failures that could have been identified.

Achieving five-nines availability typically necessitates at least two geographically dispersed sites, each with multiple redundant sets of equipment, interconnected by at least four links capable of handling full system load. Furthermore, five-nines availability is not assessed in isolation but by evaluating the entire 911 system. Each component's meantime between failures (MTBF) and meantime to repair (MTTR) must be considered, along with the complete path from the central office (CO) to the PSAP. There is no evidence Lumen conducted such comprehensive analysis particularly at the Aggregation points of interconnection.

Regular audits of redundancy are essential to ensure the system's ongoing ability to meet availability goals. Any network or system changes should trigger a redundancy audit, and availability calculations must be reassessed whenever changes occur.

Had Lumen adhered to industry best practices for reliability and redundancy, the outcomes of these incidents could have been vastly different. The company's failure to do so and their description of how their internal business unit boundaries create gaps raises serious questions about its commitment to maintaining a robust and resilient 911 service in Nebraska.

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Section 2 Contributing Factors Review and Analysis

2.1 Fiber Cut Incident Details – 8/31/2023 Event

The 911 outage occurred August 31 into the morning of September 1, 2023. A fiber cable was cut in Minnesota on August 30,2023 that is used for transporting 911 traffic from Nebraska to the Intrado core. This cut initially had no impact on the calls in Nebraska. However, a second fiber cut in Omaha caused a failure of the ingress aggregation point that attaches to the Lumen core routers. The fiber cuts caused 911 calls to be unable to reach the Intrado core.

8/30/2023 – 1:50 PM

A Construction contractor cut three Lumen fiber cables that were buried beneath railroad tracks.

a) This did not impact 911 service to Nebraska
b) One of the fiber cables was used for diversity of the Nebraska NG911 service
c) The Lumen NOC received alerts, but all traffic remained operational on the redundant paths
d) Because of the location within the railroad right of way, Lumen had to follow Railroad regulatory requirements to gain access and coordinate repair
e) One of the non-Lumen locators failed to respond to the request and delayed the repair for over three hours

8/31/2023 – 7:05 PM

While repairs to the damaged fiber in Minnesota were being performed, another construction crew bored through a fiber cable in Omaha.

a) The second fiber cut alerted the NOC that there were multiple services down
b) Lumen dispatched teams to identify the location and confirmed that the boring hit the Lumen fiber cable
c) This event along with the Minnesota ongoing repair meant that transport of 911 calls to the NG911 core was disrupted

9/1/2023 – 5:32 AM

The Minnesota fiber repairs completed

9/1/2023 – 6:54 PM

The Omaha fiber repairs completed

According to Lumen, the total period of time of the outage began with the Omaha fiber cut on August 31 at 7:05 PM and completed when the Minnesota fiber repair was completed on September 1 at 5:32 AM. This time frame is justifiable, but it should be noted that the system was still operating on one thread until 6:54 PM on September 1, 2023, at which time the Omaha fiber repair was completed.

Lumen operated a single-threaded 911 system between August 30 and 31, 2023 with a single point of failure and did not notify the State of Nebraska that they were in a vulnerable situation.

Lumen had diverse paths, and redundancy built into the network; but this outage demonstrates that they did not have enough site diversity and redundancy for 911 services. In this instance, the single cut of the fiber in Minnesota had no impact except for removing a thread of the diversity. However, the second cut in Omaha took down access from the Grand Island POI and 911 for many PSAPs. PSAPs that were not fully on the ESInet and had existing direct connections to the OSPs were able to get calls from the OSP. Any PSAP already on the ESInet and those that removed their OSP connections were not able to get 911 calls.

While the primary issue presented by Lumen was the loss of the Grand Island, NE POI and much of the emphasis of their root cause analysis discusses that location, the Council Bluffs, IA POI was also impacted by the loss of connectivity to the OC192 national network and NGCS core.

While Lumen explains that this unlikely series of events was unpredictable, they have not acknowledged that their statewide NG911 contract specifies that it is for an end-to-end NG911 system. In particular flaws are present in their design and implementation of NG911 that caused their system to fail are required by the Federal Communications Commission (FCC).[3]

2.2 Lumen SLA from NG911 contract

Lumen provided their response to SLA use cases in the NG911 proposal based upon standard service level objectives within their NG911 product. The contract for NG911 utilizes the SLA as the threshold for operation of the entire system. From the contracted SLA's below with Lumens response and using Lumen' – they have exceeded the threshold.

SLA 1	*…..Ingress carrier network is designed to have multiple termination locations that can take 100% of the load in the event of a location failure. Connections to the PSAP are sized up to accommodate necessary bandwidth based on a concurrent G.711 SIP session (Call path). Each circuit is engineered to handle 100% of the call demand in the case of a failure of the primary or secondary circuit……* *….CenturyLink integrates a comprehensive set of tools for constant monitoring and management of the network. Multiple network management components will monitor network elements, IP paths, packet rates, packet loss, retransmission, and other IP network metrics. These components will generate alarms to appropriate systems. These components generate alarms to system operators if the reliable delivery of calls or data is threatened. Delivery of monitoring reports, including bandwidth utilization and connectivity, are provided as mutually agreed upon during contract negotiations. Traditional network management tools are complemented by active application monitoring and alerting. Application elements, BRIX probes and well as SDWAN deployment will also report network failures as detected by their monitoring activity, some of which is specific to managing the availability and integrity of the network….*

[3] 47 CFR § 9.19 - covered 911 service providers must annually file a certification with the Commission attesting whether they have taken measures to ensure the reliability of their network with respect to circuit diversity, backup power, and network monitoring

SLA 10	*We will follow standard MTTR operational guidelines for responding to customer troubles and providing updates on all products. Specific MTTR criteria will establish severity levels as part of the mutually agreed SLA. TTR times begin when a trouble ticket is opened after detection or report of an outage. Calculation of TTR service level will be based on the time taken to restore service following an event that results in the outage. MTTR characteristics are commensurate with the appropriate level of service at which the ESInet system is functioning (i.e., system components in the call path are Life and Mission Critical Services (LCMS) while, peripheral systems are considered Business Critical Services (BCS). The MTTR characteristics are listed in the table below.* ** Life and Mission Critical Services (LCMS)* ** Business Critical Services (BCS)* ** Business Essential Services (BES)* ** Business Support Services (BSS)* ** Unsupported Business Services (UBS)*
SLA 11	*Based on our public safety experience, CenturyLink has found that measuring Service Availability from a call processing perspective is more applicable and relevant to 9-1-1 service vs. traditional methods of calculating availability thru MTBF and MTTR measures. CenturyLink believes that the most relevant measure of service availability is evidenced by uninterrupted, reliable 9-1-1 call routing and delivery to the PSAPs. Our NG9-1-1 availability is calculated from the time an outage begins that impacts call processing ability, until such time that the NG9-1-1 call processing ability is restored. This includes all NG9-1-1 downtime for the end-to-end service.*
SLA 12	*CenturyLink's overall reliability is 99.999%.* *Our CenturyLink network is known for its reliability, security, and redundancy. It uses a private, high-speed, MPLS IP backbone, not the public Internet, for transmission; and it has an availability target of 99.999%. Our CenturyLink network is known for its reliability, security, and redundancy. It uses a private, high-speed, MPLS IP backbone, not the public Internet, for transmission; and it has an availability target of 99.999%. We accomplish this through problem detection, prevention, redundancy, and restoration offers to ensure that the network is always up and running. To ensure circuit 99.999% reliability will require at least two diverse circuits going to different POPs and utilizing different carriers where possible and at a minimum media diversity. Two connections are included in our ESInet design to each Host PSAP site supported by two separate edge routers and two separate IP VRF instances increasing the network reliability. All network routing infrastructure and equipment is designed and deployed in an N+1 model. N+1 redundancy provides a minimum of one additional unit, module, path, or system in addition to the minimum required to satisfy the base connectivity, ensuring that a failure of any single component at a given diverse site, such as an LNG, will not render the location inoperative making our network more reliable. Our two (2) physically diverse MPLS Network to each PSAP are predetermined, so packets travel only along the paths to which they are directed, adding reliability to our network. Our NG9-1-1 ESInet is designed to meet more stringent requirements for security, resiliency, and reliability service levels than most other IP networks. CenturyLink ESInet utilizes an MPLS private IP network that includes the use of third-party network providers that provide the local access and path diversity. These networks are comprised of different components, multiple technical solutions, and various types of interfaces. Due to the nature of MPLS-based transport, WAN failures (within the carrier network or last-mile) may not be immediately detected by NGCS network equipment at the physical layer. Knowing this, the CenturyLink ESInet*

	solution employs a more robust means of end-to-end failure detection to ensure the reliable delivery of 9-1-1 traffic All systems and components have redundant (parallel) capabilities into each of our CenturyLink facilities to provide additional reliability including: ** Datacenters are widely separated, and are powered off of different power grids* ** Redundant Power systems* ** Telecommunications services* ** Network electronics* ** Cooling* ** Fuel* *SLA Reliability - Assuming a 7x24x365 deployment (8,760 available hours), these ranges produce the following expected outage totals.*
SLA 13	*1.End-to-end, the CenturyLink solution is architected to be secure, reliable, resilient, and robust. All applications and networks in the 9-1-1 call path are designed to achieve 99.999% system availability using a number of techniques to improve resiliency such as geo-diverse redundancy, fail-over techniques, virtualization, high availability, etc. The solution utilizes redundant hardware components (network interfaces, hard disks, hot swap power supplies, etc.) wherever possible, and the solution has no single point of failure. NGCS services operate in an active-active configuration in two geo-diverse datacenters. This feature employs redundant, high-quality, fault-tolerant critical components operating continuously in tandem. If one should fail, the redundant component continues to carry the entire load with no interruption of service. No failover time is required. All applications are deployed on virtual servers and data is shared among and within each datacenter. These applications leverage high availability functionality within the hypervisor. DRS and HA features are utilized to ensure an "always on" architecture. Because of this, no single point of failure will disrupt the ability to provide on-going call processing. Transactions or call traffic divert to available components on failure or degradation of service of a given functional component or a loss of a physical site. IP transport paths for critical service components are redundant and designed for multipath IP packet delivery so the failure of a given IP transport mechanism does not affect overall service availability. Core sites include redundant network transport and redundant network interfacing elements to ensure optimal operation and availability. Network interfacing elements include switches, routers, SBCs, firewalls, and other security devices. All network routing infrastructure is designed and deployed in an N+1 model. N+1 redundancy provides a minimum of one additional unit, module, path, or system in addition to the minimum required to satisfy the base connectivity, ensuring that a failure of any single component at a given diverse site, such as an LNG, will not render the location inoperative. All network connectivity is established via dynamic routing protocols. The use of dynamic routing protocols allows the routers to automatically discover each connected network and adapt to changes in the network topology. Network probes will also report network failures as detected by their monitoring activity, some of which is specific to managing the availability and integrity of the network. Network Probes – will test end to end call quality metrics (MOS Scoring) this system will also do automatic call testing to insure network availability and functionality. CenturyLink's Statistic and Risk analysis reporting tools will be used to provide Distribution of calls by destination; Call success rate; Average call length; Average number of calls per day; Ratio of incoming versus outgoing calls; and Average mean opinion score (MOS) value scores. The NG9-1-1 Service availability SLA measures the*

	availability requirement of 99.999% for Call Processing ("Service Availability"). Call Processing is the ability of the Service to deliver calls from the inbound Service demarcation point into the Core Call Processing Nodes and from the Service demarcation point to a Valid Destination (for example a PSAP). The Service Availability is calculated from the time an issue is reported that impacts Call Processing ability, until such time that the Service Call Processing ability is restored. The Service Availability downtime will not exceed 26.3 seconds per month. Customers are eligible for remedies and service credits when the Service Availability SLA is not achieved. 2.We use a combination of platforms for accomplishing monitoring, data management, and oversight tasks, including SolarWinds, Brix network probes. Splunk, and Oracle Operations control Monitor and others. Outputs from the various platforms are gathered, calculated, and combined into single-pane views specific to the NG9-1-1 services arena using developed tools. This combined approach allows CenturyLink to tailor the solutions to the specific NG9-1-1 environment while leveraging best-in-class off-the-shelf tools where appropriate monthly results are viewable. Service Level Agreements (SLAs) will be provided as a part of our Program Development Plan (PDP). The CenturyLink Program Manager will work with the Commission or PSAP's to track services against SLAs and provide monthly reporting to the customer. During the planning phase of the project the CPrgM will work with the state to define reporting criteria, format, and frequency. Refer to Attachment labeled "2.d CenturyLink Sample Program Management Plan for Nebraska."

Nines	Availability	%	Downtime/ Year	Downtime/ Month*	Downtime/ Week
One	0.9	90%	36.5 days	73 hours	17.18 hours
Two	0.99	99%	3.65 days	7.30 hours	1.72 hours
Three	0.999	99.9%	8.76 hours	43.2 minutes	10.1 minutes
Four	0.9999	99.99%	52.56 minutes	4.32 minutes	1.01 minutes
Five	.99999	99.99%	5.3 minutes	25.9 seconds	6 seconds

SLA 15	*The CenturyLink Network/Security Operations Center (NOC/SOC) is staffed 24 hours a day, seven days a week, 365 days a year to actively monitor and manage CenturyLink's NGCS Solution associated services and connectivity. When a potential or actual customer-affecting event or outage is defined and determined to be an incident, the Incident Administration team is engaged by the NOC. The team uses established processes that are ISO 9001:2015-compliant for immediate escalation, notification, resolution, and reporting. In case of a service interruption and/or outage, we have instituted Incident Management processes and procedures for dealing with various severity levels during the course of an event. Our incident response tools include use of the Incident Command System (ICS modeled directly from the Federal Emergency Management Agency (FEMA) Emergency Management Institute. The ICS processes include resolution, documentation of any incident, communications, and post-event review and root cause analysis. We manage incidents and provide customers with notifications and status of ongoing service affecting issues that may impact the CenturyLink's NGCS Solution.* ***Notification*** *The CenturyLink support center shall notify the ISP and ICC within 30 minutes of discovering an event or outage that may impact 9-1-1 services. CenturyLink's NGCS Solutions service assurance strategy places the highest emphasis on service restoration.*

	Communication will be supplied to all parties provided to CenturyLink by the Customer and its entities.
SLA 17	*The CenturyLink support center shall notify the ISP and ICC within 30 minutes of discovering an event or outage that may impact 9-1-1 services. CenturyLink's NG9-1-1 solution service assurance strategy places the highest emphasis on service restoration. Communication will be supplied to all parties provided to CenturyLink by the Customer and its entities.*
SLA 18	*CenturyLink repair procedures emphasize quality service for responsiveness and reliability to all the 9-1-1 centers. Our escalation policies and procedures allow for escalation to be invoked at any time deemed necessary by the customer, by the CenturyLink 9-1-1 Field Technicians, or by CenturyLink in-house Tier 2 technical support. CenturyLink will track all escalations via the CenturyLink repair web portal. Each escalation will be tracked during the entire duration of the repair. CenturyLink agrees to begin Tier 1 support within 15 minutes of identifying a service affecting event. CenturyLink agrees to begin Tier 2 support within (2) hours of identifying a service affecting event and Tier 3 support with (4) hour or upon Center request. Under our normal protocol, for all Severity Level 1 & 2 (Critical and Major is your example) issues reported, we provide an immediate response, and will ensure the initiation of corrective action no longer than 30 minutes from time of notification. Within two (2) hours of any Severity Level 1 & 2 report, if the problem has not been corrected, we begin the escalation process and ensure an onsite dispatch, if required, has been affected.*

The SLA provided above is from the State of Nebraska PSC NG911 contract. The statements identified in purple in the table above, are Lumen's written response to the use cases in the RFP based upon their understanding of the requirement, compliance with the use case, and define the service level objectives that they would provide to meet the NG911 service level requirements.

There are 23 specific service level objective use cases in the RFP, which are also part of the NG911 Contract. Of those 23 SLA provisions Lumen failed to meet their compliance threshold that they defined for 8 of the 23 objectives.

Lumen SLA violations:

- SLA 1 – Lumen did not have multiple termination locations that could 100% of the load in the event of a location failure. Once Grand Island, NE failed, OSP traffic (except for a few) was unable to be delivered to the PSAP.
- SLA 1 – Functional components supplied by Lumen as part of the project did not generate alarms specifically for the critical 911 services.
- SLA 10 – MTTR calculations that were completed, should have included a consideration for the length of time to gather approvals, and access to the railroad to complete the restoration of the fiber transport.
- SLA 10 – MTTR defined characteristics, and the calculation was not used to prioritize 911 recovery, and allowed a lack of coordination of priority during recovery and increased the lack of clarity among the PSC and the PSAPs.
- SLA 11 – The SLA response discusses CenturyLink MTTR is based on uninterrupted, reliable 911 calls. And that the calculation is based on the time the outage begins until normal operations have

been restored. This indicates that Lumen / CenturyLink understand that this contract is for an end-to-end system. While the ESInet and NGCS did not fail, the system as contracted most certainly did fail.

- SLA 12 – The overall reliability stated by Lumen and agreed to by contract was 99.999%. This is just over 5 minutes a year. Therefore, in this 10 hour and 27-minute outage the SLA provided on Lumens terms exceeded the annual SLA outage time by roughly 120 years.
- SLA 13 – States that the 99.999% is end-to-end NG911 service level and does not remove the Ingress and OSP aggregation from the equation.
- SLA 15 – States that the CenturyLink support center would notify the ISP and ICC within 30 minutes of an event or outage that may impact 9-1-1 services. The PSC was not notified when the August 30 fiber cut happened and were not notified directly by CenturyLink until after several PSAPs reported issues to the PSC.
- SLA 17 – Similar to SLA 15, the PSC did not know of any potential issue to the 911 system after the August 30 fiber cut and was not notified quickly enough during the August 31 fiber cut that services were incapable of delivering 911 calls.
- SLA 18 – The criticality of the outage was not defined and defined tiers of support, communications and coordination discussed by Lumen do not appear to have been followed as described.

Overall, Lumen lacked contingency plans that encompassed all of the service elements (Ingress, Core and Egress) which were tied to the SLA; that could have minimized the situation. To evaluate testimony that suggests the outage was an ingress failure and outside of the Lumen jurisdiction, which is covered by the NG911 contract for statewide services, is unacceptable. NG911 standards and the State of Nebraska contract call for Lumen to be the 911 System Service Provider (SSP) for 911. The State of Nebraska trusted Lumen with this endeavor and specified that a single authority (Lumen) would be able to work with the PSAPs to connect their 911 to the core. It was Lumen who arranged for the aggregation points of interconnection and worked with the OSPs to connect. Failure of the path from the aggregation points to the core is a Lumen outage, not an E911 outage. In addition, as mentioned earlier the MTTR calculations should include railroad access to Lumen facilities as they became a barrier to recovery efforts.

2.3 People and Process

The review of testimony reveals systemic issues within Lumen's organization regarding personnel, business processes, and system management, all of which contributed to the 911 service failures. The following areas require significant improvement to ensure the technology delivers the reliability expected by the 911 community.

1. **Project Scope:** The statewide NG911 contract is for end-to-end service including Ingress, Core and Egress. Lumen has provided communication in the form of answering questions and through testimony that seems to separate the OSP Ingress from the contracted requirements. As a matter of ensuring their implementation of a NENA STA-010 standard service, Ingress is the most critical functionality for the system. Their contract for Statewide NG911 services specifically calls for a public safety grade system, which does not change the existing functionality provided with the old system being replaced. Lumen stated that if sites had not moved to their ESInet the PSAPs would not have experienced an outage. The NG911 requirements state that NG911 should not

decrease the reliability and resiliency of the existing 911 system. The statement by Lumen in the context of the failure indicates that Lumen did not implement a system that is comparable to the Legacy 911 system.

2. **Risk Management:** Lumen has not adequately assessed risks to their system as implemented. A risk assessment if completed would have identified the single Grand Island, NE site for aggregation of 911 calls to the ESInet as a risk, and the State of Nebraska may have been aware that Lumen needed additional scope, budget and or time to build the Ingress as the RFP required. Risks should have triggered a contingency / alternative plan. Changes can also introduce new risks, so as the recovery was going on Lumen should have continued assessing risks until the system was fully restored.

3. **Configuration Management:** While Lumen has configuration control processes for E911 telecommunications services and NG911, they are not effectively integrated, impacting both the E911 service and NG911 statewide system. This fragmented method of operations and administration creates additional internal issues that contribute to a self-inflicted problem with troubleshooting, alerting and notification. Lumen has indicated they are conducting a review of their configuration management information and will leverage the review within project management to identify areas needing improvement.

4. **Business Process and NG911 Standards:** Gaps in Lumen's internal processes caused more confusion between internal areas of their converged business units (see #3 above). A review of each business unit process and how they integrate together to deliver NG911 is needed for all defined processes and products

5. **Requirements Management:** Lumen needs a thorough analysis of customer needs and objectives to ensure system requirements are well understood, well-defined, and compliant with regulations. All stakeholders must agree on changes impacting project cost, schedule, or performance. Performance requirements must satisfy user needs, and operations and maintenance requirements must be fully specified.

6. **Detailed Design:** Lumen's detailed design lacks sufficient information to reflect how 911 services are implemented. Lumen has created a walled garden between local and national services which conflicts with a statewide NG911 contract. In this instance they make the claim that their E911 and NG911 service were not out. However, if a call cannot get through their ingress point of interconnection when a caller dials – their service is out. They are contractually responsible for delivering the call to PSAP. By stating that the ingress failed yet their system was operational is absurd.

7. **Continuity of Operations:** Lumen must define how 911 services will be maintained regardless of incident magnitude, adhering to the "five nines" requirement as a rule, not an aspiration. This includes ingress, core, and egress without hesitation.

Section 3 Recommended Actions and Remedies (Conclusions)

This section summarizes the recommended actions and remedies based upon the 911 Authority teams' analysis. They include:

1. Implement NG911 network standards
2. Conduct Lumen Audit of 911 Services
    a. Risk Assessment
    b. Configuration Management
    c. Continuity of Operations
    d. Disaster Recovery
3. Improve Notification and Communication during incidents

3.1 Implement NG911 standards

The investigation into Lumen's 911 service outages reveals a critical need for the company to reassess its entire approach to designing, engineering, and implementing 911 services. Lumen cannot continue to ignore the ingress side of the NG911 system as outside of their authority.

NG911 is an integrated service that utilizes many siloed products across multiple business units and vendors. This can create friction between business units and may create confusion for customers and problems for broad, complex services such as NG911. Lumen has indicated that they are working on a remediation process to document all services, update diagrams and assess their products and services that contain 911.

Upon review, alarms that were necessary for 911 operation were not in place. The alarms received were for network transport outages, but Lumen did not receive notification that critical 911 circuits themselves were out.

The "five nines" standard (high availability) for 911 service is required by the Statewide NG911 contract. High Availability is not an arbitrary goal; it is a non-negotiable requirement to ensure public safety. High Availability is measured from end-to-end, not on each product boundary. Furthermore, the NG911 contract contains an SLA that makes five-nines a mandatory threshold without regard to ingress core and egress.

To rectify this situation, Lumen must undergo a comprehensive overhaul of its NG911 national product(s) and concentrate on the 911 service infrastructure and operational procedures between business units. This includes a thorough reassessment of network design, prioritizing redundancy, and resilience, investing in advanced monitoring and alarm systems, and adopting a proactive maintenance strategy. Furthermore, a cultural shift is needed within the organization to prioritize 911 service as a mission-critical function, demanding the highest level of attention and investment. Siloed business products and processes cannot cause customer issues.

Lumen must evaluate its ability to provide 911 service across internal boundaries from the telco side to the NG911 national team. NENA standards that are followed by the NG911 team seem to be marginalized by the telco groups in favor of their siloed polices with respect to alert and notification, outage management, response, and recovery. This entails applying the most current NG911 standards to every component of their network and service, encompassing multiple paths, multiple vendors, additional

network support tools, additional electrical power sources, and modified connections to both OSPs and PSAPs to ensure uninterrupted operation.

Lumen's inability to provide reliable 911 service even if they suggest ingress failures are not a part of the NG911 system; puts lives at risk and erodes public trust.

3.2 Conduct Audit of Lumen 911 Services

Lumen certifies its compliance with the FCC's 911 audit requirements on an annual basis. This audit does provide some level of assurance that the service they are delivering meets a minimum requirement. Commonly the audit process does not uncover individual component issues or directly assess the service and system within the boundaries of industry standards. Based on a review of the outage it is also unlikely that the service meets many of the requirements established in 47 CFR part 9 as follows.

47 CFR 9.19(a)(10) *Provision of reliable 911 service. All covered 911 service providers shall take reasonable measures to provide reliable 911 service with respect to circuit diversity, central-office backup power, and diverse network monitoring. Performance of the elements of the certification set forth in paragraphs (c)(1)(I), (c)(2)(i), and (c)(3)(i) of this section shall be deemed to satisfy the requirements of this paragraph. If a covered 911 service provider cannot certify that it has performed a given element, the Commission may determine that such provider nevertheless satisfies the requirements of this paragraph based upon a showing in accordance with paragraph (c) of this section that it is taking alternative measures with respect to that element that are reasonably sufficient to mitigate the risk of failure, or that one or more certification elements are not applicable to its network.*

Annual reliability certification. One year after the initial reliability certification described in paragraph (d)(1) of this section and every year thereafter, a certifying official of every covered 911 service provider shall submit a certification to the Commission as follows.
(1) Circuit auditing.

(i) A covered 911 service provider shall certify whether it has, within the past year:
(A) Conducted diversity audits of critical 911 circuits or equivalent data paths to any PSAP served.
(B) Tagged such critical 911 circuits to reduce the probability of inadvertent loss of diversity in the period between audits; and
I Eliminated all single points of failure in critical 911 circuits or equivalent data paths serving each PSAP.
(ii) If a Covered 911 Service Provider does not conform with all of the elements in paragraph I(1)(i) of this section with respect to the 911 service provided to one or more PSAPs, it must certify with respect to each such PSAP:
(A) Whether it has taken alternative measures to mitigate the risk of critical 911 circuits that are not physically diverse or is taking steps to remediate any issues that it has identified with respect to 911 service to the PSAP, in which case it shall provide a brief explanation of such alternative measures or such remediation steps, the date by which it anticipates such remediation will be completed, and why it believes those measures are reasonably sufficient to mitigate such risk; or
(B) Whether it believes that one or more of the requirements of this paragraph are not applicable to its network, in which case it shall provide a brief explanation of why it believes any such requirement does not apply.

(3) Network monitoring.

(i) A covered 911 service provider shall certify whether it has, within the past year:
(A) Conducted diversity audits of the aggregation points that it uses to gather network monitoring data in each 911 service area.
(B) Conducted diversity audits of monitoring links between aggregation points and NOCs for each 911 service area in which it operates; and
I Implemented physically diverse aggregation points for network monitoring data in each 911 service area and physically diverse monitoring links from such aggregation points to at least one NOC.

> *(ii) If a Covered 911 Service Provider does not conform with all of the elements in paragraph I(3)(i) of this section, it must certify with respect to each such 911 Service Area:*
> *(A) Whether it has taken alternative measures to mitigate the risk of network monitoring facilities that are not physically diverse or is taking steps to remediate any issues that it has identified with respect to diverse network monitoring in that 911 service area, in which case it shall provide a brief explanation of such alternative measures or such remediation steps, the date by which it anticipates such remediation will be completed, and why it believes those measures are reasonably sufficient to mitigate such risk; or*
> *(B) Whether it believes that one or more of the requirements of this paragraph are not applicable to its network, in which case it shall provide a brief explanation of why it believes any such requirement does not apply.*

While Lumen self-assures the FCC through this process, Lumen should consider performing an audit of its entire NG911 solution by an independent resource. An Independent Validation and Verification (IVV) would find the gaps in the system operationally and technically. An IVV may identify gaps that exist with the individual product lines that are integrated into the NG911 contract for services. This type of verification would help Lumen be better prepared to support the State of Nebraska. Lumen should also conduct a full assessment of the Administration, Operation and Technical aspects of the NG911 service and any system that is being used to deliver 911 from ingress, to core, to egress. An audit of this nature will ensure compliance with the diversity and redundancy requirements from the standards.

3.3 Improve Notifications and Communications During Incidents

Lumen's communication and notification procedures were deficient, failing to adequately inform the PSC, OSPs, and PSAPs that a single fiber cut caused the NG911 system to be single threaded.

During the incident Lumen engaged several internal teams for response and recovery, but those teams appear to have had no knowledge of the contract arrangement and SLA thresholds in the State of Nebraska contract for NG911 service. Without that knowledge the response and recovery focused on getting the fiber fixed but did not look at the contract to try to work out a contingency / or alternative for 911. This lack of focus on the overall governance and administration of critical 911 services should not happen. The current "all hands-on deck" approach, while indicative of a desire to resolve the issue, reveals a lack of structured response mechanisms.

Lumen must adopt a proactive stance towards risk management, ensuring that all potential failure points are identified and addressed through robust contingency plans that include any NG911 contract elements and SLAs. This includes not only technical redundancies but also clear operational procedures and communication protocols to minimize downtime and ensure the uninterrupted flow of critical 911 services.

3.4 Violation Analysis

The figure below defines the boundary expected for NG911 System Service Providers. An NG911 SSP who implements a large statewide system such as the one that Lumen has in Nebraska must include the Ingress Core and Egress in the service platform. While some of the component pieces are not directly under Lumen control, it is their responsibility as contracted to the State. Lumen has testified that Ingress is not in their control, however the Ingress facilities and systems are an important component to how the network operates upstream.

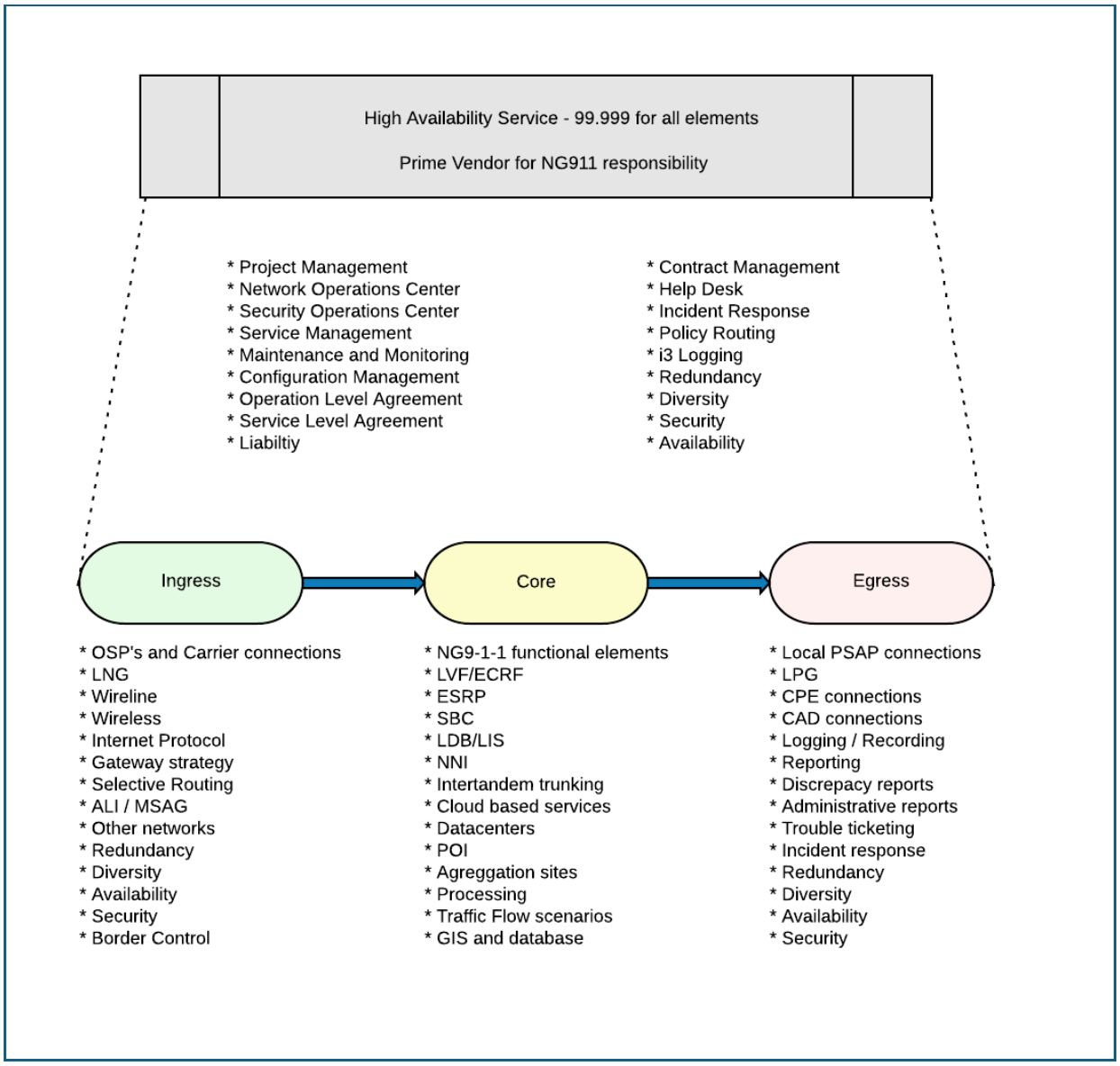

Figure 1: NG911 System Service Provider responsibilities

The NGCS core and Egress rely upon messaging, data, and transactional information to perform to the NENA STA-010.2[4] NG911 Standard. As a matter of convenience Lumen has testified that their ESInet and NGCS were unharmed by the outage. While this is technically true, the reason that it was spared from the outage was that Lumen implemented a system that has boundaries only at the ESInet. The NG911 Standard identifies how the LNG and LSRGs drive traffic to the NGCS core. To separate their system in this manner is unacceptable.

[4] The RFP used the most current NENA STA-010.2 standard at that time, for clarification the most current standard is now NENA STA-010.3.

Appendix A Documentation Citations

- 1-4-24 PSC Hearing
    a. Transcript of 1/4/2024 hearing
- 2024-03 911-075 PI-248 Amended Protective Order
    a. Protective Order
- Exhibit 31-52
    a. Exhibits provided by Lumen
- Exhibit List & Exhibit 1-30
    a. Exhibits provided by Lumen
- Lumen Contract
    a. Lumen NG911 Contract
- Lumen NDA
    a. Lumen NDA
- Lumen – Business Continuity Overview
    a. Lumen Business Continuity plan
- Lumen – SLA
    a. Lumen Service Level Agreement for NG911

- NOTHING FOLLOWS -

EXHIBIT
58 (911-075)

BEFORE THE NEBRASKA PUBLIC SERVICE COMMISSION

In the Matter of the Nebraska Public Service Commission, on its own motion, conducting an investigation into the 911 service outage that began on August 31, 2023 in areas of Nebraska served by Lumen and its affiliates.	)	Application No. 911-075/ PI-248
In the Matter of the Nebraska Public Service Commission, on its own motion, conducting an investigation into 911 service outages occurring in areas of Nebraska served by Lumen and its affiliates.	)	Application No. 911-077/ C-5581/PI-252
	)	WRITTEN TESTIMONY OF BRIAN ROSEN

November 5 , 2024:

PSC Docket 911-075 / PI-248 Pre-filed testimony of Brian Rosen

1. What is your name and occupation?

   A: Brian Rosen. I am a systems architect and consultant.

2. Did you provide a curriculum vitae and does that document summarize your experience working in the telecommunications industry and is that marked as exhibit 12 on docket 911-077/C-5581/PI-252, and exhibit 61 on docket 911-075/ PI 258 and is the information it contains true and complete to the best of your knowledge?

   A: Yes.

3. What is your role with the 911, Authority, LLC?

   A: I am a consultant and subcontractor to 911 Authority, LLC.

4. What does 911 Authority, LLC do?

   A: We provide consulting services to states and local governments on 911 systems.

5. As part of a contract between the Nebraska Public Service Commission and 911 Authority, LLC were you asked to provide an expert opinion regarding service interruptions that occurred in Nebraska on August 31, 2023, April 17, 2024, and July 9, 2024?

   A: Yes

6. Are your findings contained in two reports one being Exhibit 57 under docket 911-075/PI-248 and Exhibit 8 on Docket 911-077/C-5581/PI-252?

   A: Yes

7. Please explain your understanding of the part of the Lumen system that failed in all of the events at issue here:

   A: Lumen has a “Legacy Network Gateway” which converts legacy 911 signaling to NG911 signaling (also known as i3 signaling). A number of legacy telephone switches connect to a selective router in Nebraska which operates as an aggregation switch, aggregating the 911 calls from all the local switches. There is a network that connects the aggregation switch to the LNG. This network, which uses SS7 signaling, has failed, in different ways for each outage, which interrupts the 911 calls from the aggregation switch to the LNG.

8. Please explain what a 99.999% (or five nines) system means?

A: It represents the percent of the time a system is available to do the job it is intended to do. Five nines systems are only allowed to be down .001% of the time, which is about 5 minutes a year. While we can measure actual availability, typically, we calculate projected availability, which is a product of Mean Time Between Failures and Mean Time to Repair a failure.

9. Please explain how we determine if a system meets a 99.999% availability standard

   A: While we can measure actual availability, typically, we calculate projected availability, which is a product of Mean Time Between Failures (MTBF) and Mean Time to Repair a failure (MTTR). We accumulate the MTBF of all the components of the system, and the expected best case and worst case repair time for each component. If a system calculation doesn't meet five nines, we add additional redundancy and/or improve the MTBF or MTTR to achieve our needed availability

10. Is the Lumen 911 network, designed to meet that standard? Why or why not?

    A: Not in my opinion. Based on my understanding of typical MTBF and MTTR values of the systems used, and based on the actual results, the system is unable to meet a five 9s standard. While most of the components have a reasonably high Mean Time Between failures, it appears to me there is an exceptionally low level of redundancy. In a typical design, involving an aggregation switch, LNG and the network that connects them in a 911 system, there would be two geographically diverse sites, each containing at least 2 instances of every component, and they would be connected by a total of at least four separate network connections or links, two per site. And given the observed MTBF and MTTR of these events, when considered in total, I think that any real calculation would show that even that would not be sufficient, especially considering the issues raised by these events.

11. What caused the service interruption that occurred on August 31, 2023?

    A: Two fiber cuts in a ring service caused a failure in a SS7 network, which was the only connection between the aggregation switch and the Legacy Network Gateway, which resulting in 911 calls traversing that connection to fail.

12. What caused the service interruption on April 17, 2024?

    A: A single fiber cut in what was supposed to be a ring connection caused a failure of the same part of the 911 system which was the connection between the aggregation switch and the Legacy Network Gateway, albeit in a different part of that connection. It turned out, according to Lumen's own response, that a failure over a decade ago somewhere else on the ring was never rectified, and thus the single failure in this event caused the connection to fail, which again interrupted calls between the aggregation switch and the Legacy Network Gateway. Normally it would take two fiber cuts to sever the connection, but because the 11 year old cut

was never fixed, at least for this network, a single fiber cut caused the network to fail. In this failure, it wasn't the SS7 signaling that failed, but the trunk connections that actually carry the voice traffic that were severed. The result was the same, 911 calls going between the aggregation switch and the Legacy Network Gateway failed.

13. What caused the service interruption on July 9, 2024?

    A: A power failure in a Houston facility caused yet another failure in the same SS7 network, again in a different part of the network than the other incidents. While normally, that part of the SS7 network has components in at least two geographically diverse sites, all four connections were routed through the single Houston site.

14. For all of these service interruptions at least one of the triggering events, occurred outside the state of Nebraska, how and why do out of state events, impact different areas within Nebraska and not the entire state?

    A: Lumen chose to use a national network to connect the aggregation switch to the Legacy Network Gateway. That network is a large ring which traverses many states. Failures along the path of the ring can affect calls connecting from the aggregation switch in Nebraska to the LNG in Chicago, In the case of the July 9 incident, the ring itself was not affected, but the switches that connect the Signaling Transfer Points in the network were all routed through Houston, which meant a failure in Texas interfered with calls in Nebraska and other states.

15. The report also outlines root causes for the three service interruptions, please describe what causational commonality each service interruptions share?

    A: A surprising lack of redundancy throughout. The aggregation switch (which is not itself redundant) is connected to a single LNG, through a single network. Any failure causes a complete break in the 911 system serving the subscriber switches connected to the aggregation switch. While each incident shows a different lack of redundancy, the pattern is quite clear, and alarming. There is no way rigorous analysis of this network could ever have a five 9s availability, and that availability requirement is on the whole 911 system and not just this piece.

    Furthermore, there is a total lack of auditing for diversity. 911 circuits are supposed to be audited periodically and Lumen appears to believe that since the fiber path was not solely dedicated to 911 that it doesn't have to audit it. I think that is wrong. Compounding this, they apparently never test failover, which is a fundamental tool to assure that when you need the redundant elements, they will be available to take over.

16. How does the service interruption that occurred on August 31, 2023, demonstrate that commonality?

    A: Failure of a single network, the fiber ring, caused failures for all calls sent between the aggregation switch and the LNG. There was only the one ring that connected the single aggregation switch to the single LNG. None of those should have been single points of failure.

17. How does the service interruption that occurred on April 17, 2024, demonstrate that commonality?

    A: The single fiber cut brought down a different part of the network that connected the single aggregation switch to the single LNG. Not only was the ring collapsed for over a decade, but it was the only connection for all the trunks. The lack of auditing and failover allowed the collapsed ring to be undetected prior to the failure.

18. How does the service interruption that occurred on July 9, 2024, demonstrate that commonality?

    A failure of a single site brought down a different part of the SS7 network that connected the single aggregation switch to the single LNG. The routes for all four SS7 signaling links ran through a single site. Lack of auditing and lack of failover testing allowed this situation to persist for a long time.

19. In your opinion what changes to Lumen's network would need to be in place to prevent that causational commonality from reoccurring?

    A: Lumen must implement true five 9s availability across the entire 911 system it provides to Nebraska, from the egress of a subscriber switch to the ingress of a PSAP. It must complete a thorough reassessment of network design, prioritizing redundancy, and resilience, investing in advanced monitoring and alarm systems, and adopting a proactive maintenance strategy.

20. Would those same changes achieve 5 nines? Why or why not?

    A: If implemented conscientiously, I believe they would. If the system was architected for five 9s from subscriber switch egress to PSAP ingress and implemented with care, I believe Nebraska could indeed have a system that was available 99.999% of the time.

21. In your opinion, what changes in Lumen's operating procedures are needed, beyond the changes in the network, to be achieved to prevent these kinds of events from happening?

    A: If Lumen did architect the 911 system to meet a 5 nines availability standard, and it implemented the system to that design. it then has to audit the

implementation, to assure Nebraska that the resulting 911 system will meet its SLAs to the State, and FCC regulations. The audit has to be rigorous, and cover the entirety of the 911 system.

And, it has to greatly improve its monitoring and recovery processes. We were struck by the realization that during all of these events, the Lumen 911 staff made no effort to work around the problem; they just waited until the network came back up. They had no contingency planning, no ability to make any kind of alternate arrangements. They just waited until the SS7 network was restored. Lumen must treat 911 as mission critical, and not just another revenue source.

22. Please explain some more about audits. What audits is Lumen not doing which you think they should be doing?

A: Every redundant path has to be audited to assure that it is, indeed redundant, and conforms to the design that was predicted to meet 5 nines. The audit must be at every level: signaling, circuit and physical. The audits have to be completed regularly, as per the FCC regulations.

Exhibit 59 may be viewed under docket 911-077 marked as Exhibit 10.

EXHIBIT
60 (911-075)

Brian Rosen
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(724) 382-1051

Background Summary

Consultant in deployment of Next Generation 9-1-1. Consultant in Video Relay Service (VRS). Primary standards author, system architecture and leadership of Next Generation 9-1-1 project. Forty-year history of bringing groundbreaking technology advances to market. Seasoned entrepreneur and systems architect in computer systems, networking, medical imaging and other disciplines. Aggressive new technology thought leader. Able to rapidly master complex new problems and lead teams to achieve aggressive goals. Subject Matter expert in public safety systems, concentrating on the 9-1-1 system and Video Relay Service. Experienced standards participant with strong leadership credentials.

Work History

2018 – Present Brian Rosen Technologies LLC, Principal. Consultant to states and local governments on deployment of Next Generation 9-1-1. Assist in creating Request For Proposals, evaluation of responses, selection of vendors and monitoring progress. Technical evaluations of failures. Consultant to company's and government on Video Relay Service which serves the deaf community. Currently co-chair of the sipcore and vcon working groups in IETF, and the i3 architecture working group in NENA. Recent projects include:

- Bond Communications: Chief Architect of a new Video Relay Service. Assist founder to specify and implement a new VRS system with deaf children and their families as initial target customers.
- State of Nebraska: Assist in evaluating multiple failures of the 911 system and recommending mitigation measures
- Washington State: expert witness to the State Attorney General Public Counsel regarding failures of the 911 system
- Mitre Corporation: Advise Mitre and FCC on issues in the Video Relay Service.

2005 – 2018. Neustar Inc, Sterling VA. Various Positions, most recently Fellow. Subject Matter Expert for 9-1-1 and other public safety efforts as well as Neustar's participation in Deaf/Hard of Hearing services. Systems Architect for a number of ENUM based services including the iTRS Directory, a highly reliable/redundant call routing database provided under contract to the FCC for the deaf community. Direct contact with FCC staff for deaf communications services. Ran a team building external tests to assure Neustar services remain available to customers. Assisted other teams in architecture, technology direction and standards compliance. Active participant in standards activities in IETF and the National Emergency Number Association.

2004 – 2005 Founder and President, Emergicom, Mars, PA
This was a new startup working on upgrading public safety communications systems including the 9-1-1 system and responder communications networks which was never funded.

1999 – 2004. Marconi (formerly FORE Systems), Warrendale, PA. Various positions, most recently Vice President, Technology Introduction. Reported to Tim Dwight, Chief Technology Officer, Broadband Routing and Switching Division. Marconi was an international leader in telecommunications networking products, with particular strengths in optical, access and broadband routing/switching. Duties include Voice/Video Over IP product direction, architecture, new product innovation and standards activities. I also worked on emergency call (9-1-1) for VoIP. Was a significant contributor to the VoIP efforts at the Internet Engineering Task Force (IETF, the Internet standards body) and NENA, the National Emergency Number Association.

I was the leader of a small team that developed an entirely new telepresence product line for Marconi. Called "ViPr" (for "Virtual Presence"), this product is generally acknowledged as a breakthrough communications tool for geographically dispersed teams. I conceived the product, defined its architecture, recruited the team, and lead the engineering effort through general release to customers.

As an individual contributor, I worked on the area of multimedia communications on data networks as well as security for data networks. I did architecture work on several of Marconi's telecom products, and was frequently called upon to make presentations to customers on our work in these areas, as well as speak in many industry events.

1994-1998, NOMOS Corporation, Sewickly, PA. Various positions, including Director of Technology Assessment and Vice President of Product Implementation. Reported to Mark Carol, President and Founder, or Gil Peterson, COO. NOMOS manufactures complex computer based systems for treatment planning and delivery of radiation therapy. The products I was involved in are presently the standard of care for certain forms of cancers of the brain and other organs, using Intensity Modulation Radiation Therapy, pioneered by NOMOS. I recruited and lead the initial development team that developed a planning tool as well as the electronics and software for the delivery device and served as the architect of it's main product from its inception through initial customer release. I later started a project that became the company's second product line that uses ultrasound to do very accurate soft tissue localization. At NOMOS I created the initial software development process and documentation systems that easily achieved FDA clearance. I managed and staffed most of the company's administrative, manufacturing and technical support teams from 1994-5. During that time I was also responsible for creating the company's quality and safety programs.

1992- 1994, Cognos-centi Corporation, Pittsburgh, PA. President. Founded this consulting company which did the initial research and conceptualization for radiation oncology systems under contract to Medical Equipment Development Corporation. In early 1994, MEDCO acquired Cognos-centi and became NOMOS Corporation.

1989-1992, Mars Microsystems, Wexford, PA. President and Founder. Mars designed Sun compatible workstations for far-east manufacturers. Its major product was the Mariner 4i, an innovative workstation that had both SPARC and x86 processors and was 100% compatible with all Solaris and Windows applications. All functions except marketing and sales reported to me. I directed cross-functional teams with Mars engineers, on-site Taiwanese nationals and engineers in Taiwan, with support functions provided by the corporate headquarters staff. I served as the systems architect for the product.

1985-1989, MegaScan Corporation, President and Founder. MegaScan was a venture capital funded startup that developed ultra-high resolution monitors and display controllers. MegaScan's initial product was a 4096 x 3300 resolution, CRT based, 300 dpi, black-and-white display system, used for pre-press automation/page layout. Its major success was a 2560x2048, 12 bit grayscale system which was the first display acceptable by radiologists for diagnosis of chest X-Rays. These products, with nearly identical specifications, are still in production for radiology PACS (Picture Archiving and Communications Systems) in use hospitals worldwide.

1978-1995, Perq Systems (originally, Three Rivers Computer Corp), Founder, Vice President, Engineering and Vice President, Advanced Development. Perq delivered the first engineering workstation, predating Sun Microsystems and all competitors. I was the systems architect and engineering manager for the entire product line that was based on my work at Xerox PARC.

1976-1978, Xerox Palo Alto Development Center, Palo Alto, CA, Member of Technical Staff. Design engineer on the "Dolphin" the middle range processor that was part of Xerox's STAR workstation effort. I also designed the memory system for the "Dorado", the high-end workstation.

1970-1976, Carnegie-Mellon University, Computer Science Department Engineering Laboratory, Staff Engineer. Designed research equipment for artificial intelligence. My major project was a calligraphic computer graphics system.

Industry Organizations

2003-present co-chair of National Emergency Number Association (NENA) i3 Architecture working group and active contributor to 5 other work groups. Technical Editor of NENA STA-010.2, the base NG9-1-1 technical standard. Major contributor to APCO/NENA Emergency Incident Data Document work. Also significant contributor to NG GIS, NG PSAP and other NG9-1-1 standards work.

2017-present co-chair of Internet Engineering Task Force (IETF) sipcore working group

2005-2016 co-chair of Internet Engineering Task Force (IETF) p2psip, siprec and paws working groups. Author/Co-Author of ~17 RFCs

2011-2012 editor of Database-to-Database Synchronization Interoperability Specification, Whitespace Database Administrator's Group
2010-2013 Committee member of various CSRIC groups. Co-chair of WG2, SG2
2004-2009, co-editor of NRIC VII Focus Groups 1b and 1d reports
2001-2003, co-chair of Internet Engineering Task Force SIP Working Group.
2000-2002, organizer of Megaco Interop Events, held at the University of New Hampshire
2000-2002, co-chair of Technical Advisory Committee (TAC) of the International Softswitch Consortium
2000-2001, interim chair, Interoperability Working Group, Multiservice Switching Forum
1999-2002, co-author and IETF editor of RFC3015, Megaco Protocol
1998-2000, contributor to VoATM and Security working groups of the ATM Forum

Volunteer Activities

1997-Present, National Armorer, USA Fencing
1993-2005, Board Member, Pine Township Zoning Hearing Board
1992-1995, Assistant Scoutmaster, Troop 344, Wexford

Personal

Married, 4 children 5 grandchildren.
Leisure activities include gardening, woodworking, most water sports and travel.

“Exhibit 61” withheld pursuant
to protective order.

BEFORE THE NEBRASKA PUBLIC SERVICE COMMISSION

In the Matter of the Nebraska Public Service Commission, on its own motion, conducting an investigation into the 911 service Outage that began on August 31, 2023, in areas of Nebraska served by Lumen and its affiliates.	)))))	Application No. 911-075/PI-248

CENTURYLINK COMMUNICATIONS, LLC d/b/a LUMEN TECHNOLOGIES GROUP'S RESPONSES TO COMMISSION STAFF'S SECOND SET OF DATA REQUESTS

COMES NOW CenturyLink Communications, LLC d/b/a Lumen Technologies Group, (hereafter, "Lumen"), and for its responses to the Nebraska Public Service Commission Staff's Second Set of Data Requests in the above-captioned matter, states as follows:

PRELIMINARY STATEMENT

As stated in Lumen's response to the Commission's First Set of Data Requests, the responses provided herein are based upon information presently available and specifically known by Lumen. Further discovery and investigation may disclose additional facts and add meaning to known facts, all of which may lead to additions to, changes in, and/or variations from, the answers set forth herein. The following answers are given without prejudice to Lumen's right to produce evidence of any subsequently discovered fact or facts. Accordingly, Lumen reserves the right to supplement any and all responses herein if additional information become known.

All responses provided herein are made without waiving any and all objections to relevancy, privilege, confidentiality, and admissibility of evidence at any additional evidentiary hearing or further proceeding.

OBJECTION TO DEFINITIONS:

Lumen objects to the definitions set forth in the Second Set of Data Requests, including but not limited to, the following:

- Definition No. 1: the definition of "Lumen" incorrectly and improperly groups together *all* "parents, subsidiaries, and affiliates" and "former and present officers, directors, employees, representatives, agents, and attorneys"; CenturyLink Communications, LLC d/b/a Lumen Technologies Group is the entity involved in the Outage currently being investigated, and, as noted above, is the entity responding to this Second Set of Data Requests;
- Definition No 8: the definition of "Outage" to the extent it does not comport with E-911 industry standards and/or statutory definitions; and
- Definition No. 9: the definition of "August 31, 2023 Outage" incorrectly assumes the Outage being investigated occurred on the "Lumen 911 System" in Nebraska, because, as defined in the Second Set of Data Requests, the term "Lumen 911 System" means the Legacy 911 System and the NG-911 System. As set forth in prior response to data requests, written testimony, and testimony at the January 4, 2024 hearing in the above-captioned docket, The E911 and NG-911 networks were working and were not impacted by the transport outages being investigated by the Commission under this docket.

LUMEN'S DEFINITIONS

"Outage Period" referred to herein means August 31, 2023, to September 1, 2023.

"Fiber Cut No. 1" referred to herein means the August 30, 2023 cable that was cut by a third party contractor in Minnesota, through no fault of Lumen.

"Fiber Cut No. 2" referred to herein means the August 31, 2023 cable that was cut by a third party contractor in Omaha, Nebraska, through no fault of Lumen.

RESPONSES TO DATA REQUESTS

REQUEST NO. 1: The testimony seems to indicate that the Grand Island equipment was a switch that was operating as a selective router and as an aggregation switch. Please explain what is meant by an "aggregation switch" and how that differs from a selective router with trunk-to-trunk routing to another switch.

RESPONSE TO REQUEST NO. 1: The Grand Island switch referenced was operating as a traditional E-911 Selective router for PSAPs that had not yet migrated to NG-911. In this capacity the originating Office providers provide trunks to the E-911 Selective Router and the E-911 Selective Router then does a routing lookup and sends the call to a dedicated 911 trunk to PSAP's that have not yet cut to the NG-911 Solution.

The Grand Island switch also acts as an aggregation switch for 911 traffic destined for the NG-911 network; for PSAPs migrated to the NG-911 network, the switch does a routing lookup and determines the call is destined to a PSAP served by the NG911 network and forwards the call over TDM ES trunks to the LNG that then converts the traffic to SIP to forward to the NG911 network.

REQUEST NO. 2: The diagram shows Lumen "LNGs". Is this actually an LSRG and just mislabeled? If not, please explain how calls are handled from the origination switch to the LNG and what LNG stands for.

RESPONSE TO REQUEST NO. 2: Lumen objects to this request because it fails to specifically identify what "diagram" is being referred to and the Definitions section of this Second Set of Data Requests does not define "diagram". Subject to and without waiving said objection, Lumen's understanding is that OSP providers will build 911 ES trunks to the LNG and the LNG will convert TDM to SIP, or OSP will build or have ES trunks to the aggregation point and the aggregation point will then forward the traffic to the LNG over ES trunks where the traffic will then be converted to SIP. LNG stands for "Legacy Network Gateways".

REQUEST NO. 3: Were both SS7 signaling and trunk connections lost in the incident? Why or why not?

RESPONSE TO REQUEST NO. 3: Lumen objects to this request because it fails to specifically identify what "trunk connection" is being referred to and the Definitions section of this Second Set of Data Requests does not define "trunk connection". Subject to and without waiving said objection, this incident was two separate fiber cuts along two diverse paths to the NG911 network, referred to by Lumen as Fiber Cut No. 1 and Fiber Cut No. 2. Assuming this request refers to the SS7 signaling network and the trunks between the OSP and the selective router or the selective router and the PSAP, then Lumen's response is no, the trunks were not lost in the incident when the SS7 network was lost. SS7 signaling was impacted due to two diverse A-Links being down due to the separate fiber cuts, No. 1 and No. 2. These are the SS7 "connections" that caused the SS7 impact. The voice or "bearer"

trunks configured as SS7 remained up and in service.

REQUEST NO. 4: Was the network configuration that allowed for the failure in this incident, a transition step, or is this backhauling of TDM calls the final network design?

a. If this was a transition step, when is the final network configuration going to be completed?

b. Does either the current network or the final network configuration include placing legacy network gateways at the arrogation point?

RESPONSE TO REQUEST NO. 4:

The network configuration at the time of the incident was in a transitionary stage.

- **For PSAPs that had not yet transitioned to the NG-911 solution, calls entered the network from the end user to their Carrier and then to the legacy selective router. The selective router uses the SS7 network to retrieve information to complete the 911 calls to the correct PSAP with the caller information.**
- **For PSAPs that had transitioned to the NG-911 solution, calls entered the network from the end user to their Carrier and then to the legacy selective router. For 911 calls destined for the PSAPs that have converted to the NG911 solution, the selective router is now functioning as an aggregation point, passing all 911 traffic to the Lumen Points of Interface (POIs) as a part of the NG911 solution, until the OSPs complete their own connections to the POIs.**
- **Some calls were delivered from the OSP directly to the Lumen POIs as a part of the final NG911 solution.**

a. The State of Nebraska has 61 of 67 PSAPs deployed as well as 2 State Patrols. There are 6 PSAPs left to deploy in the State. Of those 6, there are 5 scheduled in Q2 2024 and one (Thurston County) is pending PSAP readiness for deployment. Originating Service Providers (OSPs) are in various stages of their migration process to move to the final network configuration – 36% have completely deployed, and 26% have completed their connectivity orders and are now working through migration and testing.

b. The i3 solution supports end-to-end IP connectivity. Gateways are used to accommodate legacy wireline and wireless origination networks that are non-IP.

REQUEST NO. 5: Were any Lumen originated 9-1-1 calls affected by this outage? If so, were their alarms raised on those calls? Why or Why not?

RESPONSE TO REQUEST NO. 5: Yes, Lumen originated calls were impacted by this event. Lumen currently does not alarm on an individual call failure at the aggregation point, as it would cause multiple false alarms. Lumen monitors the trunks and trunk groups that carry the 911 services.

REQUEST NO. 6: You indicated that the cut in Minneapolis did not create an automatic alarm, but the cut in Omaha did. If these two cuts were on a ring, then the first one would not have caused a service failure, although it should have created a transport alarm. When you say that the first cut did not create an alarm, was that the transport alarm?

RESPONSE TO REQUEST NO. 6: Lumen did not get Loss of Redundancy (LOR) or SS7 alarming because the com-links failed when Minneapolis fiber was cut. We did receive National Transport alarms for the Minneapolis fiber cut. We have further diversified the local SS7 communications links on September 8, 2023. See also Drew Groff's Written Direct Testimony, Exhibit 51, p. 7.

REQUEST NO. 7: Does Lumen assert that a single OC-192 ring is reliable enough to maintain 99.999% 9-1-1 service? Why or why not?

RESPONSE TO REQUEST NO. 7: Lumen objects to this request because it is vague, calls for speculation, improperly assumes facts and testimony not in evidence in this matter, and is not relevant to the incident that occurred during the Outage Period. Lumen further objects to the extent this request relies upon industry objectives and/or recommendations for 9-1-1 reliability and availability that are inapplicable to the issues at hand. Subject to and without waiving said objection, see the January 4, 2024 testimony of Drew Groff at 264:23 – 265:20.

REQUEST NO. 8: When the Omaha cut happened, the services failed. Testimony indicated that the Omaha cut did generate an automatic alarm. Was that alarm also a transport alarm?

RESPONSE TO REQUEST NO. 8: Yes, transport alarms were received.

REQUEST NO. 9: When the Omaha cut happened, the services failed. Testimony indicated that the Omaha cut did generate an automatic alarm. Was that alarm also a transport alarm?

RESPONSE TO REQUEST NO. 9: This is duplicative of Request No. 8 and does not require a response.

REQUEST NO. 10: Does Lumen assert that two paths are sufficient to achieve 99.999% availability? Why or why not?

RESPONSE TO REQUEST NO. 10: Lumen objects to this request because it is vague, calls for speculation, improperly assumes facts and testimony not in evidence in this matter, and is not relevant to the incident that occurred during the Outage Period. Lumen further objects to the extent this request relies upon industry objectives and/or recommendations for 9-1-1 reliability and availability that are inapplicable to the issues at hand. Subject to and without waiving said objection, see the January 4, 2024 testimony of Drew Groff at 264:23 – 265:20.

REQUEST NO. 11: Does Lumen consider a single selective router reliable enough to maintain a 99.999% service to multiple end offices? Why or why not?

RESPONSE TO REQUEST NO. 11: Lumen objects to this request because it is

vague, calls for speculation, improperly assumes facts and testimony not in evidence in this matter, and is not relevant to the incident that occurred during the Outage Period. Lumen further objects to the extent this request relies upon industry objectives and/or recommendations for 9-1-1 reliability and availability that are inapplicable to the issues at hand. Subject to and without waiving said objection, see the January 4, 2024 testimony of Drew Groff at 264:23 – 265:20.

REQUEST NO. 12: Does Lumen consider a single OC-192 multistate ring reliable enough to maintain a 99.999% 9-1-1 service?

RESPONSE TO REQUEST NO. 12: Lumen objects to this request because it is vague, calls for speculation, improperly assumes facts and testimony not in evidence in this matter, and is not relevant to the incident that occurred during the Outage Period. Lumen further objects to the extent this request relies upon industry objectives and/or recommendations for 9-1-1 reliability and availability that are inapplicable to the issues at hand. Subject to and without waiving said objection, see the January 4, 2024 testimony of Drew Groff at 264:23 – 265:20.

REQUEST NO. 13: When considering redundancy, does Lumen consider a single ring one connection or two?

RESPONSE TO REQUEST NO. 13: Lumen objects to this request because it is vague, calls for speculation and is undefined. Lumen further objects to the extent this request is irrelevant to the instant incident during the Outage Period. Subject to and without waiving said objection, Lumen states that the connection depends on the configuration. There must be two or more faults to lose service. A single fault on a properly diverse ring will not cause an outage. A ring provides two redundant paths for traffic to traverse from the entry point and the exit point on a given ring for a protected circuit or connection. A ring utilized in this configuration provides a single connection or protected circuit for traffic to traverse that portion of the network.

REQUEST NO. 14: In this particular ring, approximately how many nodes were there?

RESPONSE TO REQUEST NO. 14: Lumen objects to this request because this request lacks specificity in order for Lumen to provide any articulate response, is vague and undefined, and irrelevant to the instant incident during the Outage Period.

REQUEST NO. 15: Testimony indicated that there was a delay in notifying PSAPs which testimony seemed to attribute to the lack of an automatic alarm from the first cut that occurred in or around Minneapolis Minnesota. Please explain in more detail why this delay occurred, including what alarms occurred when, why there was confusion and how and when information was given to you that made the scope of the problem clear enough to start notifying PSAPs.

RESPONSE TO REQUEST NO. 15: Fiber Cut No. 1 caused a transport loss of redundancy, but not a 911 outage, and because of that, the 911 trunks that Lumen monitors

were not impacted. Since 911 services were working properly, no alarms were created. The delay for automatic notification for SS7 was due to the com-link failure created during the Minnesota fiber cut (Fiber Cut No. 1), because the SS7 and the alarms were on the same transport fiber. For the Nebraska fiber cut (Fiber Cut No. 2), Lumen started receiving 911 ES Trunk alarms at 7:10 p.m. (CDT), indicating trouble with the ES trunks in the network. However, it took time to correlate the alarms and determine what the exact impact (including which PSAPs were impacted). Lumen received a trouble report from Douglas County, NE reporting calls ringing busy at 7:42 p.m. (CDT) and determined we had an entire NE state impact and sent notifications at 8:37 p.m. (CDT).

REQUEST NO. 16: Was the OC-192 ring that failed marked as a 9-1-1 circuit?

RESPONSE TO REQUEST NO. 16: This OC-192 is not dedicated exclusively to 911 traffic. Lumen labels all 911 at the circuit level as critical. Those circuits that rode this OC-192 were labeled as such.

REQUEST NO. 17: Were the tickets for the two cuts eventually updated to indicate that a 9-1-1 outage was caused by the cuts? If so, when did that occur?

RESPONSE TO REQUEST NO. 17: The outage bridge was actively correlating and coordinating restoration efforts and not all related tickets were noted at the same time; however, all resources were focused on correlating impact, looking at potential reroute options, and determining which cut could be spliced first to restore 911 ingress voice services. The first recorded time that the cuts were related was 8:47 p.m. CDT.

REQUEST NO. 18: Were the repair crews working on the Minneapolis fiber cut, made aware that there was a 911 outage? If so, when?

RESPONSE TO REQUEST NO. 18: Yes, crews working on the Minneapolis fiber cut (Fiber Cut No. 1) were made aware there was 911 impact on 8/31/23 at 11:36 p.m. (CDT). However, even without that information, teams had been working with a sense of urgency. By the time the crews were able to commence splicing at 2:51 a.m. (CDT) on 9/1/23, prioritization had been provided.

REQUEST NO. 19: Were the repair crews working on the Omaha fiber cut made aware that there was a 911 outage? If so, when?

RESPONSE TO REQUEST NO. 19: The first note referencing correlation of the Omaha fiber cut (Fiber Cut No. 2) to the 911 ingress voice outage was made on the outage bridge at 08:50 p.m. CDT. By the time the Omaha team was able to begin splicing, 911 services had been restored.

REQUEST NO. 20: Testimony indicated that there were a number of other emergencies which lengthened response times. How many of the other emergencies affected both sides of an OC-192 or larger ring? How many caused a 9-1-1 failure?

RESPONSE TO REQUEST NO. 20: Lumen objects to this request because it misstates Testimony (which is defined by the Commission as the January 4, 2024 testimony of Drew Groff) by stating that Testimony "indicated that there were a number of other emergencies which lengthened response times". Subject to and without waiving said objection, Testimony regarding this issue is set forth in the hearing transcript at 143:21-144-24. Lumen further states that with respect to Fiber Cut No. 2, any other "emergencies" did not impact the Outage Period. See also Response to Request No. 23, *infra*.

REQUEST NO. 21: Explain Lumen's process for allocating crews to cuts. How does loss of 9-1-1 services affect decisions on crew allocations?

RESPONSE TO REQUEST NO. 21: Splicing/construction crews are third-party contractors. If there is any outage, Lumen will request the contractor to dispatch the closest crew available. There are primary and secondary contractors and Lumen will utilize the contractor that can allocate the crew the soonest. In this case, even though a crew was dispatched to the Nebraska fiber cut (Fiber Cut No. 2), Lumen attempted to contact three other construction crews to try to get a crew on site sooner. See also Response to Request No. 23, *infra*.

REQUEST NO. 22: Testimony indicated that 9-1-1 service loss might affect things like which fiber line was restored first after a cut. Did that occur in this instance?

RESPONSE TO REQUEST NO. 22: When Lumen is aware of any impacts to its 9-1-1 services because of a fiber cut event, Lumen Engineering, Support and Leadership teams collaborate to develop a critical service restoration priority list. This list is based on the following criteria:

- **The severity and extent of the fiber cut event and its impact on 9-1-1 services.**
- **The availability and feasibility of alternative routes or locations for 9-1-1 calls.**
- **The estimated time and resources required to repair the fiber cut and restore the 9-1-1 services.**
- **The potential risks and challenges associated with the repair and restoration process.**

In this instance, once the protect outage began, the protect circuits (which contained the 911 circuits) were prioritized.

REQUEST NO. 23: Please list the emergencies that occurred prior to the two cuts that affected 9-1-1 service for which crews that could potentially respond to one of the cuts that were part of this incident. For each emergency, please list the time you were made aware of the emergency, the nature of the emergency, the time a repair crew arrived and whether 9-1-1 (or another higher priority service) was obstructed by that emergency.

RESPONSE TO REQUEST NO. 23: Lumen maintains Service Level Agreements (SLA's) with its third-party contractors; however, Lumen is typically unaware of any third-party contractor's locations prior to contacting them directly. Lumen is not aware of any

prior emergencies in the Minnesota outage (Fiber Cut No. 1). And for this outage, the Nebraska fiber repair provided diversity to the network that was already back in service based on the repair completed in Minnesota. Lumen recognizes its third-party contractors have multiple customers and operate to provide service to all contracted customers.

REQUEST NO. 24: Please provide a detailed timeline of the repair for the Minneapolis fiber cut including :

(a) when technicians were dispatched,
(b) when technicians arrived,
(c) when repairs were started,
(d) when the first splice was completed,
(e) when the splice that restored 9-1-1 service was completed,
(f) If work was halted for train passage, please list stop time and resume time for each such stoppage.

RESPONSE TO REQUEST NO. 24: Minnesota fiber cut (Fiber Cut No. 1) (all times Central Daylight Time):

(a) Technicians were dispatched on 8/30/23 at 2:07 p.m.
(b) Technicians arrived on 8/30/23 at 3:01 p.m.
(c) Following prep work and substantial delays by the railroad and locate providers, excavation began on 8/31/23 at 4:32 a.m. and splicing commenced on 9/1/23 at 2:51 a.m. Between 8/30/23 at 3 p.m. and 8/31/23 at 4:32 a.m., Lumen personnel spoke with railroad personnel, who initially would not allow work to begin until the morning of 8/31/23, escalated with railroad personnel and received clearance to begin work immediately, confirmed there were twelve (12) buried utilities and sent Emergency Locate tickets, marked the repair area and then waited for the all the emergency locates to be completed. Once locates were completed and railroad flaggers were in place, Lumen contractors began exposing hand holes and preparing for the boring efforts that were needed. The boring rig was staged and boring was completed by about 2:00 a.m. on 9/1/23.
(d) There were five splicing crews onsite working to splice the fibers on both ends simultaneously. While Lumen doesn't have a precise time the initial splice was completed, the company believes the first splice for one side of the work effort was completed on 9/1/23 at 3:27 a.m. Splices on both sides would have to be complete prior to any circuit being cleared. Lumen doesn't have any documentation on when individual circuits were restored, other than the 911 circuit (see response to (e) below).
(e) 911 service was restored on 9/1/23 at 5:32 a.m.
(f) Lumen does not have that information and would not track the information during a repair as the focus is restoring customers to service.

REQUEST NO. 25: Please provide a detailed timeline of the repair for the Omaha fiber cut including:

(a) when technicians were dispatched,
(b) when technicians arrived,
(c) when repairs were started,
(d) when the first splice was completed,

(e) If work was halted for train passage, please list stop time and resume time for each such stoppage.

RESPONSE TO REQUEST NO. 25: Nebraska fiber cut (Fiber Cut No. 2) (all times Central Daylight Time):

(a) Technicians were dispatched on 8/31/23 at 7:17 p.m.

(b) Lumen does not have a precise time of arrival, but technicians had already arrived and provided pictures of damage location and construction equipment in the area on 8/31/23 at 9:54 p.m,

(c) Lumen does not have a precise time of repairs beginning, but has a picture of digging on 9/1/23 at 7:35 a.m. Between 10 p.m. and 7:35 a.m. crews identified the issues, obtained approval from the railroad to begin repairs immediately, issued Emergency Locate tickets, marked the repair area and waited for railroad flaggers, who arrived after 7:00 a.m.

(d) The first splice was completed on 9/1/23 at 6:19 p.m.

(e) Lumen does not have that information and would not track the information during a repair as the focus is restoring customers to service.

REQUEST NO. 26: If a repair crew arrives at the location of a cut, under what circumstances, if any, would that crew be redirected to another, higher priority cut before completing repairs at the site they began working?

RESPONSE TO REQUEST NO. 26: It is not Lumen policy to redirect a crew from one repair to another repair. Most fiber cuts are not close to each other, and redirecting a crew would further delay repairs on the first cut, potentially without speeding repairs on the cut where the crew is redirected. See also the Response to Request No. 23.

REQUEST NO. 27: How are fiber cut priorities identified and who makes that decision?

RESPONSE TO REQUEST NO. 27: Fiber cut prioritization plans, when applicable, are established by Network Implementation Managers with data provided by NOC and Field Management. Fiber cut prioritization plans are designed to optimize the use of resources and minimize the impact of service outages. The prioritization plans are based on the some of the following guidelines:

- **The priority of a fiber cut is determined by the number and type of services affected, the duration of the outage, and the availability of alternative routes or backup systems.**
- **The priority of a fiber cut may change over time, depending on the progress of the restoration, the status of the affected services, and the feedback from the customers.**
- **The priority of a fiber cut may vary in each instance, depending on the specific circumstances and challenges of the situation.**

REQUEST NO. 28: Please supply more details on why the automated alarm did not occur. It appears from the testimony that the alarm may have been at least partially provisioned on the network that failed. Is it Lumen policy that alarm mechanisms are allowed to ride on the network

they are monitoring? If not, please detail how this alarm was "inhibited"?

RESPONSE TO REQUEST NO. 28: Lumen objects to this request because the request to "supply more details" is overbroad, vague, improperly calls for a narrative response, and seeks information that is already in this record. Subject to and without waiving said objection, Lumen states that this request appears to be related to the Minnesota fiber cut (Fiber Cut No. 1); subject to that assumption, Lumen states as follows: in this case the only alarms not received were related to the SS7 network, because the SS7 alarms and the SS7 traffic were on the same fiber. Lumen attempts to maximize diversity wherever possible, and Lumen diversified the SS7 alarms away from the SS7 traffic shortly after this outage. See also Response to Request No. 6, *supra*.

REQUEST NO. 29: When the Grand Island SR could not complete 9-1-1 calls, did that not generate an alarm automatically? Why or why not?

RESPONSE TO REQUEST NO. 29: The Grand Island SR does not alarm on single call failures as Lumen does not monitor at that level. Lumen monitors the 911 ES trunks and trunk groups. The trunks are set to alarm at 25% out of service condition so the technicians in the center need to review all the alarms to see the percentage of trunk impact. The center received 443 alarms total for this event within a 1-hour time frame.

REQUEST NO. 30: Lumen designed part of the NG9-1-1 system to utilize the OC-192 ring that failed. It knew, or should have known, which PSAPs would be affected by a failure of the Grand Island SR, and it knew that the Grand Island SR was connected to the LNG by this ring. Why did it take an hour from when the ring failure occurred to determining that the Grand Island SR could not pass traffic to the LNG, and thus all PSAPs with originating service providers connected to the Grand Island SR would be affected?

RESPONSE TO REQUEST NO. 30: It took time to correlate all the alarms and the amount of impact to determine all the PSAP's that were impacted. The PSAP's in the E911 network were still receiving calls which caused confusion on determining the exact cause and to identify the impacted PSAP's or offices.

REQUEST NO. 31: Is the aggregation switch in Grand Island, and the Lumen LNG connected to part of the NG9-1-1 service or is it a separate service provided under a different contract or tariff?

RESPONSE TO REQUEST NO. 31: Yes, the Grand Island selective router also currently functions as an aggregation point to the NG-911 solution so that conversions to the NG-911 system can be completed more quickly. The agreement between the State of Nebraska and Lumen for NG-911 service references integration with the legacy selective routers (serving as an aggregation point) as a part of the transitional solution. However, the Grand Island aggregation point is managed under a different agreement between Lumen and the OSPs. The Lumen LNG is included as a part of the NG-911 solution.

REQUEST NO. 32: Please provide a list of incidents for the immediately preceding 10 years to this outage of two fiber cuts on the same Lumen SONET ring and an estimate of the number of SONET rings Lumen maintains.

RESPONSE TO REQUEST NO. 32: Lumen objects to this request because the request for a "list of incidents" for the preceding 10 years is vague, irrelevant, overly broad in temporal scope, is unduly burdensome, and seeks information that is beyond the scope of the Nebraska Discovery Rules, which are applicable to these responses.

REQUEST NO. 33: Based on review of the reports the Next Generation Core Services (NGCS) was operational, but 911 calls could not be routed to the NGCS by the Lumen infrastructure to a PSAP. What process is in place to ensure that 911 calls be delivered to a default route if routing to the NGCS is unavailable?

RESPONSE TO REQUEST NO. 33: Currently there is no automated way to reroute calls in this type of outage. We would need One single PSAP accept responsibility to answer all calls for the 911 Selective Router/Aggregation Point via admin lines with no ALI. The other option is every OSP provider would need to do a reroute to an admin line to the PSAP that answers calls for their office. That is a manual endeavor and takes a long time to implement.

REQUEST NO. 34: How many 911 calls were not delivered during the outage?

RESPONSE TO REQUEST NO. 34: There were 639 failed calls from the Council Bluff aggregation point. Grand Island showed 4 failed calls between the aggregation point and the LNG but since that office was isolated, Lumen had no visibility to calls that were sent to the aggregation point and did not make it due to the SS7 isolation. Lumen does not have any data on the Norfolk Aggregation point and the data is too old to pull those numbers at this time.

REQUEST NO. 35: Documents show the ESInet remained operational. Are traffic statistics available that show the traffic processed by the NGCS during this event? If so, please provide the statistics. If not, please explain why they are not available.

RESPONSE TO REQUEST NO. 35: The ESINet remained operational. Probe calls that traverse through the LNG and the NG-911 network completed successfully during the event and Lumen's NG-911 vendor confirmed ESINet links remained up to all PSAPs over the NG-911 network and completed test calls to the PSAPs. This data is no longer available.

REQUEST NO. 36: Realizing that the SS7 network failure resulted in calls not getting to the Lumen system what options are available to assist the OSPs in having diversity to the aggregation point?

RESPONSE TO REQUEST NO. 36: The Lumen NG-911 solution provides for two diverse TDM POIs per LATA. OSPs are expected to connect to both POIs for each of the LATAs in which they provide services. Additionally, there are two geographically diverse

SIP POIs available to OSPs that wish to connect via that method. If the OSPs are unable to build their own network to the POIs, they can order facilities from Lumen or other providers to reach the POIs.

Dated this 4th day of June 2024.

Respectfully Submitted,

BY: /s/ *Katherine A. McNamara*

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CERTIFICATE OF SERVICE

The undersigned hereby certifies that on this 4th day of June 2024, the foregoing was filed electronically with the Nebraska Public Service Commission via e-mail to the following:

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BY: /s/ *Katherine A. McNamara*
Katherine A. McNamara, #25142

BEFORE THE NEBRASKA PUBLIC SERVICE COMMISSION

In the Matter of the Nebraska Public Service Commission, on its own motion, conducting an investigation into the 911 service outage that began on August 31, 2023 in areas of Nebraska served by Lumen and its affiliates,	)	Application No. 911-075/PI-248
and	)	
In the Matter of the Nebraska Public Service Commission, on its own motion, conducting an investigation into 911 service outages in areas of Nebraska served by Lumen and its affiliates.	)	Application No. 911-077/C-5581/PI-252 (Consolidated)

WRITTEN DIRECT TESTIMONY OF DREW GROFF, ON BEHALF OF CENTURYLINK COMMUNICATIONS, LLC, D/B/A LUMEN TECHNOLOGIES GROUP, DATED OCTOBER 30, 2024

Hearing Date: November 4-5, 2024

Q. **PLEASE STATE YOUR NAME AND BUSINESS ADDRESS.**

A. My name is Drew Groff. My business address is 5325 Zuni Street, Denver, Colorado, 80221.

Q. **PLEASE STATE THE NAME OF YOUR EMPLOYER, YOUR CURRENT TITLE, AND HOW LONG YOU'VE BEEN EMPLOYED.**

A. I am currently employed by Lumen Technologies Group as Director of the Network Operations Center ("NOC"), Public Safety & Compliance. I have been employed by Lumen Technologies Group, or its predecessors, for approximately 23 years.

Q. **WHAT PARTY ARE YOU PROVIDING TESTIMONY FOR IN THIS MATTER?**

A. CenturyLink Communications, LLC d/b/a Lumen Technologies Group, (hereafter in this testimony, "Lumen")

Q. **WHAT IS THIS TESTIMONY INTENDED TO ADDRESS?**

A. This testimony is intended to supplement my prior testimony for Nebraska Public Service Commission Docket 911-075/PI-248 and serves as my initial written testimony for Docket 911-077/C-5581/PI-252.

Q. **HAVE YOU HELD ANY PRIOR POSITIONS WITH LUMEN IN YOUR 23 YEARS WITH THE COMPANY?**

A. Yes. I have previously held positions of Senior Manager Network Operations, Senior Engineer, Supervisor of Network Operations, and Customer Communications Technician.

Q. **PLEASE DESCIRBE YOUR DUTIES AND RESPONSIBILITIES FOR LUMEN IN YOUR CURRENT ROLE AS DIRECTOR OF NOC, PUBLIC SAFETY & COMPLIANCE.**

A. In my current role, I provide strategic leadership, direction, workload, and performance management for the Public Safety Services NOC and Compliance team at Lumen. I am responsible for Service Assurance functions supporting E-911, NG-911, and reporting to state utility commissions and the Federal Communications Commission ("FCC").

Q. **PLEASE DESCRIBE YOUR EDUCATIONAL BACKGROUND.**

A. I hold a Bachelor of Science in Information Technology degree completed in May, 2005.

Q. **WHAT IS THE PURPOSE OF PROVIDING YOUR TESTIMONY IN THIS PROCEEDING?**

A. To further assist in the Commission's investigation of the outages that occurred between August 31, 2023, to September 1, 2023, and in April and July, 2024.

Q. **PLEASE TELL THE COMMISSION THE CURRENT STATUS OF THE MIGRATION TO NG-911 IN NEBRASKA.**

A. As of July 24, 2024, sixty-seven (67) of the sixty-eight (68) PSAPs have migrated to the NG-911 network. Thurston County is the only PSAP that is not live on the NG-911 ESINet, but this is due to a third-party contractual equipment issue that does not involve Lumen. To date, 57.14% of all originating service providers ("OSP") in Nebraska have deployed/cut to the dual POI in each Local Access and Transport Area ("LATA"), and twelve (12) OSP are 100% complete deployment to the POI and away from the legacy time-division multiplexing ("TDM") selective router ("SR")/aggregation switches. This provides less dependence upon SS7 for delivery to the National LNG form Lumen's local switches, but still requires the OSP to deliver the calls and monitor their traffic to reach the point of interconnection ("POI") (and ultimately the National legacy network gateway "LNG") as the paths may not be common with Lumen traffic. Lumen does not monitor other OSP ingress traffic until it hits the LNG and is common to all 911 traffic prior to reaching the NG-911 network.

Q. **HAVE YOU REVIEWED LUMEN'S RESPONSES TO THE COMMISSION'S SECOND SET OF DATA REQUESTS FOR DOCKET 911-075/PI-248, BEING THE INVESTIGATION FOR THE AUGUST 31-SEPTEMBER 1, 2023 EVENT?**

A. Yes, and I assisted in providing the responses to those data requests.

Q. **IN RESPONSE TO THE SECOND SET OF DATA REQUESTS, DATA REQUEST NO. 27, YOU REFER TO FIBER CUT PRIORITIZATION PLANS. CAN YOU PLEASE DESCRIBE THIS PROCESS IN FURTHER DETAIL?**

A. Yes. As mentioned in Response No. 27, the priority of a fiber cut is determined by the number and type of services affected, the duration of the outage, and the availability of alternative routes or backup systems. Specific to 911, Lumen has a 911 repair outage/isolation process wherein one of the steps is to determine whether priority splicing or physical reroutes can be implemented. Assuming the trouble/issue has been identified, correlated and isolated to this step, it is Lumen's standard procedure to prioritize splicing fibers that would restore 911 services when possible and/or identifying physical reroutes when feasible. Lumen may also pursue both avenues (prioritization of splicing and physical reroutes) when possible, but it is not always the case that one or either option are possible/feasible.

Q. **PLEASE SUMMARIZE ANY REMEDIATION ACTIONS THAT OCCURRED IMMEDIATELY FOLLOWING THE JULY 9-10, 2024, OUTAGE.**

A. Post-Hurricane Beryl, Lumen immediately completed diagnostic testing and remediation on the generators in Houston, including testing for microbial growth (results were negative), cleaning the fuel tank, adding fuel inhibitor, replacing both fuel pumps, and performing eight (8) hours load bank testing. As additional measures, Lumen has dedicated more resources to disaster recovery, including adding more resources from internal teams and vendors in advance of a storm path. Lumen deployed an additional four (4) resources in the field, two (2) additional vendor generator technicians, one (1) additional disaster recovery fueling vendor, and four (4) back-office support resources for tracking issues and capturing/validating alarms. Lumen has proactively revised its maintenance program

BEFORE THE NEBRASKA PUBLIC SERVICE COMMISSION

In the Matter of the Nebraska Public Service Commission, on its own motion, conducting an investigation into the 911 service Outage that began on August 31, 2023, in areas of Nebraska served by Lumen and its affiliates.	)))))	Application No. 911-075/PI-248

CENTURYLINK COMMUNICATIONS, LLC d/b/a LUMEN TECHNOLOGIES GROUP'S RESPONSES TO COMMISSION STAFF'S SECOND SET OF DATA REQUESTS

COMES NOW CenturyLink Communications, LLC d/b/a Lumen Technologies Group, (hereafter, "Lumen"), and for its responses to the Nebraska Public Service Commission Staff's Second Set of Data Requests in the above-captioned matter, states as follows:

PRELIMINARY STATEMENT

As stated in Lumen's response to the Commission's First Set of Data Requests, the responses provided herein are based upon information presently available and specifically known by Lumen. Further discovery and investigation may disclose additional facts and add meaning to known facts, all of which may lead to additions to, changes in, and/or variations from, the answers set forth herein. The following answers are given without prejudice to Lumen's right to produce evidence of any subsequently discovered fact or facts. Accordingly, Lumen reserves the right to supplement any and all responses herein if additional information become known.

All responses provided herein are made without waiving any and all objections to relevancy, privilege, confidentiality, and admissibility of evidence at any additional evidentiary hearing or further proceeding.

OBJECTION TO DEFINITIONS:

Lumen objects to the definitions set forth in the Second Set of Data Requests, including but not limited to, the following:

- Definition No. 1: the definition of "Lumen" incorrectly and improperly groups together *all* "parents, subsidiaries, and affiliates" and "former and present officers, directors, employees, representatives, agents, and attorneys"; CenturyLink Communications, LLC d/b/a Lumen Technologies Group is the entity involved in the Outage currently being investigated, and, as noted above, is the entity responding to this Second Set of Data Requests;
- Definition No 8: the definition of "Outage" to the extent it does not comport with E-911 industry standards and/or statutory definitions; and
- Definition No. 9: the definition of "August 31, 2023 Outage" incorrectly assumes the Outage being investigated occurred on the "Lumen 911 System" in Nebraska, because, as defined in the Second Set of Data Requests, the term "Lumen 911 System" means the Legacy 911 System and the NG-911 System. As set forth in prior response to data requests, written testimony, and testimony at the January 4, 2024 hearing in the above-captioned docket, The E911 and NG-911 networks were working and were not impacted by the transport outages being investigated by the Commission under this docket.

LUMEN'S DEFINITIONS

"Outage Period" referred to herein means August 31, 2023, to September 1, 2023.

"Fiber Cut No. 1" referred to herein means the August 30, 2023 cable that was cut by a third party contractor in Minnesota, through no fault of Lumen.

"Fiber Cut No. 2" referred to herein means the August 31, 2023 cable that was cut by a third party contractor in Omaha, Nebraska, through no fault of Lumen.

RESPONSES TO DATA REQUESTS

REQUEST NO. 1: The testimony seems to indicate that the Grand Island equipment was a switch that was operating as a selective router and as an aggregation switch. Please explain what is meant by an "aggregation switch" and how that differs from a selective router with trunk-to-trunk routing to another switch.

RESPONSE TO REQUEST NO. 1: The Grand Island switch referenced was operating as a traditional E-911 Selective router for PSAPs that had not yet migrated to NG-911. In this capacity the originating Office providers provide trunks to the E-911 Selective Router and the E-911 Selective Router then does a routing lookup and sends the call to a dedicated 911 trunk to PSAP's that have not yet cut to the NG-911 Solution.

The Grand Island switch also acts as an aggregation switch for 911 traffic destined for the NG-911 network; for PSAPs migrated to the NG-911 network, the switch does a routing lookup and determines the call is destined to a PSAP served by the NG911 network and forwards the call over TDM ES trunks to the LNG that then converts the traffic to SIP to forward to the NG911 network.

REQUEST NO. 2: The diagram shows Lumen "LNGs". Is this actually an LSRG and just mislabeled? If not, please explain how calls are handled from the origination switch to the LNG and what LNG stands for.

RESPONSE TO REQUEST NO. 2: Lumen objects to this request because it fails to specifically identify what "diagram" is being referred to and the Definitions section of this Second Set of Data Requests does not define "diagram". Subject to and without waiving said objection, Lumen's understanding is that OSP providers will build 911 ES trunks to the LNG and the LNG will convert TDM to SIP, or OSP will build or have ES trunks to the aggregation point and the aggregation point will then forward the traffic to the LNG over ES trunks where the traffic will then be converted to SIP. LNG stands for "Legacy Network Gateways".

REQUEST NO. 3: Were both SS7 signaling and trunk connections lost in the incident? Why or why not?

RESPONSE TO REQUEST NO. 3: Lumen objects to this request because it fails to specifically identify what "trunk connection" is being referred to and the Definitions section of this Second Set of Data Requests does not define "trunk connection". Subject to and without waiving said objection, this incident was two separate fiber cuts along two diverse paths to the NG911 network, referred to by Lumen as Fiber Cut No. 1 and Fiber Cut No. 2. Assuming this request refers to the SS7 signaling network and the trunks between the OSP and the selective router or the selective router and the PSAP, then Lumen's response is no, the trunks were not lost in the incident when the SS7 network was lost. SS7 signaling was impacted due to two diverse A-Links being down due to the separate fiber cuts, No. 1 and No. 2. These are the SS7 "connections" that caused the SS7 impact. The voice or "bearer"

trunks configured as SS7 remained up and in service.

REQUEST NO. 4: Was the network configuration that allowed for the failure in this incident, a transition step, or is this backhauling of TDM calls the final network design?

a. If this was a transition step, when is the final network configuration going to be completed?

b. Does either the current network or the final network configuration include placing legacy network gateways at the arrogation point?

RESPONSE TO REQUEST NO. 4:

The network configuration at the time of the incident was in a transitionary stage.

- **For PSAPs that had not yet transitioned to the NG-911 solution, calls entered the network from the end user to their Carrier and then to the legacy selective router. The selective router uses the SS7 network to retrieve information to complete the 911 calls to the correct PSAP with the caller information.**
- **For PSAPs that had transitioned to the NG-911 solution, calls entered the network from the end user to their Carrier and then to the legacy selective router. For 911 calls destined for the PSAPs that have converted to the NG911 solution, the selective router is now functioning as an aggregation point, passing all 911 traffic to the Lumen Points of Interface (POIs) as a part of the NG911 solution, until the OSPs complete their own connections to the POIs.**
- **Some calls were delivered from the OSP directly to the Lumen POIs as a part of the final NG911 solution.**

a. The State of Nebraska has 61 of 67 PSAPs deployed as well as 2 State Patrols. There are 6 PSAPs left to deploy in the State. Of those 6, there are 5 scheduled in Q2 2024 and one (Thurston County) is pending PSAP readiness for deployment. Originating Service Providers (OSPs) are in various stages of their migration process to move to the final network configuration – 36% have completely deployed, and 26% have completed their connectivity orders and are now working through migration and testing.

b. The i3 solution supports end-to-end IP connectivity. Gateways are used to accommodate legacy wireline and wireless origination networks that are non-IP.

REQUEST NO. 5: Were any Lumen originated 9-1-1 calls affected by this outage? If so, were their alarms raised on those calls? Why or Why not?

RESPONSE TO REQUEST NO. 5: Yes, Lumen originated calls were impacted by this event. Lumen currently does not alarm on an individual call failure at the aggregation point, as it would cause multiple false alarms. Lumen monitors the trunks and trunk groups that carry the 911 services.

REQUEST NO. 6: You indicated that the cut in Minneapolis did not create an automatic alarm, but the cut in Omaha did. If these two cuts were on a ring, then the first one would not have caused a service failure, although it should have created a transport alarm. When you say that the first cut did not create an alarm, was that the transport alarm?

RESPONSE TO REQUEST NO. 6: Lumen did not get Loss of Redundancy (LOR) or SS7 alarming because the com-links failed when Minneapolis fiber was cut. We did receive National Transport alarms for the Minneapolis fiber cut. We have further diversified the local SS7 communications links on September 8, 2023. See also Drew Groff's Written Direct Testimony, Exhibit 51, p. 7.

REQUEST NO. 7: Does Lumen assert that a single OC-192 ring is reliable enough to maintain 99.999% 9-1-1 service? Why or why not?

RESPONSE TO REQUEST NO. 7: Lumen objects to this request because it is vague, calls for speculation, improperly assumes facts and testimony not in evidence in this matter, and is not relevant to the incident that occurred during the Outage Period. Lumen further objects to the extent this request relies upon industry objectives and/or recommendations for 9-1-1 reliability and availability that are inapplicable to the issues at hand. Subject to and without waiving said objection, see the January 4, 2024 testimony of Drew Groff at 264:23 – 265:20.

REQUEST NO. 8: When the Omaha cut happened, the services failed. Testimony indicated that the Omaha cut did generate an automatic alarm. Was that alarm also a transport alarm?

RESPONSE TO REQUEST NO. 8: Yes, transport alarms were received.

REQUEST NO. 9: When the Omaha cut happened, the services failed. Testimony indicated that the Omaha cut did generate an automatic alarm. Was that alarm also a transport alarm?

RESPONSE TO REQUEST NO. 9: This is duplicative of Request No. 8 and does not require a response.

REQUEST NO. 10: Does Lumen assert that two paths are sufficient to achieve 99.999% availability? Why or why not?

RESPONSE TO REQUEST NO. 10: Lumen objects to this request because it is vague, calls for speculation, improperly assumes facts and testimony not in evidence in this matter, and is not relevant to the incident that occurred during the Outage Period. Lumen further objects to the extent this request relies upon industry objectives and/or recommendations for 9-1-1 reliability and availability that are inapplicable to the issues at hand. Subject to and without waiving said objection, see the January 4, 2024 testimony of Drew Groff at 264:23 – 265:20.

REQUEST NO. 11: Does Lumen consider a single selective router reliable enough to maintain a 99.999% service to multiple end offices? Why or why not?

RESPONSE TO REQUEST NO. 11: Lumen objects to this request because it is

vague, calls for speculation, improperly assumes facts and testimony not in evidence in this matter, and is not relevant to the incident that occurred during the Outage Period. Lumen further objects to the extent this request relies upon industry objectives and/or recommendations for 9-1-1 reliability and availability that are inapplicable to the issues at hand. Subject to and without waiving said objection, see the January 4, 2024 testimony of Drew Groff at 264:23 – 265:20.

REQUEST NO. 12: Does Lumen consider a single OC-192 multistate ring reliable enough to maintain a 99.999% 9-1-1 service?

RESPONSE TO REQUEST NO. 12: Lumen objects to this request because it is vague, calls for speculation, improperly assumes facts and testimony not in evidence in this matter, and is not relevant to the incident that occurred during the Outage Period. Lumen further objects to the extent this request relies upon industry objectives and/or recommendations for 9-1-1 reliability and availability that are inapplicable to the issues at hand. Subject to and without waiving said objection, see the January 4, 2024 testimony of Drew Groff at 264:23 – 265:20.

REQUEST NO. 13: When considering redundancy, does Lumen consider a single ring one connection or two?

RESPONSE TO REQUEST NO. 13: Lumen objects to this request because it is vague, calls for speculation and is undefined. Lumen further objects to the extent this request is irrelevant to the instant incident during the Outage Period. Subject to and without waiving said objection, Lumen states that the connection depends on the configuration. There must be two or more faults to lose service. A single fault on a properly diverse ring will not cause an outage. A ring provides two redundant paths for traffic to traverse from the entry point and the exit point on a given ring for a protected circuit or connection. A ring utilized in this configuration provides a single connection or protected circuit for traffic to traverse that portion of the network.

REQUEST NO. 14: In this particular ring, approximately how many nodes were there?

RESPONSE TO REQUEST NO. 14: Lumen objects to this request because this request lacks specificity in order for Lumen to provide any articulate response, is vague and undefined, and irrelevant to the instant incident during the Outage Period.

REQUEST NO. 15: Testimony indicated that there was a delay in notifying PSAPs which testimony seemed to attribute to the lack of an automatic alarm from the first cut that occurred in or around Minneapolis Minnesota. Please explain in more detail why this delay occurred, including what alarms occurred when, why there was confusion and how and when information was given to you that made the scope of the problem clear enough to start notifying PSAPs.

RESPONSE TO REQUEST NO. 15: Fiber Cut No. 1 caused a transport loss of redundancy, but not a 911 outage, and because of that, the 911 trunks that Lumen monitors

were not impacted. Since 911 services were working properly, no alarms were created. The delay for automatic notification for SS7 was due to the com-link failure created during the Minnesota fiber cut (Fiber Cut No. 1), because the SS7 and the alarms were on the same transport fiber. For the Nebraska fiber cut (Fiber Cut No. 2), Lumen started receiving 911 ES Trunk alarms at 7:10 p.m. (CDT), indicating trouble with the ES trunks in the network. However, it took time to correlate the alarms and determine what the exact impact (including which PSAPs were impacted). Lumen received a trouble report from Douglas County, NE reporting calls ringing busy at 7:42 p.m. (CDT) and determined we had an entire NE state impact and sent notifications at 8:37 p.m. (CDT).

REQUEST NO. 16: Was the OC-192 ring that failed marked as a 9-1-1 circuit?

RESPONSE TO REQUEST NO. 16: This OC-192 is not dedicated exclusively to 911 traffic. Lumen labels all 911 at the circuit level as critical. Those circuits that rode this OC-192 were labeled as such.

REQUEST NO. 17: Were the tickets for the two cuts eventually updated to indicate that a 9-1-1 outage was caused by the cuts? If so, when did that occur?

RESPONSE TO REQUEST NO. 17: The outage bridge was actively correlating and coordinating restoration efforts and not all related tickets were noted at the same time; however, all resources were focused on correlating impact, looking at potential reroute options, and determining which cut could be spliced first to restore 911 ingress voice services. The first recorded time that the cuts were related was 8:47 p.m. CDT.

REQUEST NO. 18: Were the repair crews working on the Minneapolis fiber cut, made aware that there was a 911 outage? If so, when?

RESPONSE TO REQUEST NO. 18: Yes, crews working on the Minneapolis fiber cut (Fiber Cut No. 1) were made aware there was 911 impact on 8/31/23 at 11:36 p.m. (CDT). However, even without that information, teams had been working with a sense of urgency. By the time the crews were able to commence splicing at 2:51 a.m. (CDT) on 9/1/23, prioritization had been provided.

REQUEST NO. 19: Were the repair crews working on the Omaha fiber cut made aware that there was a 911 outage? If so, when?

RESPONSE TO REQUEST NO. 19: The first note referencing correlation of the Omaha fiber cut (Fiber Cut No. 2) to the 911 ingress voice outage was made on the outage bridge at 08:50 p.m. CDT. By the time the Omaha team was able to begin splicing, 911 services had been restored.

REQUEST NO. 20: Testimony indicated that there were a number of other emergencies which lengthened response times. How many of the other emergencies affected both sides of an OC-192 or larger ring? How many caused a 9-1-1 failure?

RESPONSE TO REQUEST NO. 20: Lumen objects to this request because it misstates Testimony (which is defined by the Commission as the January 4, 2024 testimony of Drew Groff) by stating that Testimony "indicated that there were a number of other emergencies which lengthened response times". Subject to and without waiving said objection, Testimony regarding this issue is set forth in the hearing transcript at 143:21-144-24. Lumen further states that with respect to Fiber Cut No. 2, any other "emergencies" did not impact the Outage Period. See also Response to Request No. 23, *infra*.

REQUEST NO. 21: Explain Lumen's process for allocating crews to cuts. How does loss of 9-1-1 services affect decisions on crew allocations?

RESPONSE TO REQUEST NO. 21: Splicing/construction crews are third-party contractors. If there is any outage, Lumen will request the contractor to dispatch the closest crew available. There are primary and secondary contractors and Lumen will utilize the contractor that can allocate the crew the soonest. In this case, even though a crew was dispatched to the Nebraska fiber cut (Fiber Cut No. 2), Lumen attempted to contact three other construction crews to try to get a crew on site sooner. See also Response to Request No. 23, *infra*.

REQUEST NO. 22: Testimony indicated that 9-1-1 service loss might affect things like which fiber line was restored first after a cut. Did that occur in this instance?

RESPONSE TO REQUEST NO. 22: When Lumen is aware of any impacts to its 9-1-1 services because of a fiber cut event, Lumen Engineering, Support and Leadership teams collaborate to develop a critical service restoration priority list. This list is based on the following criteria:

- **The severity and extent of the fiber cut event and its impact on 9-1-1 services.**
- **The availability and feasibility of alternative routes or locations for 9-1-1 calls.**
- **The estimated time and resources required to repair the fiber cut and restore the 9-1-1 services.**
- **The potential risks and challenges associated with the repair and restoration process.**

In this instance, once the protect outage began, the protect circuits (which contained the 911 circuits) were prioritized.

REQUEST NO. 23: Please list the emergencies that occurred prior to the two cuts that affected 9-1-1 service for which crews that could potentially respond to one of the cuts that were part of this incident. For each emergency, please list the time you were made aware of the emergency, the nature of the emergency, the time a repair crew arrived and whether 9-1-1 (or another higher priority service) was obstructed by that emergency.

RESPONSE TO REQUEST NO. 23: Lumen maintains Service Level Agreements (SLA's) with its third-party contractors; however, Lumen is typically unaware of any third-party contractor's locations prior to contacting them directly. Lumen is not aware of any

prior emergencies in the Minnesota outage (Fiber Cut No. 1). And for this outage, the Nebraska fiber repair provided diversity to the network that was already back in service based on the repair completed in Minnesota. Lumen recognizes its third-party contractors have multiple customers and operate to provide service to all contracted customers.

REQUEST NO. 24: Please provide a detailed timeline of the repair for the Minneapolis fiber cut including :

(a) when technicians were dispatched,
(b) when technicians arrived,
(c) when repairs were started,
(d) when the first splice was completed,
(e) when the splice that restored 9-1-1 service was completed,
(f) If work was halted for train passage, please list stop time and resume time for each such stoppage.

RESPONSE TO REQUEST NO. 24: Minnesota fiber cut (Fiber Cut No. 1) (all times Central Daylight Time):

(a) Technicians were dispatched on 8/30/23 at 2:07 p.m.
(b) Technicians arrived on 8/30/23 at 3:01 p.m.
(c) Following prep work and substantial delays by the railroad and locate providers, excavation began on 8/31/23 at 4:32 a.m. and splicing commenced on 9/1/23 at 2:51 a.m. Between 8/30/23 at 3 p.m. and 8/31/23 at 4:32 a.m., Lumen personnel spoke with railroad personnel, who initially would not allow work to begin until the morning of 8/31/23, escalated with railroad personnel and received clearance to begin work immediately, confirmed there were twelve (12) buried utilities and sent Emergency Locate tickets, marked the repair area and then waited for the all the emergency locates to be completed. Once locates were completed and railroad flaggers were in place, Lumen contractors began exposing hand holes and preparing for the boring efforts that were needed. The boring rig was staged and boring was completed by about 2:00 a.m. on 9/1/23.
(d) There were five splicing crews onsite working to splice the fibers on both ends simultaneously. While Lumen doesn't have a precise time the initial splice was completed, the company believes the first splice for one side of the work effort was completed on 9/1/23 at 3:27 a.m. Splices on both sides would have to be complete prior to any circuit being cleared. Lumen doesn't have any documentation on when individual circuits were restored, other than the 911 circuit (see response to (e) below).
(e) 911 service was restored on 9/1/23 at 5:32 a.m.
(f) Lumen does not have that information and would not track the information during a repair as the focus is restoring customers to service.

REQUEST NO. 25: Please provide a detailed timeline of the repair for the Omaha fiber cut including:

(a) when technicians were dispatched,
(b) when technicians arrived,
(c) when repairs were started,
(d) when the first splice was completed,

(e) If work was halted for train passage, please list stop time and resume time for each such stoppage.

RESPONSE TO REQUEST NO. 25: Nebraska fiber cut (Fiber Cut No. 2) (all times Central Daylight Time):

(a) Technicians were dispatched on 8/31/23 at 7:17 p.m.

(b) Lumen does not have a precise time of arrival, but technicians had already arrived and provided pictures of damage location and construction equipment in the area on 8/31/23 at 9:54 p.m,

(c) Lumen does not have a precise time of repairs beginning, but has a picture of digging on 9/1/23 at 7:35 a.m. Between 10 p.m. and 7:35 a.m. crews identified the issues, obtained approval from the railroad to begin repairs immediately, issued Emergency Locate tickets, marked the repair area and waited for railroad flaggers, who arrived after 7:00 a.m.

(d) The first splice was completed on 9/1/23 at 6:19 p.m.

(e) Lumen does not have that information and would not track the information during a repair as the focus is restoring customers to service.

REQUEST NO. 26: If a repair crew arrives at the location of a cut, under what circumstances, if any, would that crew be redirected to another, higher priority cut before completing repairs at the site they began working?

RESPONSE TO REQUEST NO. 26: It is not Lumen policy to redirect a crew from one repair to another repair. Most fiber cuts are not close to each other, and redirecting a crew would further delay repairs on the first cut, potentially without speeding repairs on the cut where the crew is redirected. See also the Response to Request No. 23.

REQUEST NO. 27: How are fiber cut priorities identified and who makes that decision?

RESPONSE TO REQUEST NO. 27: Fiber cut prioritization plans, when applicable, are established by Network Implementation Managers with data provided by NOC and Field Management. Fiber cut prioritization plans are designed to optimize the use of resources and minimize the impact of service outages. The prioritization plans are based on the some of the following guidelines:

- **The priority of a fiber cut is determined by the number and type of services affected, the duration of the outage, and the availability of alternative routes or backup systems.**
- **The priority of a fiber cut may change over time, depending on the progress of the restoration, the status of the affected services, and the feedback from the customers.**
- **The priority of a fiber cut may vary in each instance, depending on the specific circumstances and challenges of the situation.**

REQUEST NO. 28: Please supply more details on why the automated alarm did not occur. It appears from the testimony that the alarm may have been at least partially provisioned on the network that failed. Is it Lumen policy that alarm mechanisms are allowed to ride on the network

they are monitoring? If not, please detail how this alarm was "inhibited"?

RESPONSE TO REQUEST NO. 28: Lumen objects to this request because the request to "supply more details" is overbroad, vague, improperly calls for a narrative response, and seeks information that is already in this record. Subject to and without waiving said objection, Lumen states that this request appears to be related to the Minnesota fiber cut (Fiber Cut No. 1); subject to that assumption, Lumen states as follows: in this case the only alarms not received were related to the SS7 network, because the SS7 alarms and the SS7 traffic were on the same fiber. Lumen attempts to maximize diversity wherever possible, and Lumen diversified the SS7 alarms away from the SS7 traffic shortly after this outage. See also Response to Request No. 6, *supra*.

REQUEST NO. 29: When the Grand Island SR could not complete 9-1-1 calls, did that not generate an alarm automatically? Why or why not?

RESPONSE TO REQUEST NO. 29: The Grand Island SR does not alarm on single call failures as Lumen does not monitor at that level. Lumen monitors the 911 ES trunks and trunk groups. The trunks are set to alarm at 25% out of service condition so the technicians in the center need to review all the alarms to see the percentage of trunk impact. The center received 443 alarms total for this event within a 1-hour time frame.

REQUEST NO. 30: Lumen designed part of the NG9-1-1 system to utilize the OC-192 ring that failed. It knew, or should have known, which PSAPs would be affected by a failure of the Grand Island SR, and it knew that the Grand Island SR was connected to the LNG by this ring. Why did it take an hour from when the ring failure occurred to determining that the Grand Island SR could not pass traffic to the LNG, and thus all PSAPs with originating service providers connected to the Grand Island SR would be affected?

RESPONSE TO REQUEST NO. 30: It took time to correlate all the alarms and the amount of impact to determine all the PSAP's that were impacted. The PSAP's in the E911 network were still receiving calls which caused confusion on determining the exact cause and to identify the impacted PSAP's or offices.

REQUEST NO. 31: Is the aggregation switch in Grand Island, and the Lumen LNG connected to part of the NG9-1-1 service or is it a separate service provided under a different contract or tariff?

RESPONSE TO REQUEST NO. 31: Yes, the Grand Island selective router also currently functions as an aggregation point to the NG-911 solution so that conversions to the NG-911 system can be completed more quickly. The agreement between the State of Nebraska and Lumen for NG-911 service references integration with the legacy selective routers (serving as an aggregation point) as a part of the transitional solution. However, the Grand Island aggregation point is managed under a different agreement between Lumen and the OSPs. The Lumen LNG is included as a part of the NG-911 solution.

REQUEST NO. 32: Please provide a list of incidents for the immediately preceding 10 years to this outage of two fiber cuts on the same Lumen SONET ring and an estimate of the number of SONET rings Lumen maintains.

RESPONSE TO REQUEST NO. 32: Lumen objects to this request because the request for a "list of incidents" for the preceding 10 years is vague, irrelevant, overly broad in temporal scope, is unduly burdensome, and seeks information that is beyond the scope of the Nebraska Discovery Rules, which are applicable to these responses.

REQUEST NO. 33: Based on review of the reports the Next Generation Core Services (NGCS) was operational, but 911 calls could not be routed to the NGCS by the Lumen infrastructure to a PSAP. What process is in place to ensure that 911 calls be delivered to a default route if routing to the NGCS is unavailable?

RESPONSE TO REQUEST NO. 33: Currently there is no automated way to reroute calls in this type of outage. We would need One single PSAP accept responsibility to answer all calls for the 911 Selective Router/Aggregation Point via admin lines with no ALI. The other option is every OSP provider would need to do a reroute to an admin line to the PSAP that answers calls for their office. That is a manual endeavor and takes a long time to implement.

REQUEST NO. 34: How many 911 calls were not delivered during the outage?

RESPONSE TO REQUEST NO. 34: There were 639 failed calls from the Council Bluff aggregation point. Grand Island showed 4 failed calls between the aggregation point and the LNG but since that office was isolated, Lumen had no visibility to calls that were sent to the aggregation point and did not make it due to the SS7 isolation. Lumen does not have any data on the Norfolk Aggregation point and the data is too old to pull those numbers at this time.

REQUEST NO. 35: Documents show the ESInet remained operational. Are traffic statistics available that show the traffic processed by the NGCS during this event? If so, please provide the statistics. If not, please explain why they are not available.

RESPONSE TO REQUEST NO. 35: The ESINet remained operational. Probe calls that traverse through the LNG and the NG-911 network completed successfully during the event and Lumen's NG-911 vendor confirmed ESINet links remained up to all PSAPs over the NG-911 network and completed test calls to the PSAPs. This data is no longer available.

REQUEST NO. 36: Realizing that the SS7 network failure resulted in calls not getting to the Lumen system what options are available to assist the OSPs in having diversity to the aggregation point?

RESPONSE TO REQUEST NO. 36: The Lumen NG-911 solution provides for two diverse TDM POIs per LATA. OSPs are expected to connect to both POIs for each of the LATAs in which they provide services. Additionally, there are two geographically diverse

SIP POIs available to OSPs that wish to connect via that method. If the OSPs are unable to build their own network to the POIs, they can order facilities from Lumen or other providers to reach the POIs.

Dated this 4th day of June 2024.

Respectfully Submitted,

BY: /s/ *Katherine A. McNamara*

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CERTIFICATE OF SERVICE

The undersigned hereby certifies that on this 4th day of June 2024, the foregoing was filed electronically with the Nebraska Public Service Commission via e-mail to the following:

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BY: /s/ *Katherine A. McNamara*
Katherine A. McNamara, #25142

BEFORE THE NEBRASKA PUBLIC SERVICE COMMISSION

In the Matter of the Nebraska Public Service Commission, on its own motion, conducting an investigation into the 911 service outage that began on August 31, 2023 in areas of Nebraska served by Lumen and its affiliates,	)	Application No. 911-075/PI-248
and	)	
In the Matter of the Nebraska Public Service Commission, on its own motion, conducting an investigation into 911 service outages in areas of Nebraska served by Lumen and its affiliates.	)	Application No. 911-077/C-5581/PI-252 (Consolidated)

WRITTEN DIRECT TESTIMONY OF DREW GROFF, ON BEHALF OF CENTURYLINK COMMUNICATIONS, LLC, D/B/A LUMEN TECHNOLOGIES GROUP, DATED OCTOBER 30, 2024

Hearing Date: November 4-5, 2024

Q. **PLEASE STATE YOUR NAME AND BUSINESS ADDRESS.**

A. My name is Drew Groff. My business address is 5325 Zuni Street, Denver, Colorado, 80221.

Q. **PLEASE STATE THE NAME OF YOUR EMPLOYER, YOUR CURRENT TITLE, AND HOW LONG YOU'VE BEEN EMPLOYED.**

A. I am currently employed by Lumen Technologies Group as Director of the Network Operations Center ("NOC"), Public Safety & Compliance. I have been employed by Lumen Technologies Group, or its predecessors, for approximately 23 years.

Q. **WHAT PARTY ARE YOU PROVIDING TESTIMONY FOR IN THIS MATTER?**

A. CenturyLink Communications, LLC d/b/a Lumen Technologies Group, (hereafter in this testimony, "Lumen")

Q. **WHAT IS THIS TESTIMONY INTENDED TO ADDRESS?**

A. This testimony is intended to supplement my prior testimony for Nebraska Public Service Commission Docket 911-075/PI-248 and serves as my initial written testimony for Docket 911-077/C-5581/PI-252.

Q. **HAVE YOU HELD ANY PRIOR POSITIONS WITH LUMEN IN YOUR 23 YEARS WITH THE COMPANY?**

A. Yes. I have previously held positions of Senior Manager Network Operations, Senior Engineer, Supervisor of Network Operations, and Customer Communications Technician.

Q. **PLEASE DESCIRBE YOUR DUTIES AND RESPONSIBILITIES FOR LUMEN IN YOUR CURRENT ROLE AS DIRECTOR OF NOC, PUBLIC SAFETY & COMPLIANCE.**

A. In my current role, I provide strategic leadership, direction, workload, and performance management for the Public Safety Services NOC and Compliance team at Lumen. I am responsible for Service Assurance functions supporting E-911, NG-911, and reporting to state utility commissions and the Federal Communications Commission ("FCC").

Q. **PLEASE DESCRIBE YOUR EDUCATIONAL BACKGROUND.**

A. I hold a Bachelor of Science in Information Technology degree completed in May, 2005.

Q. **WHAT IS THE PURPOSE OF PROVIDING YOUR TESTIMONY IN THIS PROCEEDING?**

A. To further assist in the Commission's investigation of the outages that occurred between August 31, 2023, to September 1, 2023, and in April and July, 2024.

Q. **PLEASE TELL THE COMMISSION THE CURRENT STATUS OF THE MIGRATION TO NG-911 IN NEBRASKA.**

A. As of July 24, 2024, sixty-seven (67) of the sixty-eight (68) PSAPs have migrated to the NG-911 network. Thurston County is the only PSAP that is not live on the NG-911 ESINet, but this is due to a third-party contractual equipment issue that does not involve Lumen. To date, 57.14% of all originating service providers ("OSP") in Nebraska have deployed/cut to the dual POI in each Local Access and Transport Area ("LATA"), and twelve (12) OSP are 100% complete deployment to the POI and away from the legacy time-division multiplexing ("TDM") selective router ("SR")/aggregation switches. This provides less dependence upon SS7 for delivery to the National LNG form Lumen's local switches, but still requires the OSP to deliver the calls and monitor their traffic to reach the point of interconnection ("POI") (and ultimately the National legacy network gateway "LNG") as the paths may not be common with Lumen traffic. Lumen does not monitor other OSP ingress traffic until it hits the LNG and is common to all 911 traffic prior to reaching the NG-911 network.

Q. **HAVE YOU REVIEWED LUMEN'S RESPONSES TO THE COMMISSION'S SECOND SET OF DATA REQUESTS FOR DOCKET 911-075/PI-248, BEING THE INVESTIGATION FOR THE AUGUST 31-SEPTEMBER 1, 2023 EVENT?**

A. Yes, and I assisted in providing the responses to those data requests.

Q. **IN RESPONSE TO THE SECOND SET OF DATA REQUESTS, DATA REQUEST NO. 27, YOU REFER TO FIBER CUT PRIORITIZATION PLANS. CAN YOU PLEASE DESCRIBE THIS PROCESS IN FURTHER DETAIL?**

A. Yes. As mentioned in Response No. 27, the priority of a fiber cut is determined by the number and type of services affected, the duration of the outage, and the availability of alternative routes or backup systems. Specific to 911, Lumen has a 911 repair outage/isolation process wherein one of the steps is to determine whether priority splicing or physical reroutes can be implemented. Assuming the trouble/issue has been identified, correlated and isolated to this step, it is Lumen's standard procedure to prioritize splicing fibers that would restore 911 services when possible and/or identifying physical reroutes when feasible. Lumen may also pursue both avenues (prioritization of splicing and physical reroutes) when possible, but it is not always the case that one or either option are possible/feasible.

Q. **PLEASE SUMMARIZE ANY REMEDIATION ACTIONS THAT OCCURRED IMMEDIATELY FOLLOWING THE JULY 9-10, 2024, OUTAGE.**

A. Post-Hurricane Beryl, Lumen immediately completed diagnostic testing and remediation on the generators in Houston, including testing for microbial growth (results were negative), cleaning the fuel tank, adding fuel inhibitor, replacing both fuel pumps, and performing eight (8) hours load bank testing. As additional measures, Lumen has dedicated more resources to disaster recovery, including adding more resources from internal teams and vendors in advance of a storm path. Lumen deployed an additional four (4) resources in the field, two (2) additional vendor generator technicians, one (1) additional disaster recovery fueling vendor, and four (4) back-office support resources for tracking issues and capturing/validating alarms. Lumen has proactively revised its maintenance program

nationwide, including shifting to occur annually in the spring, prior to hurricane season. Furthermore, additional, larger portable generators are currently on stand-by in Florida and Texas, ready to be deployed if needed.

Q. **PLEASE SUMMARIZE ANY SITE PROCEDURES THAT WERE MODIFIED OR IMPLEMENTED FOLLOWING THE JULY 9-10, 2024, OUTAGE.**

A. In addition to what I stated in my prior answer, additional efforts are as follows: Lumen launched a nationwide fuel additive/bacteria inhibitor program; the maintenance schedule for the Houston site has been moved to earlier in the calendar year, ahead of hurricane season; enhanced preventative maintenance will be conducted after each extended natural disaster run; enhanced fuel testing will detect bacteria, mold, and other contaminants that could affect performance; the frequency of fuel filter changes for all generators has increased to annually; implemented on-site generator fuel filter storage; quick connects will be incorporated at gateway locations, prioritizing seven (7) co-located gateways; generator belts and hoses will be on a 3-year replacement scheduled (as opposed to relying on a vendor to recommend replacement); and finally, Lumen has implemented Third-Party Critical Infrastructure Audit Surrounding Generators, DC Plant, Batteries, Connections & Maintenance policies.

Q. **WHAT IF ANY NETWORK AUDITS, WHETHER BY LUMEN OR A THIRD-PARTY, HAVE BEEN CONDUCTED SINCE THE JULY 2024 OUTAGE?**

A. Lumen is in the process of completing a national fiber and site audit, which includes any fiber system carrying 911 traffic, a 911 ES Trunk route location diversity audit, and a SS7

quad link (national to local) location diversity/resiliency audit. I also refer the Commission to Lumen's response to Data Request No. 18, in the First Set of Data Requests in Docket 911-077/C-5581/PI-252.

Q. **WHAT HAS BEEN DONE SINCE THE JULY 2024 OUTAGE TO ACHIEVE ADDITIONAL SS7 (SIGNALING) DIVERSITY?**

A. SS7 Diversity was addressed upon restoration (on the night of the July 2024 outage) by building a new path and routing one of the SS7 D-Links through this location diverse path (meaning, one of the D-Links was fully diverse the night of the outage on the newly created path). I refer the Commission to Lumen's Response to the Second Set of Data Requests for the July 2024 outage, *Confidential Exhibit 1*, showing the "Local and National SS7 – After". Notwithstanding this level of diversity, Lumen anticipates by Q1 2025 it will move one more of the four D-links away from Houston to through another unique route to provide even further diversity. Once achieved, this means no more than two links would have any common signal transfer point ("STP") or in-between common transport building location.

Q. **WHAT HAS BEEN DONE SINCE THE JULY 2024 OUTAGE TO ACHIEVE ADDITIONAL 911 ES TRUNK DIVERSITY?**

A. The 911 ES Trunk circuits supporting Grand Island and Scottsbluff destined for the Highlands Ranch Legacy Network Gateway (LNG) have been groomed to a new access Connecting Facility Assignment (CFA) location. Attached to my written testimony and labeled as Confidential **Exhibit A** is a summary of the pending grooms that have been completed or are pending completion as of the date of this testimony.

Q. **OVERALL, HOW DO THE ABOVE ACTIONS IMPACT SS7 AND 911 ES TRUNK DIVERSITY?**

A. The additional diversity measures I have summarized have reduced and/or eliminated a common physical location for 911 ingress paths for the dual paths to the geographically diverse National LNGs which convert TDM to Session Initiation Protocol ("SIP") for delivery to the NG911 network. Note, however, there remains one common physical location (a common building in Omaha) for traffic originating from Norfolk, Council Bluffs, and Sioux City that Lumen's internal planning team will address to eliminate common locations for physically diverse routes carrying 911 traffic across the National network. It is estimated that this groom will be completed in or around January 2025.

Q. **HAVE THERE BEEN ANY UPDATES TO LUMEN'S PSAP NOTIFICATION PROCEDURES SINCE THE JULY 2024 OUTAGE?**

A. Lumen is consistently working on automation improvements to speed up PSAP notifications in the event of an outage. The NG-911 network has multiple layers of automation and notification. The ingress time-division multiplex ("TDM") network, however, is less developed from an alarm to correlation to PSAP to automated notification perspective, and Lumen is working to close this gap. In relation to the outages at issues, however, I am not aware of any issues in notifying impacted PSAPs in Nebraska, except for a single PSAP related to the August 31, 2023 outage, which was slightly delayed, as I have previously testified to before the Commission.

Q. **HAVE THERE BEEN ANY UPDATES TO LUMEN'S ALARM SYSTEMS SINCE THE JULY 2024 OUTAGE?**

A. Yes. First, with respect to the Spokane STP, which was originally located in Houston (Sunnyvale/Houston pair): the alarms were still labeled to the old STP which impacted initial troubleshooting and correlation, and the links were updated July 24, 2024, with the correct STP points. Second, Lumen confirmed that the SS7 D-link quad ticketing did not work as designed, but the automation that failed was corrected and tested shortly after the July outage.

Q. **DO YOU HAVE KNOWLEDGE OF THE OUTAGE THAT OCCURRED ON OR ABOUT APRIL 17, 2024? IF SO, STATE THE BASIS FOR YOUR KNOWLEDGE.**

A. Yes. I was a participant on Lumen's internal outage bridges starting on April 17, 2024, to assist with coordinating resources for impact validation, isolation of the cause of the outage, and restoration efforts with my peer network operations teams. I was also a participant in Lumen's post outage root cause analysis investigation regarding this outage.

Q. **HAVE YOU REVIEWED LUMEN'S RESPONSES TO THE COMMISSION'S FIRST SET OF DATA REQUESTS FOR THE APRIL 2024 OUTAGE?**

A. Yes, and I assisted in providing the responses to those data requests.

Q. **DO THE RESPONSES TRULY AND ACCURATELY REFLECT LUMEN'S ANSWERS TO THE BEST OF YOUR KNOWLEDGE?**

A. Yes.

Q. **CAN YOU BRIEFLY SUMMARIZE WHAT OCCURRED WITH RESPECT TO THE APRIL 2024 EVENT?**

A. Yes. A third-party utility contractor initially cut an unmarked 132ct fiber cable approximately 20 feet down at the corner of Pershing and Main in Kansas City, Missouri. It was also discovered a Lumen locate contractor had not accurately marked the west side of the excavation site where the third-party utility team had placed the pole. Lumen responded to conduct an emergency repair of the fiber and in doing so, the entire cable and the collapsed rings carrying 911 traffic, which all dropped in Kansas City, Missouri, were severed, thus preventing routing around the rings and preventing traffic from continuing their path to the Chicago or Highlands Ranch LNGs.

Q. **DID THE FIBER CUTS IN APRIL 2024 IMPACT THE NG-911 NETWORK IN NEBRASKA?**

A. No, the fiber cuts did not impact the NG-911 network in Nebraska. The outage was not related to the NG-911 network; rather, it was an "ingress" outage, meaning it was on the network that transports the 911 calls from the aggregation point to the Intrado NG-911 core. The outage was caused by fiber cuts in Kansas City, Missouri that impacted geographically diverse routes for some, but not all, 911 calls placed in the state of Nebraska to reach the NG-911 network for delivery; the fiber cuts, however, did not take down fibers carrying 911 traffic. This is because the 911 network is separate from the signaling network, and its these two networks that complete calls to 911. Therefore, this SS7 outage

did not affect 911 services in Nebraska. Further, any originating service provider (OSP) with direct connection to the 911 legacy network gateway (LNG) had no impact.

Q. **DO YOU HAVE KNOWLEDGE OF THE OUTAGE THAT OCCURRED ON OR ABOUT JULY 9, 2024? IF SO, STATE THE BASIS FOR YOUR KNOWLEDGE.**

A. Yes. I was a participant on Lumen's internal outage bridges starting on July 9, 2024, to assist with coordinating resources for impact validation, isolation of the cause of the outage, and restoration efforts with my peer network operations teams. I was also a participant in Lumen's post outage root cause analysis investigation regarding this outage.

Q. **HAVE YOU REVIEWED LUMEN'S RESPONSES TO THE COMMISSION'S SECOND SET OF DATA REQUESTS IN DOCKET 911-077/C-5581/PI-252 FOR THE JULY 2024 OUTAGE?**

A. Yes, and I assisted in providing the responses to those data requests.

Q. **DO THE RESPONSES TRULY AND ACCURATELY REFLECT LUMEN'S ANSWERS TO THE BEST OF YOUR KNOWLEDGE?**

A. Yes.

Q. **CAN YOU BRIEFLY SUMMARIZE WHAT OCCURRED WITH RESPECT TO THE JULY 2024 EVENT?**

A. Yes. The outage was caused by a power outage related to Hurricane Beryl in Houston, Texas, which impacted equipment carrying four (4) SS7 D-Links which isolated the St.

Paul and Minneapolis, Minnesota Signal Transfer Points (STPs) which prevented 911 calls routed through the Grand Island, and Norfolk switches in the state of Nebraska to reach the NG-911 network for delivery.

Q. **DID THE JULY 2024 OUTAGE IMPACT THE NG-911 NETWORK IN NEBRASKA?**

A. No, the NG-911 network in Nebraska was not impacted by the July 2024 outage. The outage was not related to the NG-911 network; rather, it was an SS7 ingress outage, meaning it impacted 911 calls that were routed through the Grand Island and Norfolk switches destined for the to the Intrado NG-911 core.

Q. **WITH RESPECT TO THE APRIL AND JULY 2024 OUTAGES, DID LUMEN NOTIFY IMPACTED (OR POTENTIALLY IMPACTED) PSAPs?**

A. Yes.

Q. **WERE NOTIFICATIONS TO THE PSAPs COMPLETED IN A UNIFORM MANNER?**

A. PSAP notifications were generated upon discovery of impact and may not have been sent to or received by impacted PSAP at the same time based on information available and isolation of impact determinations.

Q. **BASED ON YOUR KNOWLEDGE AND EXPERIENCE, ARE YOU GENERALLY FAMILIAR WITH FCC REQUIREMENTS GOVERNING NOTIFICATIONS TO PSAPs?**

A. Yes.

Q. **DID THE NOTIFICATIONS TO THE IMPACTED PSAPs FOR THE APRIL AND JULY 2024 OUTAGES MEET FCC REQUIREMENTS?**

A. Yes. The FCC requirements for ingress voice outages are to notify the designated point of contact for each PSAP as soon as possible from the point of discovery.

Q. **DOES THIS CONCLUDE YOUR WRITTEN DIRECT TESTIMONY?**

A. Yes, it does. I would like to thank the Commission for considering this testimony.

“Exhibit A” withheld pursuant to protective order.