

BEFORE THE WASHINGTON UTILITIES AND TRANSPORTATION COMMISSION

WASHINGTON UTILITIES AND
TRANSPORTATION COMMISSION,

Complainant,

v.

CENTURYLINK COMMUNICATIONS, LLC,

Respondent.

DOCKET UT-181051

RESPONSE TESTIMONY

OF

CARL D. KLEIN

ON BEHALF OF

CENTURYLINK COMMUNICATIONS, LLC

March 31, 2022

Rev. December 6, 2022

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EXHIBIT-CDK-4: WASHINGTON NETWORK DESIGN (FIGURE 2)

1 **I. BACKGROUND AND SUMMARY OF TESTIMONY**

2 **Q. PLEASE STATE YOUR NAME AND SUMMARIZE YOUR CURRENT ROLE AT**
3 **LUMEN.**

4 **A.** My name is Carl D. Klein and I am a Manager of the Lumen Network Operations Center
5 (“NOC”). I have well over year 20 years of experience as a network engineer and
6 technician. Over the past few years, I’ve also served as a manager of the company’s public
7 safety services (“PSS”) NOC. The NOC’s function is to monitor and repair the company’s
8 911 network across 37 states. The PSS NOC also initiates required FCC and state PUC
9 reporting, as well as Public Service Answering Point (“PSAP”) notifications.

10 **Q. PLEASE DESCRIBE YOUR EDUCATION AND SPECIALIZED TRAINING.**

11 **A.** After graduating high school in 1982, I joined the United States Navy and served for
12 almost 8 years. During my service, I received electronics and avionics training. Over the 8
13 years, as I climbed in rank, I took and passed proficiency tests in electronics. While in the
14 Navy, I also was trained in micro-miniature repair.

15 **Q. PLEASE SUMMARIZE YOUR WORK EXPERIENCE AT LUMEN AND ITS**
16 **PREDECESSORS.**

17 **A.** I joined U S WEST in May 1996 as a Customer Communication Technician. I attended
18 various basic telephony training classes for the first 2 months, and then joined the DS0 Test
19 and Repair group where I answered Customer trouble reports and then trouble shot and
20 repaired those circuits. In 1998 I moved to the 911 department where I took customer
21 reports, monitored, and performed repairs on the 911 network for the company. In 1999, I
22 was promoted to an engineering position within the 911 department, and served in that role

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1 until 2018. During that time frame I acted as the subject matter expert for the 911 team
2 assisting with repairs. I developed a majority of the current 911 process and Job Aids that
3 are utilized within the company's 911 center. I acted as technical support to repair complex
4 issues that the regular center technicians could not handle. I assisted other companies with
5 interconnecting to our network and also assisted in the design and interconnections to our
6 network for wireless and NG911 implementations. I also support the company as a subject
7 matter expert on 911 matters before the FCC and state PUCs. I have developed internal
8 tools to help with automations and the tracking of information as it relates to the 911
9 network for the 911 NOC. I have represented the company in FCC Communication
10 Security, Reliability and Interoperability Counsel ("CSRIC") working groups that focused
11 on developing best practices. I also participated in an FCC prioritization work group and
12 was recognized by the company president for my contributions. Further, I received a letter
13 of recognition from the FCC for the contributions I made in working groups in which I
14 have participated. In 2018, I took on the role of manager of the PSS NOC

15 **Q. HAVE YOU TESTIFIED BEFORE THIS COMMISSION OR ANY OTHER**
16 **REGULATORY OR JUDICIAL BODY?**

17 **A.** I provided formal testimony in one commission proceeding; specifically, a show cause
18 proceeding (Docket C-4892) in Nebraska. In that proceeding, I testified about the 911
19 network design and circuit diversity in the Omaha area. I also responded to how the PSS
20 NOC operates and monitors the network. In addition to the Nebraska proceeding, I have
21 appeared before several state commissions (in open meetings or similar settings) to answer
22 questions about 911 issues.

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Q. PLEASE PROVIDE A BRIEF SUMMARY OF YOUR RESPONSE TESTIMONY.

A. My testimony will briefly discuss the design of the Washington 911 transition from CenturyLink to Comtech, with specific discussion of how the two companies’ networks were designed to interconnect during Phase 1 of the transition. Next, I will respond to Staff witness James Webber’s testimony that asserts that calls destined to CenturyLink-served PSAPs failed as a result of the December 2018 network outage. Finally, I briefly respond to Public Counsel Brian Rosen’s characterization of SS7 technology as outdated and inappropriate for supporting 911 services.

Q. DID YOU READ DIRECT TESTIMONIES OF JACQUE HAWKINS-JONES (STAFF), JAMES WEBBER (STAFF), STEPHANIE CHASE (PUBLIC COUNSEL) AND BRIAN ROSEN (PUBLIC COUNSEL)?

A. Yes, I have, although I focused on narrow portions for purposes of this testimony.

II. TRANSITION OF 911 SERVICES FROM CENTURYLINK TO COMTECH

Q. WERE YOU DIRECTLY INVOLVED IN CENTURYLINK’S BID IN RESPONSE TO WMD’S 2016 REQUEST FOR PROPOSAL?

A. I was involved in a limited way. I provided information about the PSS NOC to our sales team. To the best of my recollection, I did not interface with WMD or anyone external to the company.

1 **Q. ONCE WMD AWARDED THE 911 CONTRACT TO COMTECH, WERE YOU**
2 **DIRECTLY INVOLVED IN THE TRANSITION?**

3 **A.** Yes. I served as a subject matter expert on an as needed basis during the transition. I had
4 limited involvement before attending a meeting in Seattle in February 2017. At that
5 meeting, I was a resource representing the PSS NOC and provided information regarding
6 CenturyLink's then-existing 911 network in Washington. I recall the meeting being a
7 fairly cooperative discussion among the key stakeholders (Comtech, WMD, CenturyLink
8 and Intrado). In the meeting, I don't recall any stakeholder dictating particular outcomes or
9 design decisions. Ms. Lobdell discusses this more in her Response Testimony.

10 **Q. DO YOU RECALL ANYTHING YOU FOUND NOTEWORTHY ABOUT THE**
11 **FEBRUARY 2017 MEETING IN SEATTLE?**

12 **A.** Yes. During that meeting, I was surprised at the high volume of questions Comtech posed
13 to CenturyLink, in a sense asking CenturyLink how Comtech should build the 911
14 network. I advised our team to be careful to avoid instructing Comtech how to design its
15 network. I felt like Comtech would potentially attempt to blame CenturyLink should
16 Comtech experience problems when it started to receive calls on its Washington 911
17 network. Regarding the type of signaling to be used to support the 911 calling (i.e., SS7 vs
18 IP), the parties did not discuss details. The parties had high level discussions, and ended
19 the discussions by agreeing that Intrado and Comtech would continue to discuss the details
20 after the meeting.

21

22

1 **Q. WHAT WAS YOUR ROLE IN THE TRANSITION FOLLOWING THE**
2 **FEBRUARY 2017 MEETING IN SEATTLE?**

3 **A.** Following the February 2017 Seattle meeting, my role in the transition became more
4 limited. I would occasionally provide subject matter expertise. As Comtech transitioned
5 each PSAP, I worked with other company employees to ensure that Comtech took over
6 emergency reporting obligations to the FCC and state Commissions. Most of the technical
7 details for transitioning services to Comtech were worked out between Comtech and
8 Intrado, with Valerie Lobdell supporting those discussions as the company's project
9 manager.

10 **Q. PLEASE PROVIDE A HIGH LEVEL DESCRIPTION OF THE WASHINGTON 911**
11 **TRANSITION.**

12 **A.** The transition consisted of three phases, all summarized in Exhibit CDK-2C.¹

13 In Phase 1, individual PSAPs would migrate from CenturyLink to Comtech, with a goal of
14 all PSAPs being transitioned to Comtech by the end of 2018. During Phase 1, all 911 calls
15 would be initially routed to CenturyLink, with calls being forwarded to Comtech if the call
16 was destined for a Comtech-served PSAP.

17 In Phase 2, all Washington PSAPs would move off of the CenturyLink Automatic Location
18 Identifier ("ALI") database and onto the Comtech ALI database. That Phase was initially
19 planned for 2019.

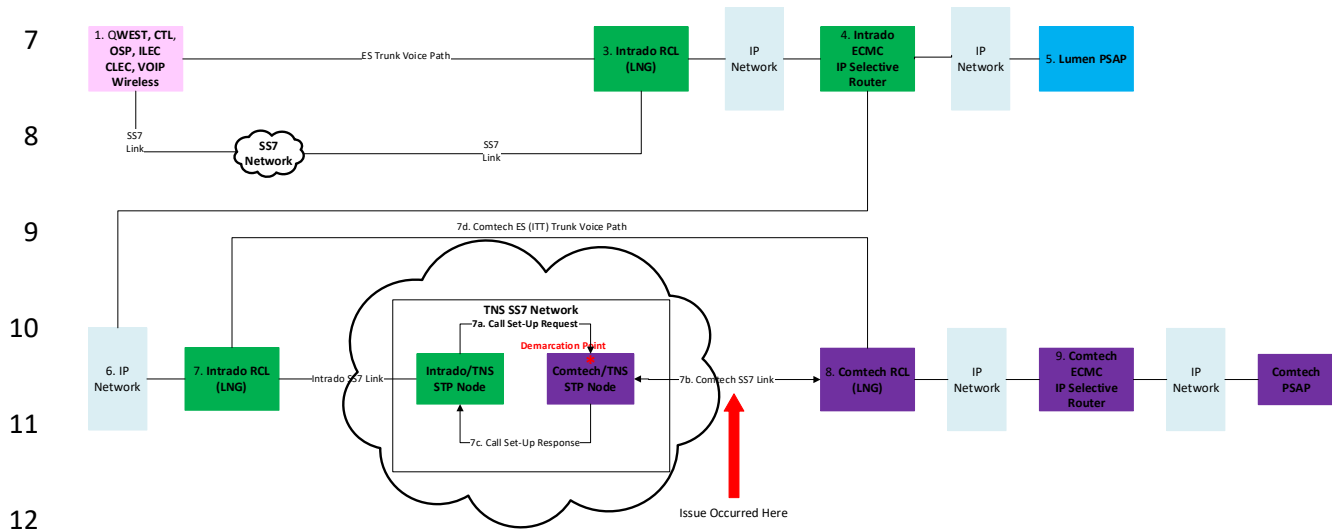
¹ The document attached as CDK-2C ("ST of WA Comtech NG911 Transition") is also attached as Appendix D to Staff's December 2020 Investigation Report.

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1 In Phase 3, all Washington central offices would be directly connected to Comtech,
2 removing CenturyLink from the call flow altogether.
3
4 At the time of the December 2018 network outage, the transition was still in Phase 1.
5 Figure 1 below presents a simplified diagram displaying the call flow for Washington 911
6 calls during Phase 1 of the transition.

6 **Figure 1: Simplified Phase 1 Call Flow (Washington)²**



13 **Q. CAN YOU DESCRIBE THE CALL FLOWS DISPLAYED IN FIGURE 1?**
14 **A.** Yes. Before discussing the network diagram in detail, it is important for me to make two
15 fundamental points. First, as Ms. Lobdell (at pages 3-5) discusses in her Response
16 Testimony, CenturyLink did not think that it should be involved in calls destined for a
17 Comtech PSAP; CenturyLink recommended that calls destined for a Comtech PSAP be
18 flash-cut to Comtech with CenturyLink out of the call flow altogether. Second, the
19 diagram depicts two different networks: the signaling network and the voice network.

² See also Exhibit CDK-3.

1 While the signaling network supports the voice network, it is important to understand that
2 they are separate networks with separate facilities.

3 Nonetheless, once it was decided that CenturyLink would be involved in the call flow
4 during Phase 1, CenturyLink worked with Comtech to get this accomplished.

5 During Phase 1, the call flow for 911 calls progressed through the following steps:

6 Step 1: the caller (regardless of technology—landline, wireless, VoIP) would dial “911”
7 which prompted the originating service providers (“OSP”) SS7 network to open an
8 emergency services voice trunk from the OSP’s switch to the Intrado gateway (also known
9 as a Remote Co-Location (“RCL”) or Local Network Gateway (“LNG”)). Intrado
10 (formerly known as West) served as CenturyLink’s underlying 911 provider—both for
11 signaling and voice communications—for Washington 911 services.

12 Step 2: This was inadvertently omitted when drawing the diagram.

13 Step 3: When the call came to Intrado in a TDM format, the Intrado gateway converted the
14 call to internet protocol (“IP”) and directed the call to the Intrado Emergency Call
15 Management Center (“ECMC”), which housed the selective router. By utilizing the 911
16 caller's telephone number, the selective router would determine which PSAP should
17 receive the 911 call.

18 Step 4: The Intrado selective router determined whether the PSAP that served the
19 telephone number was still served by CenturyLink or had transitioned to Comtech.

20 Step 5: If the destination PSAP was served by CenturyLink, the call would be handed in IP
21 format to the CenturyLink PSAP for completion.

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1 Step 6: If the destination PSAP was served by Comtech, the Intrado selective router would
2 route the call over the IP network to the Intrado gateway that was directly interconnected
3 with the Comtech gateway.

4 Step 7: Given that Comtech served 47 different PSAPs at the time, the Intrado gateway
5 had to identify the channel on Comtech's emergency services voice trunk known as the
6 inter-tandem trunk ("ITT") to hand the 911 call to. In order for the voice call to traverse the
7 ITT, Comtech's SS7 network needed to determine which channel on the ITT was available
8 for the call.³ Thus, Step 7 is comprised of several different steps. First (step 7a), Intrado's
9 SS7 network would send a call set up request (or call invite) from the Intrado STP to the
10 Comtech STP over Intrado's SS7 links. The Comtech STP would then communicate over
11 SS7 links with the Comtech gateway (step 7b) to determine which channel on the ITT was
12 available. Once determined, Comtech's STP would (step 7c) send a message back to the
13 Intrado STP identifying the specific channel available. Once the Intrado STP received this
14 information, the Intrado RCL would forward the 911 call over the appropriate channel on
15 the ITT to Comtech (step 7d).

16 Step 8: The Comtech gateway would receive the 911 call over the ITT and prepare it for
17 delivery to the Comtech selective router.

18 Step 9: The Comtech selective router would direct the call to the correct destination
19 Comtech PSAP for call answering.

³ The ITT was a voice trunk group comprised of multiple (typically 72) DS-0 voice trunks. For purposes of diversity, there were actually two ITT voice trunk groups, and thus (typically) up to 144 separate DS-0 voice trunks available for any given 911 call headed to a Comtech PSAP. Because the ITT is no longer in service, I can't confirm the actual number of voice trunks Comtech ordered in designing the ITT.

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1 From this simple description, it is easy to see why the failure occurred on Comtech's side
2 of the demarcation point. During the December 2018 outage, Intrado's STP (on behalf of
3 CenturyLink) sent signaling messages to Comtech's STP, asking which channel to route
4 the 911 call to. However, Comtech's STP never sent a responsive message back to Intrado
5 because Comtech's signaling link (the link connecting Comtech's STP and Comtech's
6 gateway) was inoperable. As a result, Intrado had no information from Comtech about
7 which channel to send the call to, preventing the 911 calls from completing.

8 **Q. FIGURE 1 IS IDENTIFIED AS A "SIMPLIFIED" CALL FLOW DIAGRAM.**
9 **WHAT DO YOU MEAN?**

10 **A.** For ease of review, Figure 1 only shows a single path connecting every point in the call
11 flow. In reality, there were redundant connections for each step. Figure 2, below, provides
12 a more detailed depiction of the Phase 1 call flows. It shows the redundant connections,
13 and provides significantly more detail for step 7, which is where Comtech calls failed
14 during the December 2018 outage.

15

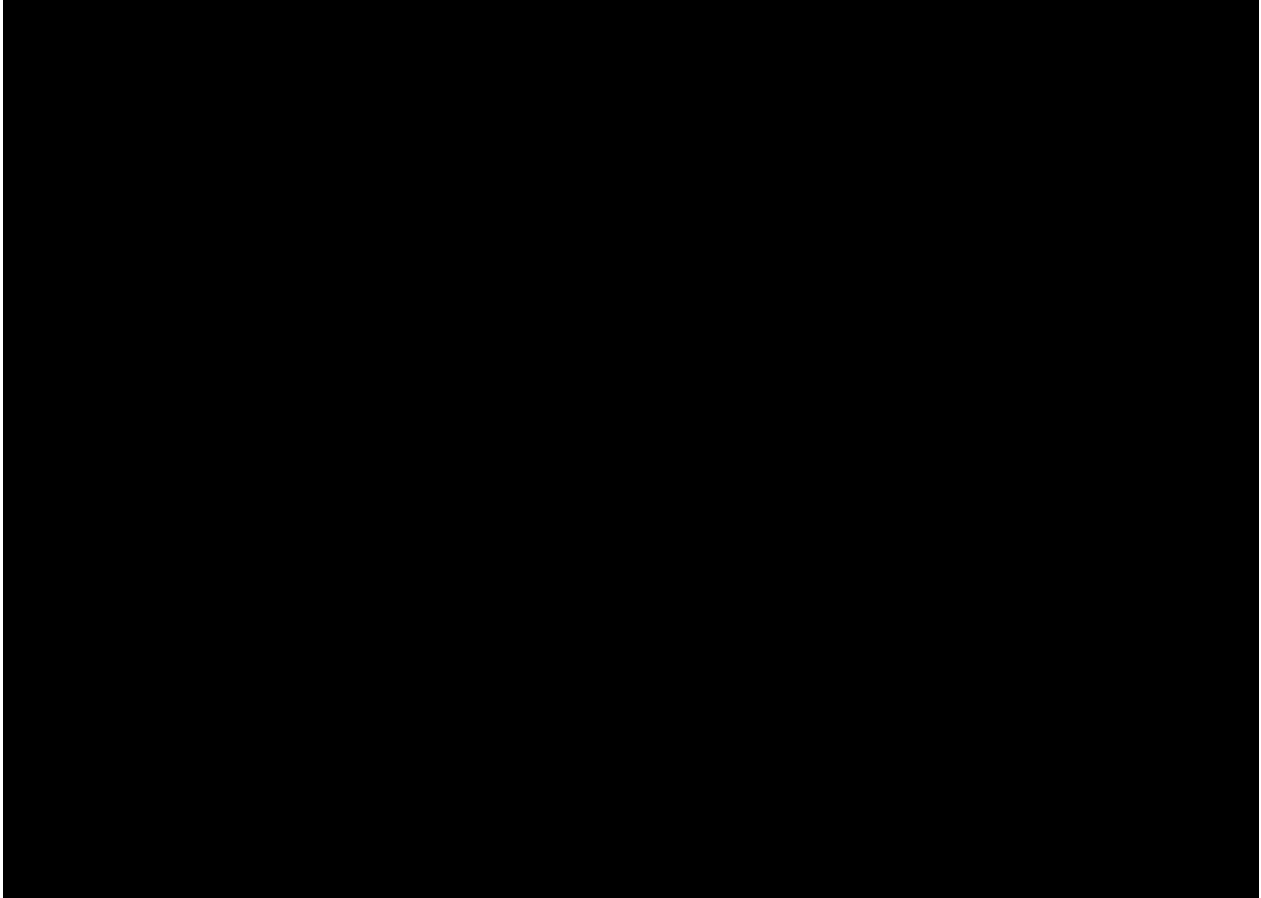
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1 **Figure 2: Non-Simplified Phase 1 Call Flow (Washington)⁴**



12 **Q. ARE THERE ANY NOTABLE DIFFERENCES BETWEEN THE**
13 **INTRADO/CENTURYLINK SS7 NETWORK AND THE COMTECH SS7**
14 **NETWORK (STEP 7)?**

15 **A.** Yes. The four SS7 links between the Intrado RCL and the Intrado SS7 STP utilized
16 supplier diversity, meaning that Intrado did not place all four circuits on the same network.
17 On the other hand, Comtech’s four SS7 links (shown as the four light blue boxes) all sat on
18 the same network (CLC’s “Green” Infinera transport network). Mr. Turner (at pages 25-

⁴ See also Exhibit CDK-4.

1 38) discusses the importance of supplier/network diversity in his testimony. The December
2 2018 network event impaired the CLC network upon which all of Comtech’s four SS7
3 links were placed, and thus Comtech lost all SS7 functionality required for Step 7b.

4 **III. RESPONSE TO STAFF DIRECT TESTIMONY**

5 **Q. MR. WEBBER CONCLUDES THAT [REDACTED] CALLS DESTINED FOR**
6 **CENTURYLINK PSAPS FAILED TO REACH THE PSAP.⁵ IS HE CORRECT?**

7 **A.** Not if he is asserting that calls failed to complete *as a result of the network outage*. Mr.
8 Webber is correct that some calls to CenturyLink PSAPs were shown as “Call Success
9 False.” This does not, however, mean that the calls did not complete because of the
10 network outage. The calls did not complete for other reasons. These reasons are detailed in
11 Exhibit ~~JDW-31C~~ JDW-28C and JDW-30C. The exhibits shows:

- 12 ➤ [REDACTED] calls identified the disconnect reason of “Only Party left in call,” which means
13 the 911 caller hung up after the call reached the PSAP equipment but before the
14 PSAP dispatcher answered the call. The records also indicate for all those calls, the
15 PSAP did answer those calls.
- 16 ➤ [REDACTED] other calls that did not complete:
- 17 ○ [REDACTED] failed showing a [REDACTED] code (Temp Unavailable), which indicates the
18 PSAP did not have enough trunks built to answer all of the calls presented at
19 the same time;
 - 20 ○ [REDACTED] failed showing a [REDACTED] code (Hyper Text Transfer Protocol Unavailable
21 Server error), which indicates the customer premises equipment (“CPE”)

⁵ Direct Testimony of James D. Webber (Dec. 15, 2021), Exhibit JDW-1TC, at 44-60.

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1 was down or overloaded and happened well after the outage was resolved on
2 December 30;
3 ○ [REDACTED] failed showing a 403 code (Forbidden Response code), which
4 indicates the CPE recognized the request but refused to authorize it; and
5 ○ [REDACTED] failed showing a 486 error code (Busy Here) also indicating the PSAP
6 had to many calls at one time and could not complete the call.

7 In other words, none of the calls destined for CenturyLink’s remaining 15 PSAPs failed to
8 complete as a result of the outage on the CLC Green Infinera network. This is because
9 CenturyLink designed and built its signaling network with supplier diversity.

10 **IV. RESPONSE TO PUBLIC COUNSEL DIRECT TESTIMONY**

11 **Q. MR. ROSEN TESTIFIES THAT SS7 TECHNOLOGY IS OUTDATED AND**
12 **INAPPROPRIATE FOR USE IN 911 NETWORKS. DO YOU AGREE?**

13 **A.** I do not. Mr. Turner (at pages 45-47) discusses SS7 – both as to its functionality and to its
14 importance/reliability – and thus I won’t repeat his statements. However, I will note that
15 SS7 technology is certainly not “outdated,” as Mr. Rosen argues. It is used to support
16 every 911 network of which I am familiar. Even Comtech acknowledges [REDACTED]
17 SS7 connections in its Washington 911 network [REDACTED]⁶ In addition, Staff Witness Webber
18 (at page 35) notes that SS7 is appropriate: “SS7 is a very flexible technology that can
19 perform many other functions, including transmitting the geographic address of a person
20 dialing 911 to the PSAP receiving an emergency call, in order to speed the response time of
21 the appropriate public safety agency.”

⁶ See Exhibit SJH-12C, Comtech response to data request CLC-5.

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1 I am unsure why Mr. Rosen so adamantly believes SS7 interconnection is outdated or
2 inherently flawed. The form of interconnection used for the signaling network (SS7/TDM
3 vs. IP) was not the reason 911 calls failed to reach Comtech PSAPs during the December
4 2018 outage. As other CLC witnesses have explained, the reason 911 calls failed to
5 complete to the PSAPs served by Comtech was because Comtech failed to design its
6 signaling network using supplier/network diversity. As a result, all four of Comtech's SS7
7 links became inoperable when the Infinera "Green" network became impaired.

8 **V. CONCLUSION**

9 **Q. DOES THIS CONCLUDE YOUR RESPONSE TESTIMONY?**

10 **A.** Yes it does.

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