nTelos completed an end-to-end 4G LTE field trial in April 2011, in cooperation with Alcatel-Lucent.[66] Although nTelos did not specify which spectrum it used for this trial, it owns AWS spectrum that covers 1.37 million POPs, as well as PCS spectrum.[67]

Allied Wireless Communications/ATN reports that it is "currently conducting technical evaluations of Long Term Evolution ('LTE') or '4G' technology, to further improve [its] network."[68] In April 2011, ATN formed a joint venture with the Navajo Tribal Utility Authority to contribute network-related assets to provide last mile services through a 4G LTE network to be constructed with federal stimulus money.[69] ATN holds cellular and PCS spectrum, as described in Appendix B to the Public Interest Statement.

Cox holds unused AWS and 700 MHz spectrum suitable for LTE and had been conducting LTE tests in Arizona and San Diego in collaboration with Alcatel-Lucent and Huawei. Cox's vice president of wireless said regarding the tests: "Through the LTE trials, we are utilizing the AWS and 700 MHz spectrum to test voice, data and video applications and services and ultimately readying to deploy 4G wireless broadband services to meet the needs of our customers. We are encouraged by the success of the Phoenix and San Diego tests, which further validate our decision to pursue 4G based on LTE, specifically the 3GPP Release 8

---

[66] Alcatel-Lucent, nTelos Wireless and Alcatel-Lucent complete field trial of end-to-end 4G LTE network (Apr. 7, 2011), http://www.alcatel-lucent.com/wps/portal/!ut/p/kcxml/04_Sj9SPykssy0xPLMnMz0vM0YQjzKLd4w3MfQFSYGYRq6m-pEoYgbxjgiRIH1vfV-P_NxU_QD9gtzQiHJHR0UAAD_zXg!!/delta/base64xml/L0lJayEvUUd3QndJQSEvNElVRkNBISEvNl9BX0U4QS9lbl93dw!!?LMSG_CABINET=Docs_and_Resource_Ctr&LMSG_CONTENT_FILE=News_Releases_2011/News_Article_002403.xml.

[67] Lynnette Luna, *nTelos tests LTE with Alca-Lu*, Fierce Broadband Wireless (Apr. 10, 2011) http://www.fiercebroadbandwireless.com/story/ntelos-tests-lte-alca-lu/2011-04-10.

[68] Allied Tele-Network, Annual Report (Form 10-K) at 5 (Mar. 16, 2011).

[69] Allied Tele-Network, Quarterly Report (Form 10-Q) at 19-20 (May. 10, 2011).

standard."[70] On May 24, 2011, it was reported that Cox would be providing service through the Sprint Nextel network,[71] but it has not announced what it will do with its 700 MHz and AWS spectrum.[72]

19. REQUEST:

Page 4 of the Reed and Tripathi Declaration states that "[n]or does it follow that a higher frequency network operator would necessarily have materially higher costs even if more base stations were required to obtain equivalent coverage. While the number of base stations deployed is certainly one important driver of wireless costs, there are many others."

i. Describe in detail circumstances in which the many other costs would result in a network operator not having higher costs from use of higher-frequency spectrum.

The number of base stations that an operator needs is only one of many elements that affects an operator's overall network costs. At the outset, however, it is important to reiterate that the central point made by Professors Reed and Tripathi is that in today's wireless networks, the number of base stations in many situations will be driven by *capacity*, not by coverage. Although lower-frequency spectrum has superior propagation characteristics, it is the very coverage advantages of lower-frequency spectrum that lead to capacity disadvantages. In many instances today, a purely coverage-based approach to the placement of base stations would be quickly overwhelmed by the large number of wireless users and the heavy demand they place on the network, and carriers with lower-frequency spectrum will often have to engage in cell-

[70] Press Release, Cox Communications, Cox Successfully Demonstrates the Delivery of Voice Calling, High Definition Video Via 4G Wireless Technology, *available at* http://cox.mediaroom.com/index.php?s=43&item=469.

[71] Stephen Lawson, *Cox to Close Its Own Cell Network, Use Sprint*, PCWorld (May 24, 2011), http://www.pcworld.com/businesscenter/article/228608/cox_to_close_its_own_cell_network_use_sprint.html.

[72] Jeff Baumgartner, *Speculating About Cox's Spectrum*, Light Reading Cable (May 26, 2011), http://www.lightreading.com/document.asp?doc_id=208365.

splitting. The end result will often be that the higher-frequency carriers will not have materially more base stations in an area than the lower-frequency carrier.

There are a number of other types of costs which, either independently but often in combination, can offset the propagation advantages of lower frequency spectrum. Some of these include the following: (1) The relative advantages and disadvantages of different types of spectrum are built into the cost of the spectrum itself, and to the extent that higher frequency spectrum requires the construction of more base stations, those higher deployment costs are likely to be reflected in the bids at auction. (2) Higher frequency spectrum is much better at supporting newer technologies that can increase throughput, like MIMO. (3) Carriers like AT&T must support multiple frequencies and technologies (*e.g.*, GSM, UMTS, and LTE), whereas other carriers can lower their overall network costs by skipping certain technologies altogether; thus Clearwire skipped older technologies and built a nationwide WiMAX network, LightSquared has skipped older technologies and is building a nationwide LTE network, and MetroPCS skipped 3G altogether and is constructing an LTE network. (4) Carriers have claimed other cost advantages as well – for example Clearwire has stated that its cell tower costs using 2.5 GHz spectrum are nearly half that of other cell providers.[73] (5) Higher frequency spectrum is generally available in wider bands, which may allow an operator to avoid multi-band equipment and other infrastructure costs associated with combining different lower frequency bands to achieve the same bandwidth. (6) There are many other cost categories that may vary from carrier to carrier depending upon business strategy, including customer acquisition, retail distribution, and advertising.

---

[73] *See* Clearwire Investor Presentation, Feb. 10, 2010, slide 10, *available at* http://phx.corporate-ir.net/External.File?item=UGFyZW50SUQ9Mjc4NDc1OHxDaGlsZElEPTM3MTE4MXxUeXBlPTI=&t=1.

In short, the propagation advantages of lower-frequency spectrum do not necessarily mean that a carrier will have overall lower costs than a higher-frequency carrier. Indeed, analysts have recently stated that they believe that MetroPCS's costs are *lower* than AT&T's and Verizon's.[74]

ii. Provide underlying link budget assumptions for both the uplink and downlink for bands used or planned to be used by AT&T that are above and below 1 GHz (*e.g.*, PCS, AWS, WCS, 850 MHz and 700 MHz) including (but not limited to):

a. Assumed transmit power and all gains and losses;

b. Assumed performance requirements (bit rate) for mobile and pedestrian applications, including corresponding signal to noise ratio requirements;

c. Indoor penetration losses and other assumptions that may be specific to urban, suburban and rural deployments; and

d. Fade and other assumed margins.

RESPONSE:

Although carriers use link budgets as a tool in determining where to place base stations in their networks, link budgets are just that – a tool and a starting point – and they can provide only certain types of information that are relevant to those determinations. In essence, they provide a theoretical estimate of signal loss from the base station given the propagation characteristics of the spectrum and the technology being deployed – in other words, they are most helpful in determining where to locate a base station if the carrier is pursuing a largely coverage-driven deployment. For these reasons, link budgets are most useful at the very beginning of the deployment of a network. As a network matures – and even at early stages of network rollout in

[74] *See, e.g.,* Scott Woolley, *The upstart company that made the AT&T-mobile merger possible* , Fortune (Mar. 22, 2011), *available at* http://tech.fortune.cnn.com/2011/03/22/the-upstart-company-that-made-the-att-mobile-merger-possible.

high traffic areas – cell site spacing determinations may be primarily driven not by signal strength but by interference issues (in the uplink by interference from other handsets and in the downlink by interference from other base stations).

In addition, there are many other types of considerations not captured in the link budget that have a major effect on where and how many base stations a network operator might deploy in the real world. These additional factors would include such things as: (1) the overall characteristics of the RF environment, including how much "noise" and other interference there is from other devices and handsets in the area as well as other natural and man-made RF emissions, (2) the availability of optimal cell site locations (geographic location, height, orientation, obstructions); (3) the clutter environment (including buildings and other man-made structures and topography, and foliage); (4) which cellular technology (*e.g.*, GSM vs. LTE) is being deployed; (5) topography and the overall physical environment, including whether there are obstructions such as buildings or trees; and (6) the availability and use of MIMO or other technologies that are more effective in higher frequency bands.

For these and other reasons, there is no single, universal link budget for any given spectrum band or even for any given spectrum band for a particular technology. AT&T intends to use the Qualcomm Spectrum in its new LTE network once the relevant standards and equipment are available, and AT&T has conducted some link budget analysis in connection with the initial roll out of that network. AT&T is planning to use its 700 MHz and AWS spectrum for its LTE deployment, and therefore we have provided AT&T's internal link budget assumptions for the four categories requested for 700 MHz and AWS spectrum.[75] Our response is in the form

[75] Although the attached Excel spreadsheet does not separately present link budget assumptions for 800 MHz and 1900 MHz, they are likely to be similar to those for 700 MHz and AWS, respectively.

of a spreadsheet, LTE link budget final.xlsx, which is attached.[76] The worksheets labeled LTE DL link budget template, and LTE UL link budget template define the values or range of values for the parameters specified in the four categories requested plus additional parameters that are required to conduct a link analysis for the LTE DL and UL, respectively. Values or range of values are shown for operation at 700 MHz and AWS frequency bands, which are designated Band 17 and Band 4, respectively in 3GPP specifications. For each link parameter, a value or range of values is provided along with a brief explanation in the comments column. A number of parameters are calculated from various input parameters and are designated as "Calculation" under the value column. These calculated parameters include the Transmit (TX) bandwidth, TX EIRP, Receive (RX) noise floor, RX sensitivity, and Maximum Allowable Path Loss (MAPL). The corresponding equations are provided for all of these calculated parameters.

In addition, the enclosed Excel file (Attachment 18.ii) also provides example link budgets for the DL and UL for both 700 and AWS bands, for a DL which supports a 1 Mbps bit rate and for an UL that supports 256 kbps, where both DL and UL assume a 5 MHz LTE channel bandwidth. These examples are contained in the worksheets labeled LTE DL link budget 700&AWS, and LTE UL link budget 700&AWS, respectively. The MAPL is calculated for each of the four possible links, **[Begin Highly Confidential]**

[End Highly Confidential]

[76] *See* Attachment 19.ii.

Finally, there are a number of subtleties associated with LTE link budget analysis and we have identified many of them in the comments column. The required Signal to Noise Ratio ("SNR") to support a given bit rate is typically commercially sensitive information, as this is one of the areas where the LTE infrastructure vendors attempt to differentiate themselves. The SNR values used in the examples represent a blend of inputs from various sources, and as noted in the comments, the value is dependent upon a number of variables, which could ultimately lead to quite a bit of variability in the value assumed. Also, some LTE link budgets may include a Frequency Selective Scheduling ("FSS") gain for the UL, and a handoff gain, or what might be more appropriately called a best server selection gain for both the DL and UL. **[Begin Highly Confidential]**

[End Highly Confidential] The FSS gain is the result of the UL scheduler being able to select the best resource blocks for a given user. **[Begin Highly Confidential]**

[End Highly Confidential] A handoff gain may be realized by a mobile device at the cell edge that can handoff to a neighboring cell with more favorable shadowing, *i.e.* lower path loss. **[Begin Highly Confidential]**

[End Highly Confidential] Note this latter gain is achieved even though LTE does not have a soft handoff capability as in CDMA or WCDMA.

20. REQUEST:

Provide all documents, data and analysis cited in the Public Interest Statement and the declarations of David Wise, Kristin S. Rinne, Professor Jeffrey H. Reed and Dr. Nishith D. Tripathi, and all documents and data relied upon in preparing those documents, grouped by declaration/Public Interest Statement as stated in Instruction number 6. To the extent the information has already been provided, specify the response to which it was also submitted.

RESPONSE:

AT&T will provide documents, data and analysis cited in the declaration of Kristin S. Rinne and declaration Professor Jeffrey H. Reed and Dr. Nishith D. Tripathi, and all documents and data relied upon in preparing them, at a later date. Documents, data and analysis cited in the declaration of David Wise, and all documents and data relied upon in preparing it, will be provided separately by Qualcomm in its response to the Request.

21. REQUEST:

Provide all documents discussing AT&T's valuation(s) of Qualcomm's spectrum assets. Include any valuations of Qualcomm's spectrum assets in the absence of the proposed AT&T/Deutsche Telekom-T-Mobile merger, as well as any valuations assuming that proposed merger has been approved. Provide all documents discussing the cost and relative valuation of any spectrum license the AT&T considered acquiring or acquired in the secondary market.

RESPONSE:

AT&T will provide documents responsive to this request, if any, at a later date.

22. REQUEST:

Provide all strategic plans, policies, analyses, reports and presentations discussing the Qualcomm spectrum and its expected use.

RESPONSE:

AT&T will provide plans, analyses and reports responsive to this request, if any, at a later date.

23. **REQUEST:**

Provide all documents discussing presentations to management committees, executive committees, boards of directors, investors, investor analysts, and industry analysts regarding the effect of the Proposed Transaction, including the effect on AT&T's spectrum constraints and business plans, (a) for circumstances as set forth in the Proposed Transaction (i.e., absent any AT&T/Deutsche Telekom-T-Mobile merger), and (b) for circumstances that assume the AT&T/Deutsche Telekom-T-Mobile merger has been approved.

RESPONSE:

AT&T will provide documents responsive to this request, if any, at a later date.

24. **REQUEST:**

Provide all strategic plans, policies, analyses, reports and presentations discussing how AT&T evaluates and monitors capacity, including the amount of spectrum, speed of connection, and facilities (including, cell site configuration and backhaul) that are required to meet consumer demand.

RESPONSE:

AT&T will provide plans, analyses and reports responsive to this request, if any, at a later date.

25. **REQUEST:**

Provide all strategic plans, policies, analyses, reports and presentations discussing AT&T network traffic — including network traffic statistics and current and projected data on traffic loads in both the uplink and downlink directions — for your current and projected customer base, and the corresponding technologies and services currently used or projected to be used through 2014.

RESPONSE:

AT&T will provide plans, analyses and reports responsive to this request, if any, at a later date.

26. REQUEST:

Provide copies of the following AT&T documents that were provided to the Department of Justice:

i. **Proposed Solution for the Low 700 MHz Band (dated August 13, 2010);**

ii. **Spectrum Band Plan Strategy, Spectrum Steering Committee (dated August 30, 2010);**

iii. **Playbook for Wireless Network Quality Impact (not dated): Bates number AT&T00001;**

iv. **Spectrum Acquisition Estimates (not dated): Bates number AT&T00037;**

v. **AT&T Inc. Acquisition of 700MHz Spectrum from Qualcomm Inc. (Arnold & Porter dated Jan 14, 2011);**

vi. **December 2010 Spectrum Activity Summary (not dated): Bates number AT&T000207- 216 ;**

vii. **Wireless Evolution: Supply/Demand Analysis: Bates number AT&T00140-00173 (March 8, 2010);**

viii. **LTE 250M POPs by 2013- LTE "Largely Complete by 2013" Plan 8k/16k/20k=44k nodes - RAN fundamental Planning: Bates number AT&T00174-00206 (January 11, 2011);**

ix. **Spectrum Acquisition Estimates: Bates number AT&T00037-00054 (August 3, 2010); and**

x. **Tabular Data (including data on number of base stations, number of subscribers, and spectrum and demand requirements): Bates number AT&T00055-000139.**

RESPONSE:

AT&T will provide these documents at a later date.

Attachment 1.1
In Response to Request 1

This entire attachment consisting of 1.1-1 through 1.1-43 has been redacted.

Attachment 2(a).1
In Response to Request 2(a)

This entire attachment consisting of 2(a).1-1 through 2(a).1-1198 has been redacted.

Attachment 2(c).1
In Response to Request 2(c)

This entire attachment consisting of 2(c).1-1 through 2(c).1-470 has been redacted.

Attachment 2(d).1
In Response to Request 2(d)

This entire attachment consisting of 2(d).1-1 through 2(d).1-6 has been redacted.

Attachment 2(e).1
In Response to Request 2(e)

This entire attachment consisting of 2(e).1-1 through 2(e).1-2 has been redacted.