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September 19, 2011

Delivered by Email, RESS and Courier

Ms. Kirsten Walli
Board Secretary
Ontario Energy Board
2300 Yonge Street
Suite 2701
Toronto, ON M4P 1E4

Dear Ms. Walli:

Re: Board File No. EB-2011-0120
Canadian Distributed Antenna Systems Coalition (CANDAS)
Canadian Electricity Association – Responses to Interrogatories of CANDAS

Pursuant to Procedural Order No. 2, dated August 26, 2011, and the letter of the Assistant Board Secretary, dated September 7, 2011, extending the deadline for filing responses to interrogatories on intervenor evidence, please find attached the responses of the Canadian Electricity Association (the CEA) to the interrogatories of CANDAS in the EB-2011-0120 proceeding.

Yours very truly,

Goodmans LLP

Robert Malcolmson
Encls.

c.c. Helen T. Newland, CANDAS counsel (via e-mail and courier)
Michael Schaffler, CANDAS counsel (via e-mail and courier)
Kristi Sebalj, OEB counsel (via e-mail and courier)
All Parties (via e-mail)

IN THE MATTER OF the *Ontario Energy Board Act*, *1998*,
S.O. 1998, c. 15, (Schedule B);

AND IN THE MATTER OF an Application by the **Canadian Distributed Antenna Systems Coalition** for certain orders under the *Ontario Energy Board Act*, 1998.

RESPONSES TO INTERROGATORIES OF

CANADIAN DISTRIBUTED ANTENNA SYSTEMS COALITION ("CANDAS")

(on the evidence of the Intervenor, the Canadian Electricity Association (the "CEA")

September 19, 2011

1.

Reference: LCC Report, Executive Summary, page 2 of 39

Topic: Role of ODAS

Preamble: The LCC Report states:

> Outdoor Distributed Antenna Systems (ODAS) of the type discussed by CANDAS are but one of a new set of tools intended to supplement capacity and coverage requirements for wireless communications.

Questions:

(a) State in what way is an ODAS a tool.

(b) State to whom or what type of entity is an ODAS a tool.

(c) Define "capacity requirements for wireless communications" as referred to in the above-noted citation.

  (i) Describe the instances in which additional capacity requirements for wireless communications may arise.

(d) Define "coverage requirements for wireless communications" as referred to in the above-noted citation.

  (i) Describe the instances in which additional coverage requirements may arise.

Responses:

a) In order to provide mobile or wireless communications services, the mobile service provider has a variety of technologies to choose from (macrocells, microcells, WiFi). In this context the report describes these technologies as a set of tools to meet the marketing and technical demands of the service provider's customers. ODAS is one of these tools, alongside macrocells, microcells and WiFi.

b) ODAS is a technological tool, which along with others, is available to mobile service providers. Typically, the marketing and sales groups of a service provider will set goals for the performance of the network. Their network operations and engineering groups make decisions on what specific technology may be best suited for any particular geographic area. In this context, ODAS is a tool, alongside macrocells, microcells and WiFi, to be combined to deploy the appropriate blend of products to meet the performance goals.

c) Capacity requirements are a measure of the current and projected traffic load on a network. For example, if a mobile communications service provider projects that the data traffic from smartphones will double in the next year, and that the number of subscribers will rise by 20%, these factors combine to determine capacity requirements.

(c) (i) It is widely anticipated within the wireless industry that traffic from wireless devices will exceed traffic from wired devices in the coming years. This in turn creates additional capacity requirements for wireless service providers. For example, Cisco's Visual Networking Index (July, 2011) projects that "Traffic from wireless devices will exceed traffic from wired devices by 2015. In 2015, wired devices will account for 46 percent of IP traffic, while WiFi and mobile devices will account for 54 percent of IP traffic. In 2010,wired devices accounted for the majority of IP traffic at 63 percent."

(see: http://www.cisco.com/en/US/solutions/collateral/ns341/ns525/ns537/ns705/ns827/white_paper_c11-481360_ns827_Networking_Solutions_White_Paper.html)

Voice service was once the dominant driver of capacity requirements for wireless communications: as the number of voice subscribers increased, and the amount of talking time for each subscriber increased, the capacity requirements on the wireless networks rose. With the introduction of Internet and video services, the amount of bandwidth required to deliver data and video services is now becoming much larger than for voice communications. In addition, with the combination of voice, Internet and video services, and the introduction of consumer devices with 3G and WiFi which are not only phones, but music players, e-readers, cameras and gaming devices, the capacity requirements are increasing.

In a recent interview, Krish Prabhu**,** President and CEO of AT&T Labs said "If you take a look at our wireless network, wireless data traffic has grown by 8,000 percent over the last few years."

In a recent industry report by mobile analyst Chetan Sharma, data is now on pace to make up 95 percent of global mobile traffic by 2015. Revenue from the wireless industry worldwide is expected to surpass $1.3 trillion in 2011, equivalent to 2 percent of global gross domestic product, and mobile data revenue is expected to make up around one quarter of that.

(see: http://www.chetansharma.com/usmarketupdateq22011.htm)

d) Coverage requirements are the requirement for a sufficiently strong radio signal as received by a mobile device from a fixed antenna, to sustain reliable and high quality communications for voice, Internet and video services.

Coverage is a combination of geographic coverage (i.e. is there a signal available?) and the strength of the radio signal (i.e. is the signal strong enough to support high bandwidth communications suitable for data and video, not just voice, which requires a very small amount of bandwidth compared to video, for example).

(d) (i) As users of mobile services get used to relying on their devices wherever they are, the places where they expect reliable high quality communications continues to grow.

In some locations, even if there is sufficient radio signal for a voice call, that signal may not be able to sustain a reliable Internet session or viewing a news or live sports event on a mobile device. Mobile communications service providers have to improve the coverage and radio signal performance as part of their "r.f. plan" as referred to in the LCC report. For example coverage inside public buildings (malls, government buildings), office complexes, and in vacation areas and remote sites is where previously there was either poor coverage or no coverage. Due to subscriber demand, the introduction of smartphones, connected computers and tablet devices, reliable coverage with signal strength far better than that required to support simple voice communications is required.

2.

Reference: LCC Report, Executive Summary, page 2 of 39

Topic: Role of ODAS

Preamble: The LCC Report states:

> ODAS may become a complement to more traditional wireless technologies, in part because of their flexibility of design and because key components, including antennas, can be located at a broad range of sites.

Questions:

(a) Define "more traditional wireless technologies" as referred to in the above-noted citation.

Responses:

a) More traditional wireless technologies refers to macrocells, microcells, picocells and other wireless systems such as WiFi. Specifically, these technologies are traditionally deployed with the antenna which radiates the wireless signals in close proximity to the electronics that transform voice and Internet signals into radio signals (often referred to as a base station or cell-site equipment). These systems are deployed so that all the systems are either self-contained in a single box, or assembled so all the equipment is in one place.

3.

Reference: LCC Report, Executive Summary, page 2 of 39

Topic: Role of ODAS

Preamble: The LCC Report states:

> Manufacturers understand that new antenna systems (including ODAS and others) must be flexible in terms of where they are placed and how they interact with core network components.

Questions:

(a) Define “core network components” as referred to in the above-noted citation.

Responses:

a) A telecommunications network is typically broken down into “core”, “transport” and “access” parts of the network. The core network is the part of the network where the software that controls the management of the network, routes traffic between users, hosts advanced services (such as call forwarding) is based. Physically, the core network consists of networking products such as servers, routers and switches, all of which are integrated with sophisticated software to provide a reliable connection between a wireless subscriber and voice or Internet or video services.

4.

Reference: LCC Report, Executive Summary, page 2 of 39

Topic: Role of ODAS

Preamble: The LCC Report states:

> This report provides an overview of the wireless industry, and specifically the historical and current deployments of wireless networks using macro cells and microcells and how ODAS fits into this landscape.

Questions:

(a) Define “wireless industry” as referred to in the above-noted citation.

(b) Are there any restrictions as to the types of wireless networks discussed in the LCC Report or does the LCC Report purport to relate to all types of wireless networks?

Responses:

a) The reference in the report is to the mobile wireless communications industry (i.e wireless carriers).

b) Yes: the report does not cover satellite systems or Bluetooth wireless communications.

5.

Reference: LCC Report, Executive Summary, page 2 of 39

Topic: Other fill-in technologies

Preamble: The LCC Report states:

> Instead, ODAS and multiple other technologies (e.g., WiFi, pico-, femto-) will be used to "fill in" areas of high demand and/or unique terrain characteristics.

Questions:

(a) What spectrum frequency ranges are used to provide WiFi service in Canada?

(b) What spectrum frequency ranges are used to provide public mobile wireless communications services in Canada?

(c) In Canada, is WiFi To LCC's knowledge, does any mobile wireless network operator in Canada use WiFi spectrum to provide a mobile wireless communication service to the public?

Responses:

a) The operation of WiFi is in the 2.4GHz and 5 GHz (bands 5150–5250 MHz, 5250–5350 MHz and 5725–5825 MHz)

b) The following spectrum frequency ranges are use to provide public mobile wireless communications services in Canada:

- Cellular: 824-849 MHz/869-894 MHz
- Personal Communications Services (PCS): 1850-1915 MHz/1930-1995 MHz
- Advanced Wireless Services (AWS): 1710-1755 MHz/2110-2155 MHz
- Broadband Radio Services (BRS): 2500-2690 MHz
- Mobile Broadband Service (MBS): 698-764 MHz/776-794 MHz/ 1670-1675 MHz

Commercial mobile service providers are granted spectrum licenses, as opposed to radio licenses, which allow them to provide coverage over a specific geographic area. In Canada, these geographic areas are defined by service areas, also known as tier sizes. In the United States, the Federal Communications Commission (FCC) has similar service areas associated with spectrum licenses. Furthermore, the FCC has allocated and licensed the same frequency bands as listed above (but with slight modifications) to U.S. service providers, and deployment in these bands is currently in progress. Virtually all of the spectrum in the Cellular, PCS, and AWS bands (that is, 270 MHz in total) has been licensed to various service providers, including the three major national carriers (Rogers, Bell, and TELUS), two large regional operators

(MTS Allstream and SaskTel), and new regional operators (Videotron, Shaw, Eastlink) and new entrants (Globalive, Mobilicity and Public Mobile, amongst others). Small amounts of spectrum in the PCS and 1670-1675 MHz bands were not assigned in the initial auction and are available for licensing on a first-come, first-served basis in service areas with lower population densities.

Portions of both the MBS and BRS bands are planned for auction in 2012-2013. Up to 84 MHz of the MBS band will be available for deployment in the coming years. In the BRS band, at least 60 MHz will be available for auction across Canada.

In the frequency range from 52 MHz to 38 GHz, commercial mobile services have 539 MHz of primary allocated spectrum. This figure includes the maximum amount of spectrum to be auctioned in the 700 MHz and 2500 MHz bands.

(see: http://www.ic.gc.ca/eic/site/smt-gst.nsf/vwapj/Inventory-e.pdf/$FILE/Inventory-e.pdf)

c) Shaw Communications will blanket public areas in Western Canada's major cities with a WiFi network that will provide Shaw customers with Internet access for their mobile devices everywhere from Stanley Park to the Calgary Stampede.

Work on the network, which will focus first on Calgary, Edmonton and Vancouver, has already started, but it will be next April or May before it's ready for customers to use.

Shaw's announcement on its WiFi network follows its abandonment of plans to build a wireless phone network, an undertaking company president Peter Bissonnette said would have cost more than $1 billion. While Bissonnette declined to say what the WiFi network will cost, he pointed to analysts' reports that put such networks in the $200-million to $300-million range.

"We thought it was better use of funds, rather than spending a billion dollars plus, to spend significantly less building a very robust network that leverages on our broadband network," said Bissonnette.

(see: http://www.canada.com/technology/Shaw+Cisco+build+super+network+major+cities/5399739/story.html)

Rogers, Bell Canada and Fido have teamed to provide nearly 1,200 WiFi locations throughout Canada

(see: http://www.canadianhotspot.ca/advancedsearch.php?cmd_list_all=1)

Additional Providers

- Calgary, Alberta - Operated by WestNet Wireless, first City WiFi in Canada
- Cambridge, Ontario - paid service provided by Atria Networks for various locations throughout Waterloo Region, free at Central Public Library.
- Fredericton, New Brunswick - free, Fred-e Zone

- Kitchener, Ontario - paid service provided by Atria Networks for locations throughout Waterloo Region, free at Kitchener Public Library branches.
- Mississauga, Ontario - free, Wireless access at Mississauga Libraries, Community Centres and Arenas
- Moncton, New Brunswick - free, Service provided by Red Ball Internet of Moncton. Wireless access available at Arenas and Moncton's Public Library. It was also the first city in Canada to provide wireless internet on its public transportation fleet.
- Montreal, Quebec - free, community supported Ilesansfil
- Moose Jaw, Saskatchewan - free, city center and campus
- Prince Albert, Saskatchewan - free, city center and campus
- Quebec, Quebec - free, community supported ZAP Quebec
- Regina, Saskatchewan - free, city center and campus
- Saskatoon, Saskatchewan - free, city center and campus
- Sherbrooke, Québec - free, limited to downtown, provided by ZAP Sherbrooke
- Shawinigan, Quebec - free service, limited to downtown. City-operated.
- Toronto, Ontario - free service provided by Wireless Toronto and the Toronto Public Library system for locations throughout the Greater Toronto Area;
- Waterloo, Ontario - paid service provided by Atria Networks for locations throughout Waterloo Region, free at Waterloo Public Library branches.

6.

Reference: LCC Report, Section 1, page 3 of 39

Topic: Other fill-in technologies

Preamble: The LCC Report states:

> … LCC has performed technical services for the largest wireless operators in North and South America, Europe, the Middle East Africa and Asia.

Questions:

(a) Are there any restrictions as to the types of wireless operators referred to in the above-noted citation or does the LCC Report purport to relate to all types of wireless operators?

Responses:

a) No. LCC, the largest independent telecom services company in the world with local presence in over 50 countries, is a recognized leader in providing consulting and network services to the telecommunications industry.

7.

Reference: LCC Report, Section 1, page 3 of 39

Topic: Other fill-in technologies

Preamble: The LCC Report states:

> The Company has worked with all major access technologies (including LTE, WiMAX, HSPA, EV-DO, CDMA, EDGE and GSM) …

Questions:

(a) In the above-noted citation, different access technologies are listed.

(i) Define "access" as referred to in the above-noted citation.

(ii) Define "access technologies" as referred to in the above-noted citation.

(b) Confirm that the access technologies listed by LCC are major access technologies for mobile wireless networks. If LCC does not agree with the foregoing statement, state the type(s) of networks for which the listed access technologies are major access technologies.

(c) State whether WiFi is a "major access technology" in LCC's experience? If so, state in relation to what kind of network WiFi is a major access technology.

Responses:

a)

i) A telecommunications network is typically broken down into "core", "transport" and "access" parts of the network. The access part of a wireless network consists of the equipment that transforms voice, data and video traffic into radio signals for transmission to a mobile device.

ii) See response to Interrogatory (a)(i), above.

b) The access technologies listed by LCC in the report are considered "major access technologies" in the sense that they are widely deployed by mobile wireless service providers. WiFi is also rapidly becoming a major access technology for these service providers.

c) WiFi is rapidly becoming a major access technology. WiFi had been developed as a short-range indoor wireless communications technology, operating in unlicensed spectrum. Its adoption by mobile communications service providers has been controversial, since the technology has very high capacity and short range, so a decade ago most mobile operators did not consider WiFi as important in their networks. Over the past few years: WiFi capacity has increased, range of operation has increased, and technologies to mitigate interference so operation in the unlicensed frequency bands provides high quality service, despite potential interference from other users of the frequency band. As a result, now and going forward, WiFi is an integral part of the mobile communications landscape. In addition, whereas WiFi networks used to be stand-alone access points to the Internet, they are being integrated to the core network of mobile communications service providers, so the very same services offered on say a 3G network are offered on a WiFi network.

(see: http://www.thewirereport.ca/reports/content/12949-shaw_wifi_network_to_initially_target_malls_arenas_transit_expand_later)

According to the Federal Communications Commission's (FCC) 2011 Wireless Competition Report, 40 per cent of iPhone data is carried over WiFi. According to data collected by AT&T Inc., 59 per cent of Telco's WiFi connections were made with smartphones in 2010.

(see: http://www.fcc.gov/reports/15th-annual-mobile-wireless-competition-report)

8.

Reference: LCC Report, Section 1, page 3 of 39

Topic: Other fill-in technologies

Preamble: The LCC Report states:

> LCC has been involved in the design and optimization of networks utilizing virtually every major transport technology ranging from traditional microwave and leased line to advanced technologies.

Questions:

(a) In the above-noted citation, different transport technologies are listed.

(i) Define “transport” as referred to in the above-noted citation.

(ii) Define “transport technologies” as referred to in the above-noted citation.

(b) Provide a sketch or diagram clearly depicting the access and transport portions of a mobile wireless communications network.

(c) In a mobile wireless communications network, why are different technologies used in the access portion of the network and in the transport portion of the network.

Responses:

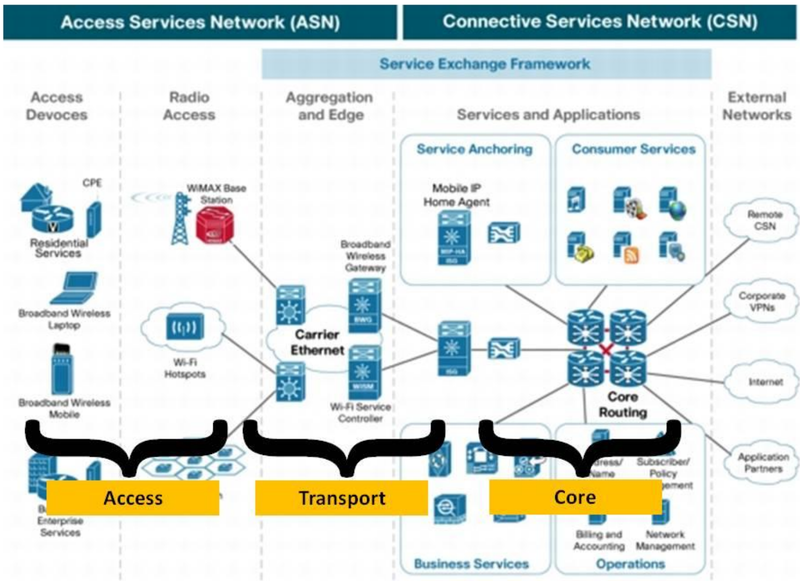
a)

i) A telecommunications network is typically broken down into “core”, “transport” and “access” parts of the network. The transport part of the network is the equipment that is used to connect the core network and the access network.

Transport is for the transport of the traffic between different parts of a telecommunications network, and interconnects various network elements such as switches, routers and base stations. The traffic is the combined traffic from hundreds and even thousands of users of the telecommunications network.

ii) Transport technologies are any form of transmission technology that can handle the high capacity of the traffic. Examples of the transmission medium are optical fiber, microwave, or copper connections. Industry standard protocols have been developed to utilize these technologies, so that the traffic can be transmitted and managed in a standardized way between different vendors' equipment.

b) Please see figure below.



c) Mobile communications service providers chose one or more access technologies based on the radio spectrum they own, the services they offer, and the current generation of technology available in the network, and the corresponding capabilities of mobile phones they want to offer to their customers.

The industry has fragmented into many competing standards (e.g. GSM vs. CDMA) which provide comparable services for 2G and the different flavours of 3G (developed in the 3GPP and 3GPP2 standards bodies). Each of these standards also have various offshoots and derivatives. In addition, WiMAX, WiFi and other access technologies have also been developed for mobile communications services. With the emergence of 4G/LTE technology, a single service provider may also have a legacy 3G network, and introduce 4G services in certain locations, followed by more widespread migration across their network.

9.

Reference: LCC Report, Section 1, page 3 of 39

Topic: Other fill-in technologies

Preamble: The LCC Report states:

> By providing increased capacity with various solutions including indoor and outdoor Distributed Antenna Systems (DAS), data off-loading and mobility services are using both licensed radio and unlicensed (WiFi) radio service solutions.

Questions:

(a) Define “data off-loading” as referred to in the above-noted citation.

(i) List examples of data off-loading services.

(ii) List North American providers of data off-loading services.

(b) Define mobility services as referred to in the above-noted citation.

Responses:

a) Many network operators have found that with limited licensed spectrum, they cannot meet the projected capacity demands of mobile traffic by deploying macrocells and microcells. “Data-Off Loading” is an industry term used to describe ways of reducing the strain of the macro cellular network. The capacity of current WiFi systems is approximately tenfold higher than 3G. So despite that fact that WiFi operates in unlicensed spectrum, by combining WiFi access with mobile, the service provider can deliver the same services they would on the 3G network, but over WiFi as the access technology.

Of course, this requires that the mobile device has WiFi connectivity, so the user experience is transparent and seamless across the 3G and WiFi network. Most smartphones and tablet devices have been deliberately designed with mobile and WiFi technology for exactly this flexibility in connecting across different networks. These networks are referred to Heterogeneous Networks or HetNets.

(see: http://www.wifidataoffload.com/)

i) The amount of global data traffic being offloaded from smartphones, feature phones and tablets to complementary fixed-device networks will grow about 47% from its 2010 level of 43.1% to an anticipated 2015 level of 63.25%, according to a new whitepaper from Juniper Research.

(see:

http://www.juniperresearch.com/whitepapers/Balancing_the_Mobile_Data_Load)

There are two types of existing solutions to alleviate the traffic load on cellular networks: offloading to small cells (Femto/Pico) and WiFi networks:

1) Femtocell for Indoor Environments: Originally, the femtocell technology (i.e., access point base stations) was proposed to offer better indoor voice and data services of cellular networks.

Femto/Pico cells work on the same licensed spectrum as the macrocells of cellular networks and thus do not require special hardware support on mobile phones. But customers may need to install short-range base stations in residential or small-business environment, for which they will provide Internet connections. Due to their small cell size, femtocells can lower transmission power and achieve higher signal-to-interference-plus-noise ratio (SINR), thus reducing the energy consumption of mobile phones. Cellular operators can reduce the traffic on their core networks when indoor users switch from macrocells to femtocells. A literature review about the technical details and challenges of femtocells can be found in Chandrasekhar et al.

(see: Chandrasekhar, V.; Andrews, J.; Gatherer, A.; Univ. of Texas at Austin, Austin, TX. This paper appears in: Communications Magazine, IEEE; Issue Date: September 2008 ; Volume: 46, Issue:9; On page(s): 59 – 67).

2) Cellular Traffic Offloading to WiFi Networks: Compared to femtocells, WiFi networks work on the unlicensed frequency bands and thus cause no interference with 3G cellular networks. As a result, cellular network operators, including AT&T, T-Mobile, Vodafone, and Orange, have deployed or acquired WiFi networks worldwide. Meanwhile, there are already several offloading solutions and applications proposed from the industry.

ii) AT&T, Verizon, T-Mobile, Sprint, Time Warner Cable, Cox, Cablevision are all major players in US that are deploying an off-loading strategy. Bell Canada, Rogers and Fido are deploying offloading strategies in Canada.

b) Mobility services are any form of wireless communications for voice, Internet or video where the user is using a portable or mobile device connected over a radio link.

10.

Reference: LCC Report, Section 1, page 3 of 39

Topic: Other fill-in technologies

Preamble: The LCC Report states:

> Wireless carriers … are looking at various technology solutions to support the ever increasing demand for bandwidth.

Questions:

(a) Provide the rate of growth of demand for bandwidth on public mobile wireless communications networks, identifying relevant sources, justifying the above-noted citation.

(b) Describe the causes of the ever increasing demand for bandwidth as referred to in the above-noted citation.

(c) Describe the causes of increasing demand for bandwidth on public mobile wireless communications networks?

Responses:

a) See response to Interrogatory 1(c)(i), citing Cisco's Visual Networking Index (July, 2011), which projects that, by 2015, traffic from wired devices will account for only 46 percent of IP traffic, while WiFi and mobile devices will account for 54 percent of IP traffic.

b) See response to Interrogatory 1(c)(i).

c) See response to Interrogatory 1(c)(i).

11.

Reference: LCC Report, Section 1, page 3 of 39

Topic: Other fill-in technologies

Preamble: The LCC Report states:

> Each solution plays a role in meeting our clients [*sic*] demand to get the wireless signal closer to where the actual users are.

Questions:

(a) State the relationship, if any, between getting "the wireless signal closer to where the actual users are" and

(i) Increasing capacity

(ii) Increasing coverage

(iii) both.

Responses:

a)

i) There is a direct relationship between the strength of a signal and the amount of information that can be carried on that signal (i.e. to carry voice only traffic at 8 kb/s requires a fraction of the signal strength for a high quality video transmission at 1 Mb/s). In order to increase capacity, it is always preferred to bring the signal closer to where the actual users are located. This also improves signal coverage.

ii) See response to Interrogatory (a)(i), above.

iii) See response to Interrogatory (a)(i), above.

12.

Reference: LCC Report, Section 2, page 4 of 39

Topic: Wireless Industry Overview

Preamble: The LCC Report states:

> From the inception of mobile communications systems, stand-alone cell towers have been the dominant way to illuminate service areas with radio signals.

Questions:

(a) Define “mobile communications systems” as referred to in the above-noted citation.

(b) Indicate whether, for purposes of the LCC Report, a “mobile communications systems” is a synonym for a mobility service.

(c) State the relationship between stand-alone cell towers and macro cells as referred to in the Executive Summary.

(d) Identify the average diameter of the geographic area that is “illuminated” using a stand-alone cell tower.

Responses:

a) For the purposes of the report, the term mobile communications systems means wireless systems which transmit voice, data and video services to subscribers.

b) Yes.

c) Please refer to the first paragraph on page 4 of the report.

d) The working range of a cell site - the range within which mobile devices can connect to it reliably - is not a fixed figure. It will depend on a number of factors, including

- The frequency of signal in use (i.e. the underlying technology).
- The transmitter's rated power.
- The required uplink/downlink data rate of the subscriber's device
- The transmitter's size.
- The array setup of panels may cause the transmitter to be directional or omni-directional.
- It may also be limited by local geographical or regulatory factors and weather conditions.

Generally, in areas where there are enough cell sites to cover a wide area, the range of each one will be set to:

- Ensure there is enough overlap for "handover" to/from other sites (moving the signal for a mobile device from one cell site to another, for those technologies that can handle it - e.g. making a GSM phone call while in a car or train).
- Ensure that the overlap area is not too large, to minimize interference problems with other sites.

13.

Reference: LCC Report, Section 2, page 4 of 39

Topic: Wireless Industry Overview

Preamble: The LCC Report states:

> The confluence of end-user demand and proliferation of devices with advanced media capabilities is putting pressure on traditional macrocell deployment and its ability to provide necessary capacity and coverage in areas of high use. … Wireless Carriers are therefore being forced to (i) develop smaller cell sites to increase the reuse of available spectrum; and (ii) deploy alternative wireless strategies such as using unlicensed WiFi to reduce the strain on capacity.

Questions:

(a) Describe the way in which increased demand puts pressure on traditional macrocell deployments.

(b) Describe the way in which this pressure alleviated through the use of smaller cell sites.

(c) In the context of outdoor coverage, indicate how far apart or at what intervals these smaller microcell sites are spaced in order to be effective in alleviating the pressure on traditional macrocell deployment.

(d) Indicate whether an ODAS is an example of a microcell deployment. If not, identify the distinguishing characteristics of an ODAS as compared to a microcell deployment.

(e) Provide examples of actual outdoor mobile wireless communications deployments that have established microcell sites using

(i) Exclusively utility poles, streetlight or other street furniture

(ii) Exclusively on buildings and rooftops

(iii) A combination of the two

(iv) In each case, state the geographic coverage area and the role of such deployment in the mobile wireless carrier's overall network.

Responses:

a) Traditional macrocell deployments run into practical limitations when the coverage and capacity requirements in a particular region may require that a macrocell with a stand-alone tower be placed with spacing of less than a mile (especially in urban or suburban areas, where this is not only economically unfeasible, but there is no physical property that can support this type of infrastructure).

b) Over a decade also, it was evident to mobile operators that there is insufficient space for erection of stand-alone towers in many locations, so they used tops or sides of existing buildings and any form of mounting structure that would support the shape, size and weight of the required equipment, and the appropriate connections for power, connection to the rest of the telecommunications network, and a suitable adjacent location for an antenna, which also had to blend into the environment based on local zoning rules.

Many innovations resulted, including the famous "fake tree" antennas. In addition, as the size of the equipment was reduced by miniaturization of the electronics, the range of buildings and other structures also became more flexible, and manufacturers built microcells that would, for example, be suitable for installation inside a shopping complex, rather than rely on radio signals from a tower at the edge of a shopping mall.

In this way, the deployment of microcellular equipment, with smaller range than macrocells, were able to fill in "what some in the industry call an "umbrella" approach for macrocells, and "underlay" approach for microcells, so there is high quality contiguous coverage for users.

c) Please see response to Interrogatory 14(a), below.

d) Yes: ODAS is a type of microcell.

e)

i) The Paradise Valley ODAS installation includes 42 cellular nodes – 37 in faux cactuses, three on streetlights, and two on traffic signals.

ii) Typically, all large stadium/venue locations, including the Dallas Cowboy Stadium NY Giants/Jet Staduim and University of Notre Dame Stadium.

iii) Some examples include:

1. Philadelphia

- Coverage area: More than 100 square miles
- Miles of fiber: About 250
- Number of DAS sites: Approximately 400
- Number of jurisdictions: More than 10
- Number of permits: Roughly 800

2. Los Angeles
- Miles of fiber: More than 500
- Number of DAS sites: Approximately 1,000

3. San Diego
- Frequency: cellular and PCS

- Number of DAS sites: more than 500
- Miles of fiber: more than 400
- Usage: streetlight poles, utility poles and traffic signal poles
- Other: the City benefits from franchise fee revenues it receives from NextG Networks.

4. Atlanta

- Frequency: 800 MHz and 1.9 GHz available
- Traffic: iDEN, CDMA
- Number of Nodes: 50
- Population served: downtown, midtown, suburban and Buckhead
- Miles of fiber: more than 30
- Usage: streetlight poles, utility poles and traffic signal poles
- Other: the City benefits from franchise fee revenues it receives from NextG Networks.

Further examples of actual deployments can be provided to the Board Secretary on a confidential basis, upon request.

iv) Please see response to Interrogatory 13(e)(iii), above.

14.

Reference: LCC Report, Section 3, page 6 of 39

Topic: Wireless Industry Overview

Preamble: The LCC Report states:

> One technology that has emerged in this drive toward smaller, more focused antenna sites, is ODAS. ODAS uses a distributed set of small antennas fed by one radio transmitter. This use of a single transmitter sharing multiple antennas is somewhat unique, in that more conventional systems assign a single transmitter to each antenna.

Questions:

(a) Provide the coverage and capacity characteristics of a micro-cell deployment.

(b) Provide coverage and capacity characteristics of an ODAS deployment.

(c) Provide the coverage and capacity characteristics of a pico-cell deployment.

(d) Provide the coverage and capacity characteristics of a femtocell deployment.

Responses:

a) This table provides the cell range, and typical coverage diameter of Macrocells, Microcells, Picocells, Femtocells, and Outdoor Distributed Antenna Systems, and Indoor Distributed Antenna Systems.

It should be noted that most networks are built with macrocells for broad coverage and then microcells are used to fill in for capacity and coverage. Other technologies are used according to the specific requirements of the mobile service provider, as stated elsewhere in the report and responses. This table does not include WiFi specifically, but the cell diameter of modern-day WiFi systems built for mobile service providers are in the Picocell/Microcell range.

Coverage and Capacity			
	cell diameter (range)	**cell diameter (typical)**	**deployment (typical)**
Macrocell	1 mile to 15 miles	2 miles	outdoor
Microcell	500 feet to 1 mile	0.5 mile	outdoor/indoor
Picocell	100 feet to 500 feet	300 feet	outdoor/indoor
Femtocell	10 feet to 100 feet	50 feet	outdoor/indoor
ODAS	500 feet to 0.5 mile	1000 feet	outdoor: multiple antennas
DAS	50 feet to 500 feet	300 feet	indoor: multiple antennas

Since the ODAS and DAS systems have multiple antennas, if an ODAS in equipped with three antenna locations, then the effective coverage would be three times stated above, and would behave like three different microcells adjacent to each other.

Regarding the capacity of these systems: the capacity of a system is dependent on numerous factors: how much licensed spectrum is used by the network operator (and whether they have chosen to supplement that with unlicensed spectrum technology (WiFi) as part of their network plan. Also, by the type of equipment that they have deployed at each location, and whether it is equipped to use the full range of spectrum resources at that location, or just a fraction of the spectrum.

b) Please see response to Interrogatory 14(a), above.

c) Please see response to Interrogatory 14(a), above.

d) Please see response to Interrogatory 14(a), above.

15.

Reference: LCC Report, Section 4, page 9 of 39

Topic: Role of ODAS

Preamble: The LCC Report states:

> There are many novel and unique aspects to DAS technology that are captured in this report and their relevance to the question of attachment rights to Utility Poles.

Questions:

(a) List the novel and unique aspects of an outdoor DAS that are captured in the LCC Report.

(b) To the extent not captured by the LCC Report, provide any other distinguishing characteristics of an ODAS deployment in terms of

(i) The topology of a ODAS network

(ii) The capacity benefits of an ODAS network.

Responses:

a) The novel and unique aspects of an ODAS include:

a. Multiple signals from the base station equipment of one or more different mobile communications service providers can be combined onto a single transmission facility, over an optical fiber network;

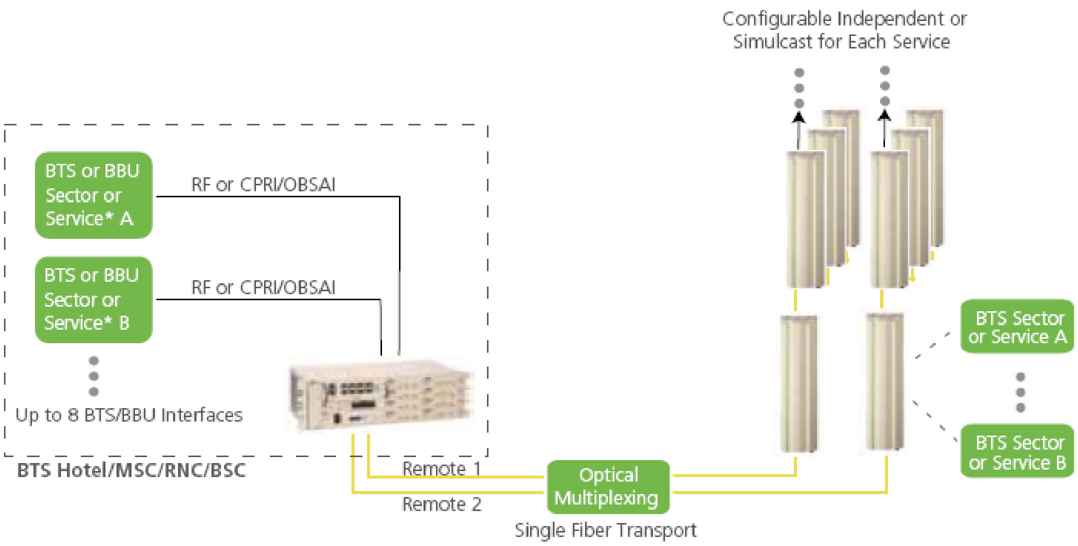
b. The antenna systems for the ODAS are placed far away from the base stations by taking the radio signals over a fiber connection to a remote antenna, rather than radiating over an antenna that is collocated at the base station site;

c. The ODAS system can carry multiple types of signals at different frequency ranges (e.g. 3G, LTE and WiFi) over the very same system, eliminating the need for dedicated cables or distribution facilities for each technology;

d. The remote unit, since its functionality is much less complex than a base station, is compact and requires less power than a base station, so it can be mounted in a remote location with much more flexibility based on size, shape and weight, over that of mounting one or a multitude of base stations;

e. Since the base stations of multiple service providers can be connected not only to the ODAS, but are also part of a larger network of microcells and macrocells, the ODAS becomes an extension of the full mobile communications network, supporting voice, data and video services to mobile devices over both licensed band and unlicensed spectrum technology (i.e. 3G, LTE and WiFi, for example).

As illustrated below, an ODAS can support the equipment of multiple service providers (A, B, etc) in the "BTS Hotel", and then the optical fiber distribution of the signals and the antenna systems are shared.



Sample System Configuration

b)

i) The Topology of a single ODAS system is illustrated above, and includes the following components:

BTS Hotel: facility where the base station equipment of one or more mobile communications service providers is located;

Host (box on left in figure above): equipment that is part of the ODAS, which is the place where multiple radio signals are combined and transmitted over a fiber connection;

Fiber transport: a dedicated fiber link that connects the host to a multitude of Remote Units, and delivers the appropriate radio signal from each base station to its corresponding remote unit;

Remote units (box on right in figure above): a multitude of installations that feed a collocated antenna, and can be attached to buildings, poles, street furniture etc., and radiate the signals from a base station. The signals radiated from a remote unit may be the same as that radiated by other adjacently-mounted remote units (in a configuration called simulcast), or may have different signals, corresponding to different "sectors" of a base station's signals.

ii) Capacity: The impact of capacity of an ODAS is essentially identical to a microcell. There are no inherent or specific attributes of an ODAS that improve the capacity of the network. The unique feature is the ability to handle multiple carriers, signals, (WiFi, 3G etc.), all in the same antenna system. This is unique, compared to installations where the antenna and base station are connected directly.

16.

Reference: LCC Report, Section 5, page 11 of 39

Topic: Other fill-in technologies

Preamble: The LCC Report states:

> Two examples of advances in mobile communications systems have various trade names such as Liquid Radio (from Nokia Siemens Networks) and Light Radio (from Alcatel Lucent). These technologies differ from ODAS, but can achieve the same purpose: to fill-in coverage and capacity as a supplement to conventional macro and micro cells. …
>
> These miniaturised devices have the ability to integrate the antennas into the box, so they can be installed as one attachment on buildings, towers and utility poles ….

Questions:

(a) Identify which mobile wireless carriers, when, where and on what scale have deployed these technologies.

(b) In each case, describe what services (*i.e.* voice services data services, mobile or fixed) services are being provided and whether services are being offered to the public for compensation or for within private networks.

Responses:

a) In a press release from Alcatel Lucent, a number of mobile communications service providers including France Telecom, Orange, Verizon Wireless and China Mobile announced plans to deploy the Light Radio technology in commercial trials in their networks.

(see: http://www.cellular-news.com/story/38295.php)

b) These technologies support voice, data and video services to mobile devices.

17.

Reference: LCC Report, Section 5, page 11 of 39

Topic: Other fill-in technologies

Preamble: The LCC Report states:

> In addition, instead of using an antenna with a fixed radiation pattern at a macro cell or microcell, "smart" antenna technologies (also called adaptive antennas) have been deployed commercially.

Questions:

(a) Identify which mobile wireless carrier, when, where and on what scale have deployed these technologies.

(b) In each case, describe what services (*i.e.* voice services data services, mobile or fixed) services are being provided and whether services are being offered to the public for compensation or for within private networks.

Responses:

a) Smart antennas is the name given to a wide range of technologies that use multiple antennas for transmitting and receiving radio signals, and by the use of sophisticated digital signal processing to improve capacity, reduce interference, and to dynamically change the radio signal pattern, in response to the traffic demands at a base station. The earliest large-scale deployment of smart antennas for mobile communications was on the PHS technology in Japan by KDDI. There were also deployments of the same technology in other Asian markets such as China and Taiwan. In the IEEE 802.20 Mobile Broadband Wireless Access standard, a product called iBurst was specified, which also uses smart antennas, and that technology has been deployed in over 30 different countries.

b) Smart antenna technologies support voice, data and video services and have no restrictions on what types of services can be supported. On the contrary, they enable the support of higher levels of traffic and bandwidth than conventional antenna systems.

   The authors do not have access to specific product sales information, and the deployments of these products tends to be confidential information held by the mobile communications service providers in their r.f. planning, but the incorporation of smart antennas in mobile wireless communications systems is now an integral part of the design of most mobile communications systems, and deemed as necessary in the LTE standards to support high speed data and video services.

18.

Reference: LCC Report, Section 5, page 12 of 39

Topic: Other fill-in technologies

Preamble: The LCC Report states:

> The industry is also moving very rapidly into new areas, such as "heterogeneous networks" where a mobile phone may be on a cellular network, but can seamlessly transition to a low-power WiFi network, to improve battery life and to maximize bandwidth availability.
>
> Most major network operators have announced plans to use WiFi technology (with short range, and typically mounted on the sides of buildings or other fixed structures) to "offload" the traffic from the conventional macro cell and micro cell networks.

Questions:

(a) Indicate whether WiFi offload provides the same functionality as a (i) microcell, (ii) ODAS, (iii) picocell, or (iv) femtocell deployment within a public mobile wireless communications network. Provide a detailed explanation justifying LCC's answers.

(b) Indicate and provide full particulars of any WiFi equipment capable of providing public switched voice services, and if so, whether LCC is aware of any service deployment by a mobile wireless carrier, or any other type of carrier using same, to provide voice services?

Responses:

a) Please see response to Interrogatory 9(a), above.

b) WiFi by its very nature is a core IP technology, so does not support public switched (circuit) voice services. However, WiFi does support Voice over IP. Numerous service deployments, include T-Mobile. All of T-Mobiles Android and Blackberry smartphones now support WiFi calling. AT&T and Verizon are incorporating a WiFi hotspot feature in all iPhones. Fixed Mobile Convergence allows for the seamless voice call hand off between Cellular and WiFi networks.

19.

Reference: LCC Report, Section 14, pages 27 to 32

Topic: Wireless Industry Overview

Preamble: The LCC Report states:

> Below we identify numerous antenna locations that rely neither on buildings, utility poles or street furniture, but instead, use existing or replacement commercial signage:

Questions:

(a) Of the antenna installations depicted on pages 27 to 32, identify the installations in which LCC has direct knowledge.

(b) LCC is requested to determine, of the antenna installations depicted, the street address of each installation.

(c) To the extent possible, LCC is requested to determine and clearly identify, of the antenna installations depicted, which are:

(i) Micro cell sites;

(ii) pico cell sites;

(iii) femtocell sites;

(iv) WiFi nodes.

Responses:

a) LCC has identified all of these installations as examples of ODAS systems being attached to structures other than utility poles. The diagrams/pictures speak for themselves.

b) Production of this information would be unduly onerous relative to its probative value, if any.

c) All sites depicted on pages 28-30 are Macro/Micro sites with the exception of the stadium picture (Mid Page 30), which is an ODAS deployment. All of the sites depicted on pages 28-30 would be suitable for ODAS deployments.

20.

Reference: LCC Report, Section 9, page 18

Topic: Differences between wireline and ODAS pole attachments

Preamble: The LCC Report states:

> Before exploring utility pole usage, it is useful to define the physical components of ODAS, and which of these are the subject of attachment rights (i.e. devices that would have to be attached to a utility pole or other structure to make ODAS operational):
>
> - A host base station with a wireline connection to the distributed antenna system
> - Distribution poles upon which DAS equipment can be installed
> - A fiber optic network (typically an existing system) to carry the signals from the base station to the antennas
> - Shared antennas and control boxes
> - Neutral host for different wireless service providers
> - Lightening [*sic*] protection box
> - Connection to a power supply
> - Battery-powered back-up supply in the event of a distribution line loss of service

Questions:

(a) Define the physical components of wireline telecommunications and CATV attachments to poles.

(b) Define the physical components of other, non-communications attachments that may typically be found on poles.

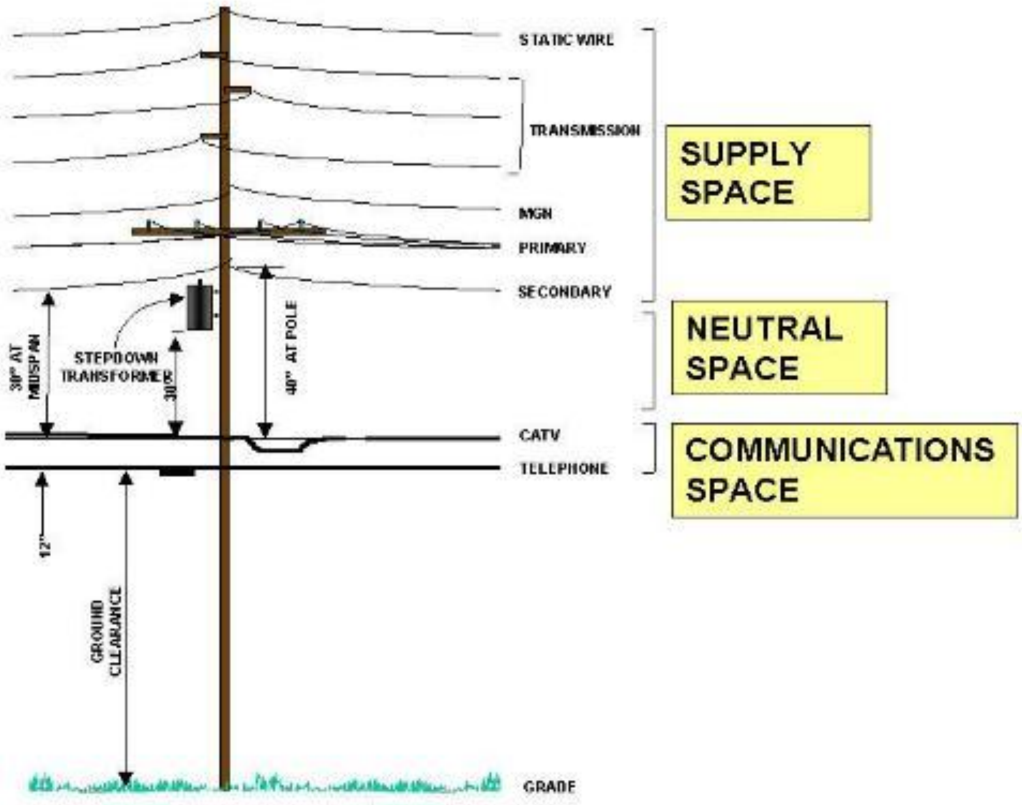
Responses:

a) Please see diagram below.

b) Please see diagram below.

Space Allocation on Joint Poles

JOINT POLE: A utility pole which supports the facilities of two or more companies.



A typical joint pole supports three facilities: electric power, cable television, and telephone.

Some joint poles also support all manner of other devices: streetlights, signs, traffic signals, seasonal decorations, fire and police call boxes, antennas, municipal communications systems, OPGW (optical ground wire) fire- and police-alarm signal wiring.

This figure illustrates the typical allocation of space on joint utility poles in the United States; the allocation is similar in Canada except that cable television and telephone are sometimes lashed to the same supporting strand.

Starting at the top and working down, facilities on the pole are allocated into three spaces: Supply Space, Safety Zone Space, and Communications Space.

The Communications Space contains telephone, cable television (CATV), and other communications cables. Communications cables are insulated; however they may be enclosed in metal shields. For safety reasons, all exposed metallic surfaces must be bonded to each other and to the MGN.

Typical communications cables include:

- Telephone: telephone cables supported by steel strand. Each telephone cable contains several individual copper wire pairs; a large cable may contain as many as several hundred pair. The strand is placed under tension to prevent excessive sag; typical strand tension is a few hundred pounds, although a strand supporting a large multipart cable may be tensioned as high as 1000 pounds.
- Cable TV: CATV coaxial cable and equipment supported by steel strand. An expansion loop at each pole absorbs expansion and contraction caused by temperature variations. The strand is placed under tension to prevent excessive sag; the typical strand tension is a few hundred pounds.
- Other: just about any other type of communications circuits. Among the more common are fire- and police-alarm wiring, traffic-signal control wiring, and closed-circuit audio or video communications circuits. Depending on purpose and age, these circuits may utilize open-wire conductors, twisted-pair cables (similar to telephone networks), coaxial cables (similar to CATV networks), or fiber optic cables.

21.

Reference: LCC Report, Section 9, page 18

Topic: Differences between wireline and ODAS pole attachments

Preamble: The LCC Report refers to a "filing with the US FCC, dated August 2010" by the Coalition of Concerned Utilities (CCU).

Questions:

(a) Provide a copy of the filing of the CCU as referred to by LCC.

Responses:

a) Please see: https://prodnet.www.neca.org/publicationsdocs/wwpdf/81710ccu.pdf

22.

Reference: LCC Report, Section 11, page 22

Topic: San Diego State University ODAS

Preamble: The LCC Report states:

> The DAS includes nodes that are strategically placed on existing utility poles, street lights, traffic signals and other structures every half mile within the coverage area.
>
> …
>
> The nodes connect to a hub via fiber optic-cable. The hub contains American Tower's head-end equipment and the service provider's Base Transceiver Station (BTS)."

Questions:

(a) Indicate whether the San Diego State University ODAS installation makes use of utility poles (including hydro poles, lampposts and streetlights) where such support structures were available.

Responses:

a) San Diego State University ODAS installation utilizes a combination of utility posts and other structure so as to strategically places nodes on approved buildings and lampposts in a manner so as to make them virtually unnoticeable.

23.

Reference: LCC Report, Section 12, page 23

Topic: Alternatives to poles

Preamble: The LCC Report states:

> One illustration is the case of Paradise Valley, Arizona, where ODAS was approved for installation and the vast majority of the DAS equipment was deployed on purpose-built structures, …

Questions:

(a) Indicate whether the Paradise Valley ODAS installation makes use of utility poles (including hydro poles, lampposts and streetlights) where such support structures were available.

Responses:

a) The Paradise Valley ODAS installation includes 42 cellular nodes – 37 in faux cactuses, three on streetlights, and two on traffic signals.

24.

Reference: LCC Report, Section 13, pages 24-25

Topic: Alternatives to poles

Preamble: The LCC Report states:

> Even when fiber isn't available, many newer technologies can rely upon a more standardized broadband connection for that purpose. The picture to the left below represents the installation of an ADC Systems wireless antenna and supporting equipment on the side of a commercial building. The picture to the right represents similar equipment attached to the structure of a sports stadium.

Questions:

(a) Provide the coverage range of the ADC Systems wireless antenna depicted in the above-referenced pages of the LCC Report.

(b) Indicate whether the ADC Systems wireless antenna operate within and require a network of contiguous nodes or whether they are systems intended to provide wireless communications to a given location only.

(c) Identify the telecommunications service, if any, that is being provided using the ADC Systems (*i.e.* fixed or mobile, voice or data or both, to the public for compensation or for a private radio service)?

Responses:

a) The actual coverage range is dependent on several factors including actual RF frequency (Band), Output Power as well at terrain.

b) The ADC Systems' wireless antenna does not operate within a system of contiguous nodes. Similarly, ODAS also does not operate within a system of contiguous nodes.

c) The ADC FlexWave product states it is a "Next Generation DAS; optimized for multiple frequency bands, services or applications". It supports users who are fixed or mobile, and support for "Each remote is multi-purpose, providing 2G, 3G and 4G services concurrently, air interface and BTS/BBU independent"and "Air Interface and BTS vendor independent" (i.e. all the major standards) and voice, data and video services.

25.

Reference: LCC Report, Section 14, pages 27 - 32

Topic: Alternatives to poles

Preamble: The LCC Report identifies "numerous antenna locations that rely neither on buildings, utility poles or street furniture, but instead, use existing or replacement commercial signage…"

Questions:

(a) Please clearly identify and provide the street address of each antenna installation depicted on the above-noted pages of the LCC Report.

(b) For each identified antenna installation, indicate whether the installation is

(i) A macrocell antenna site

(ii) A microcell antenna site

(iii) An ODAS antenna site

(iv) A picocell antenna site

(v) A femtocell antenna site

(vi) A WiFi antenna site.

Responses:

a) Production of this information would be unduly onerous relative to its probative value, if any. .

b) Please see response to Interrogatory 19 (c), above.

26.

Reference: LCC Report, Section 15, pages 33

Topic: Role of ODAS

Preamble: The LCC Report states:

> If a carrier is looking at option A as a DAS deployment or option B as something akin to a remote antenna or traditional cell site, option A will cost more.

Questions:

(a) Define "remote antenna" as referred to in the above-noted citation.

(b) List examples of "remote antenna" systems that are referred to or discussed by LCC in its Report.

(c) List the advantages of ODAS deployments over remote antennas from the perspective of a mobile wireless network operator and from the perspective of the subscribers of mobile wireless network operators.

Responses:

a) Remote antenna refers to a technology incorporating a base station where radio signals are created and its antenna by which the radio signal is transmitted over the air and is separated by a significant distance. Remote antenna systems are deployed in locations where an antenna is desired, but there are insufficient facilities at that location (due to size, power, economics) to locate a full base station, so the radio signal is fed to that location, and that signal is converted and fed into the remote antenna.

   Typically, this is done over a fiber link (a technology that was first referred to as "radio over fiber"), although systems have been developed to perform the same "remote antenna" link over a point to point microwave link as well. These installations are not aimed to feed a multitude of remote antennas, and are typically used by a specific mobile communications network, and not provided as a shared facility to multiple service providers.

b) Examples of remote antenna systems include deployment by many service providers using fiber connections in secluded areas and dead-spots, and largely in macrocellular locations, as well as in areas such a suburban transit systems, where an antenna could be placed in a tunnel to provide wireless signals to commuters from a centralized base station complex. A specific example is the 500 remote antenna units connected by fiber, used for the Sydney Olympic Games in Australia.

c) ODAS, in simplistic terms, are a derivative product of remote antennas. An ODAS is designed to support multiple remote units and antenna locations, rather than a single remote antenna. This is done by transmitting multiple radio signals over the fiber, and each remote unit can pick off and transmit only the radio signals intended for that particular location. This level of design and intelligence also allows the ODAS to support transmission of signals for multiple mobile communications service providers. This is what makes an ODAS particularly unique: for example, three mobile communications service providers may share an ODAS that is installed by one entity, and by appropriate management of signals, each of the operators can implement their own radio frequency plan (r.f. plan) over the common ODAS facilities.

27.

Reference: LCC Report, Section 16, pages 33-35

Topic: About the authors

Preamble: n/a

Questions:

(a) Is the principal author Dr. Shah or Mr. von Schaumburg?

(b) Identify and provide a copy of any written testimony, expert reports, transcripts of live testimony or depositions given by Dr. Nitin J. Shah on access to support structures (i.e. pole, duct, conduit) and rights-of-way.

(c) Identify and provide a copy of any written testimony, expert reports, transcripts of live testimony or depositions given by Dr. Nitin J. Shah on wireless communications networks and services.

(d) Identify and provide a copy of any written testimony, expert reports, transcripts of live testimony or depositions given by Mr. E.J. von Schaumburg on access to support structures (i.e. pole, duct, conduit) and rights-of-way.

(e) Identify and provide a copy of any written testimony, expert reports, transcripts of live testimony or depositions given by Mr. E.J.von Schaumburg on wireless communications networks and services.

Responses:

a) The report is jointly authored.

b) Dr. Shah has provided no such written testimony, expert reports, etc.

c) Dr. Shah has provided no such written testimony, expert reports, etc.

d) Mr. von Shaumburg has provided no such written testimony, expert reports, etc.

e) Mr. von Shaumburg has provided no such written testimony, expert reports, etc.

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