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October 11, 2011

Ms. Kirsten Walli
Board Secretary
Ontario Energy Board
2300 Yonge Street
PO Box 2319, 27th Floor
Toronto, ON
M4P 1E4

Dear Ms. Walli:

RE: Application by Canadian Distributed Antenna Systems Coalition ("CANDAS"); Board File No.: EB-2011-0120

We represent CANDAS in connection with its application to the Board regarding access to the power poles of licensed electricity distributors for the purpose of attaching wireless telecommunications equipment ("**Application**").

In accordance with Procedural Order No. 3, CANDAS is filing the Reply Evidence of Tormod Larsen. We expect to file additional reply evidence shortly.

CANDAS will file two paper copies of the above-noted evidence as soon as possible.

Yours very truly,

(signed) H.T. Newland

HTN/ko
Encls.
cc: Mr. George Vinyard

ExteNet Systems, Inc.
Mr. Mark Rodger
Borden Ladner Gervais
All Intervenors

ONTARIO ENERGY BOARD

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.*

REPLY EVIDENCE

OF

TORMOD LARSEN

11 October 2011

A. INTRODUCTION

Q.1 Describe the purpose of this evidence and state your conclusions.

1.1 I have reviewed the evidence of LCC International, Inc.[1] (the "LCC Report") filed on behalf of the Canadian Electricity Association ("CEA"), and of Michael Starkey[2] and Mary Byrne[3] filed on behalf of Toronto Hydro-Electric System Limited ("THESL") in this proceeding. In particular, I have considered their opinions that: (i) there are numerous mobile wireless small-cell access alternatives to Distributed Antenna Systems ("DAS")[4]; (ii) unlike wireline telecommunications and cable television ("CATV") networks, wireless networks, including macrocell, DAS and other small-cell access solutions, do not require uniform, contiguous support structures in order to deploy efficiently over wide geographic areas;[5] and (iii) and that DAS wireless pole attachments are "fundamentally different from traditional wireline facilities that are mounted on poles."[6]

1.2 It is apparent that important information has been omitted or overlooked by both the LCC Report and the written evidence of Mr. Starkey and Ms. Byrne. In particular:

(i) Other than outdoor DAS, none of the small-cell and WiFi wireless access alternatives identified by Mr. Starkey and in the LCC Report are deployed independent of macrocell sites to provide blanket (outdoor and indoor) and seamless cellular coverage over wide (>10 sq. km) geographic areas.

(ii) While there is no evidence that femtocell, picocell and WiFi wireless access technologies can reasonably be deployed to provide blanket, seamless wireless coverage over wide

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[1] "LCC International, Inc., "Outdoor Distributed Antenna Systems and their role in the Wireless Industry," filed 2 September 2011 on behalf of the Canadian Electrical Association in OEB File No. EB-2011-0120.

[2] Affidavit of Michael Starkey, sworn 1 September 2011, filed 2 September 2011 on behalf of Toronto Hydro-Electric System Limited in OEB File No. EB-2011-0120.

[3] Affidavit of Mary Byrne, sworn 1 September 2011, filed on behalf of Toronto Hydro-Electric System Limited in OEB File No. EB-2011-0120.

[4] LCC Report, pp. 6-15; Starkey Affidavit, p. 34: line 23 – p. 37: line 2; Starkey Affidavit, p. 37: line 16-p. 40: line 4; Starkey Affidavit, p. 41: lines 4-9.

[5] LCC Report, p. 2 (numbered item 4); Starkey Affidavit, p. 22: line 1 – p. 23: line 10; Starkey Affidavit, pp. 25-32; Starkey Affidavit, p. 46: line 17 – p. 49: line 11.

[6] LCC Report, p. 2 (numbered item 4). See also LCC Report, p. 20; Starkey Affidavit, p. 10: lines 11-21; Starkey Affidavit, p. 12: lines 5-17; Starkey Affidavit, p. 15: lines 9-10; Starkey Affidavit, p. 17: lines 16-24; Byrne Affidavit, paras. 27, 30 and 34-37.

geographic areas, to the extent that these wireless technologies evolve, the relatively higher density of wireless access nodes and backhaul links that these technologies require, means that in order to efficiently deploy over wide geographic areas, they also will require attachment to a network of uniform, contiguous support structures, of much lower average height, in relative terms, than macrocell sites. Indeed, limited outdoor WiFi deployments, including one in downtown Toronto, are located on utility poles.

(iii) Each DAS network is a hybrid of wireline and wireless components. DAS networks typically include many kilometres of fiber links that connect centrally located hub equipment facilities to distributed communications nodes with antennae that provide wireless access to end-user mobile devices. A uniform, contiguous network of support structures that permit attachment of the antenna component of DAS networks at uniform heights of between 9 -14 metres, is required in order to deploy a DAS network efficiently over wide geographic areas. Wherever utility pole infrastructure exists, it is distinctly preferable to attach both the wireline and wireless components of a DAS network to utility poles, not only for reasons of economic efficiency, but also for technical and functional reasons.

(iv) There are no material differences between the attachment of equipment to utility poles for purposes of delivering wireless access services, on the one hand, and for the purposes of delivering wireline telecommunications and CATV services, on the other.

B. <u>WIRELESS ACCESS SOLUTIONS ARE NOT INTERCHANGEABLE</u>

Q.2 What are the key characteristics of different wireless access solutions?

2.1 The wireless access solutions that are referred to in the LCC Report and by THESL, such as femtocells, picocells, macrocells and WiFi, enable access to an end-user customer, typically to an end-user's mobile handset or to portable computing equipment.

2.2 The key characteristics of these access solutions and the characteristics that distinguish among them are capacity and coverage. Capacity may be expressed by reference to the maximum number of users supported per node or access point, and coverage may be expressed in terms of radiated output power or range in metres.

Q.3 What are the differences between the various wireless access solutions referenced by the interveners THESL and CEA?

3.1 The differences between the various wireless access solutions may best be expressed in a summary table (Table 1):

TABLE 1 –USES AND LIMITATIONS OF WIRELESS ACCESS TECHNOLOGIES

	Uses and Limitations	Output Power Per Node (Microwatts or Watts)	EIRP = Output Power + Antenna Gain Per Node (Watts)	Number of Frequency Channels Per Node	Typical Coverage Range Per Node (in Metres)	Number of Typical Max. Users
Femto Cell	• Only supports single technology/single band. • Primarily an indoor application solution for small, residential spaces. • Use not widespread for outdoor applications. Where used for an outdoor application, limited to covering a very small area *e.g.* an intersection, to boost capacity of an adjoining macro cell site. • Not a stand-alone coverage and capacity solution in a given geographic area; specifically designed as a “fill-in” wireless access technology to be used in conjunction with large macrocell towers and rooftop deployment in a limited area. • Specifically designed to permit end-users to originate calls or data sessions from within a given femtocell’s footprint, but does not support seamless mobile wireless “hand-in” from the macrocell site into the femtocell, *i.e.* voice calls will be dropped and data sessions will be interrupted. • The adoption of femto cells has been slow due to challenges in integrating them into the core network and securing reliable connectivity through commercial broadband connections.	Up to 250mW	250mW	1	<100m	Limited: 4-32 users per node

	Uses and Limitations	Output Power Per Node (Microwatts or Watts)	EIRP = Output Power + Antenna Gain Per Node (Watts)	Number of Frequency Channels Per Node	Typical Coverage Range Per Node (in Metres)	Number of Typical Max. Users
Pico Cell	• Only supports single technology/single band. • A quasi-carrier grade version of the femtocell solution. Primarily an indoor application solution for smaller facilities. • Use not widespread for outdoor applications. Where used for an outdoor application, limited to addressing small "hotspot" areas. • Not a stand-alone coverage and capacity solution in a given area; specifically designed as a fill-in wireless access technology to be used in conjunction with large macrocell towers and rooftop deployment in a given area. • The adoption of picocells has been slow due to challenges in integrating them into the core network and secure reliable connectivity/backhaul.	Up to 1W	Up to 1W	1 to 2 .	<200m	Limited: 16 - 64 users per node
Micro Cell	• A carrier-grade solution utilized to either support a hotspot area or a larger zone. The objective is to either improve coverage and/or capacity. • Microcells are typically deployed in urban and suburban areas, where capacity requirements are medium to very high. • Microcells are attractive for wireless service providers licensed with a single band and a single technology. • A major challenge for microcells is achieving appropriate backhaul to centrally located switching equipment for purposes of meeting capacity requirements.	2W to 20W	20W to 200W	2 to 4	<500m	32 - 200 users per node

	Uses and Limitations	Output Power Per Node (Microwatts or Watts)	EIRP = Output Power + Antenna Gain Per Node (Watts)	Number of Frequency Channels Per Node	Typical Coverage Range Per Node (in Metres)	Number of Typical Max. Users
DAS	• A carrier-grade solution capable of meeting current and future capacity and coverage needs in a given area; not dependent on the availability of macrocell deployment in a given area. • May also be used to improve coverage and/or capacity in conjunction with macrocell deployment. • DAS is typically deployed in urban and suburban areas, where capacity requirements are medium to very high. • Supports mutiple bands and mutiple technologies. • Hybrid wireline and wireless access technology: Radiofrequency or baseband signals are delivered over fiber to remote wireless node (antenna) locations. Each node location requires a wireline (fiber) connection back to the central hub facility.	10W to 40 W	80W to 320W	Up to 16	<600m	>300 per node per band
Macro Cell	• Oldest solution (since mid-1980s) for incumbent mobile wireless carriers. • Macrocells are most efficient solution to cover very large areas with low to medium capacity. However, macrocell deployment face capacity challenges as end-users are consuming more bandwidth through video, audio and other data applications. • In addition to capacity problems, operators are faced with increasing challenges related to site acquisition and adequate dimensioning of backhaul facilities (requirement for fiber to their sites). • Can be dual-band. Macrocell sites are typically deployed in a three-sector configuration. • Require very high (40-100m) towers or rooftops, given the geographic coverage they are designed to provide.	20W to 80W	500W to 4000W	Up to 16	>1000m	>300 per sector

	Uses and Limitations	Output Power Per Node (Microwatts or Watts)	EIRP = Output Power + Antenna Gain Per Node (Watts)	Number of Frequency Channels Per Node	Typical Coverage Range Per Node (in Metres)	Number of Typical Max. Users
WiFi	• WiFi utilizes unlicensed, shared radiofrequency spectrum. Mobile wireless carriers have typically paid millions for spectrum licences over which they exercise exclusive control in a specified geographic area. • WiFi is not a mobile or cellular technology; it does not support all services or the quality of service and management typically required by licensed mobile wireless carriers. • WiFi does not enable public switched mobile wireless voice services. Although voice calls may be initiated over the Internet (*i.e*. VoIP), such calls will suffer from latency, particularly when accessed using a wireless access connection. WiFi does not support E911 location services. • Not a technology that makes sense on a large scale for a licensed mobile wireless carrier. • At best, WiFi can be used to offload certain data traffic in hotspot locations, *e.g.*, stadiums. • Requires WiFi enabled devices as well as an operator that offers data (Internet access) services.	100mW to 500mW	Up to 4W	3 useable of a total of 11	<200m	Limited: 60 users per access point

C. DAS NETWORKS ARE HYBRID WIRELINE/WIRELESS NETWORKS

Q.4 Why do outdoor DAS systems require access to uniform, contiguous support structures, like wireline telecommunications and CATV or for that matter, outdoor WiFi network deployments?

4.1 I state in my 26 July Evidence that the "construction of a typical DAS network consists of traditional fiber deployments in addition to the node site construction."[7] I stress, because it is consistently overlooked by the interveners THESL and CEA, that in addition to wireless equipment at the distributed node sites, an outdoor DAS network also requires a traditional fiber link connecting each wireless node back to the central hub facility. Pictorially and schematically depicted at page 3 of Exhibit B of my Evidence dated 26 July 2011 filed in this proceeding were typical configurations of outdoor DAS systems:

(i) a central ("BTS") hub facility;

(ii) a fiber network; and

(iii) aerial wireless nodes that are periodically attached to poles.

4.2 The outside plant of a wireline telecommunications or CATV carrier similarly consists of:

(i) a centrally located Point of Presence (POP);

(ii) a fiber or coaxial cable network; and

(iii) a wide range of remote network equipment, such as amplifiers, back-up power/power conditioning units and monitoring devices that are periodically attached to poles or housed in street furniture.

4.3 An outdoor WiFi network, such as the private OneZone network formerly operated by Toronto Hydro Telecom (currently owned and operated by Cogeco Data Services, which is not a licensed wireless

[7] Evidence of Tormod Larsen on behalf of Canadian Distributed Antenna Systems Coalition, filed 26 July 2011 in OEB File No. EB-2011-0120 at Q4, page 6.

carrier), does not enable public mobile wireless services; rather, it enables hotspot access to the Internet in a relatively small area of approximately 6 sq. km of downtown Toronto.

4.4 Notwithstanding this fact, the outside equipment installations associated with an outdoor WiFi network, such as the OneZone network, are also comparable to the outside equipment installations associated with an outdoor DAS network or a wireline telecommunications or CATV carrier network, in that they require:

(i) a Central Office;

(ii) a fiber network**;** and

(iii) wireless access points that are required to be attached periodically (albeit much more densely than is the case for outdoor DAS or wireline telecommunications or CATV deployments).

4.5 For each of these three types of networks, the requirements for utility pole access for each of the main components, are summarised in Table 2 below:

TABLE 2 – WIRELINE AND WIRELESS NETWORK ARCHITECTURE

	DAS	**Wireline Telecom/CATV**	**WiFi**
Central hub facility or point of presence	Not on poles or other support structure.	Not on poles or other support structure.	Not on poles or other support structure.
Fiber, co-axial cable or copper wire network	Requires attachment to uniform, contiguous support structures over large area. Aerial networks are preferred, but not required, as DAS nodes entail aerial antenna placements and fiber links back to central hub facility.	Requires attachment to uniform, contiguous support structures over a large area. Aerial networks are preferred, but are less necessary because no antennas are involved.	Requires attachment to uniform, contiguous support structures over a large area. Aerial networks are preferred, as WiFi access points also entail aerial antenna placements.
Remote network equipment	Requires periodic attachment to uniform, aerial, contiguous support structures. Antenna cannot be buried and relatively uniform elevations and even geographic distribution are needed for effective coverage solutions.	Requires periodic attachment to uniform, support structures. Aerial networks are preferred but not required, as amplifiers and back-up power/power conditioning units could be located in street furniture and connected via wireline cabling in underground conduits.	Requires attachment to uniform, aerial, contiguous support structures over small area. Due to lower power and smaller coverage areas, the density of nodes is much greater than for remote DAS or wireline telecommunications/CATV equipment.

4.6 The foregoing can usefully be represented in diagrammatic form. See schematics enclosed at Appendix A, entitled “Wireline and DAS Network Architectures.”

D. <u>WIRELINE TELECOMMUNICATIONS AND CATV POLE ATTACHMENTS ARE NOT MATERIALLY DIFFERENT FROM DAS POLE ATTACHMENTS</u>

Q.5 Are wireline telecommunications and CATV pole attachments materially different from DAS pole attachments, such as the proposed Toronto DAS pole attachments?

5.1 In my evidence dated 26 July 2011, I described each of the components of a DAS wireless node site.[8]

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[8] Evidence of Tormod Larsen on behalf of Canadian Distributed Antenna Systems Coalition, filed 26 July 2011 in OEB File No. EB-2011-0120 at Q4, pages 5-6.

5.2 For purposes of assessing the engineering, mechanical and safety implications of wireless carriers' attachments to electrical utility poles, the relevant considerations are the (i) method of attachment, (ii) dimensions and weight of the attached items and (iii) the configuration of cabling and equipment on poles. In this regard, contrary to what is suggested by Mr. Starkey and Ms Byrne, there are no material differences between wireless and wireline attachments to poles.

5.3 Set out in Table 3 below is a comparison of the approximate dimensions and weight of remotely placed communications equipment, which is commonly located on utility poles: (i) wireline CATV power supply equipment; (ii) WiFi access point equipment (including antenna unit) and (iii) DAS node equipment (including antenna unit):

TABLE 3 – REMOTE CATV, WiFi and DAS EQUIPMENT -- DIMENSION AND WEIGHT COMPARISONS

Remote CATV Back-Up Power/Power Conditioning Units

Dimensions	Alpha PWE-3	Alpha PWE-3 Northern Enclosure	Alpha PWE-4	Alpha PWE-6	Alpha PWE-6 Northern Enclosure	Alpha PWE-6 FT
Height (mm)	622	645	629	933	958	698
Width (mm)	615	628	768	615	628	753
Depth (mm)	315	359	406	355	359	445
Total Volume (cubic metres)	**0.120**	**0.145**	**0.196**	**0.204**	**0.216**	**0.234**
Unit Weight (kg)	18	19.1	31	31	33.1	26
Battery Capacity	3	3	4	6	6	6
Battery Weight (kg)	30.5	30.5	30.5	30.5	30.5	30.5
Total Unit Weight (kg)	**109.5**	**110.6**	**153**	**214**	**216.1**	**209**

Outdoor WiFi Access Point Equipment			
	WiFi Antenna	BelAir AP	Power
Height (mm)	310	406	305
Width (mm)	50	330	178
Depth (mm)	N/A Cylinder	N/A Cylinder	127
Volume Per Unit (cubic meters)	**0.0006**	**0.035**	**0.007**
Total Volume (cubic meters)	**0.042**		
Total Weight (kg)	**13.7**		

Remote DAS Equipment			
Dimensions	Antenna	DAS Node	Power
Height (mm)	613	500	406
Width (mm)	254	320	406
Depth (mm)	N/A Cylinder	172	223
Volume Per Unit (cubic meters)	0.031	0.028	0.037
Total Volume (cubic meters)	**0.095**		
Total Weight (kg)	**89**		

5.4 The similarities between the configuration of CATV and DAS wireline attachments to poles and between the CATV power supply assemblies and remote DAS antenna nodes can usefully be represented in diagrammatic form. See schematics enclosed at Appendix B.

*** End of document ***

Appendix A:

Wireline and DAS Network Architectures

ExteNet Systems Canada Inc. and DAScom Inc.

Reply Evidence of Tormod Larsen, 11 October 2011

Outdoor Distributed Antenna System Network Topology




■ Central Hub

- Radiofrequency (RF) signal conditioners
- RF combiners
- RF/optical converters
- Digital base band units
- Back-up power supplies

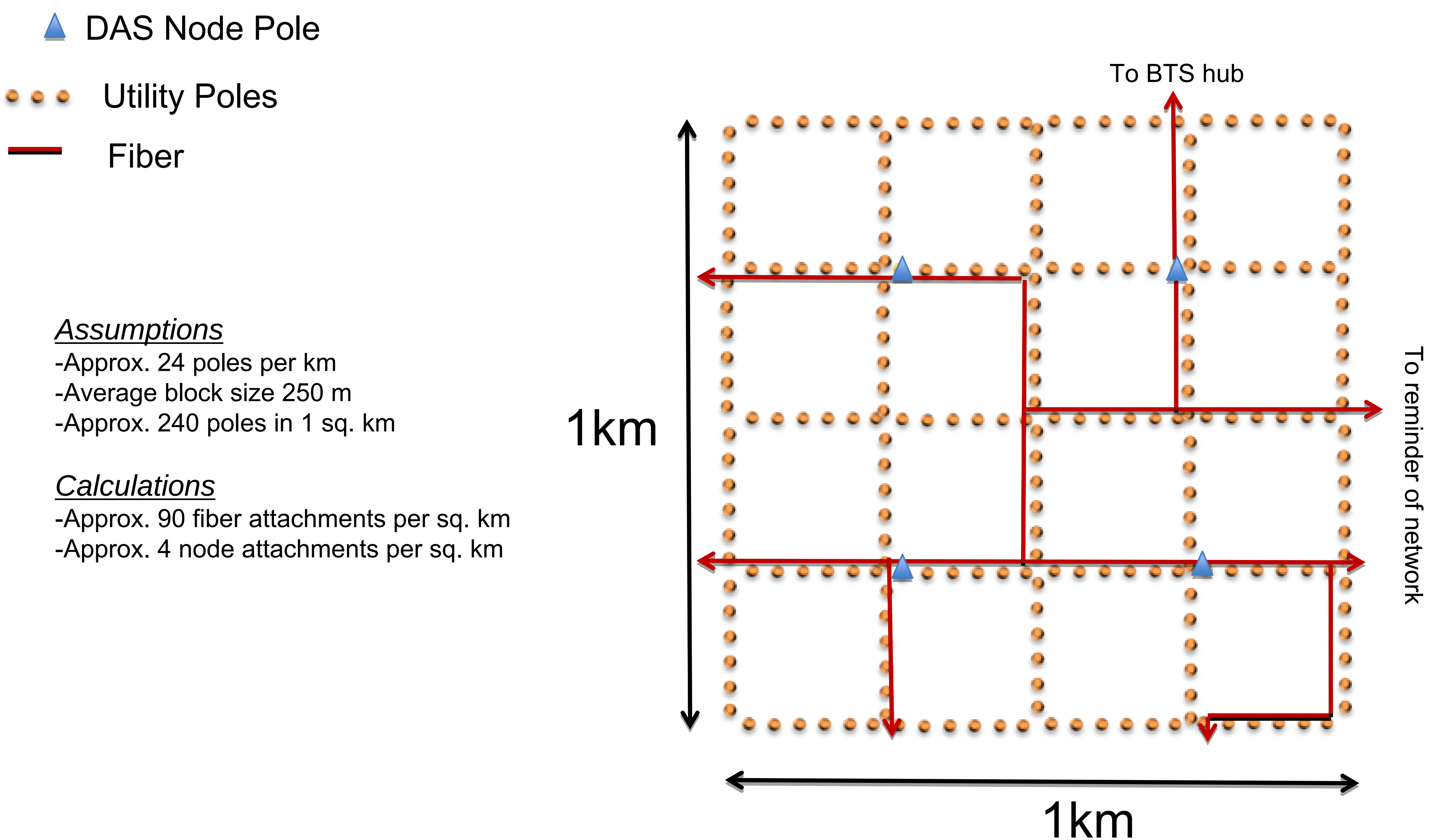
Fiber Network

- Fiber optic cabling

▪Node Sites

- Antenna
- Radio units (“nodes”): RF/optical converters and radio amplifiers
- Optional battery backup units

Outdoor Distributed Antenna System Network Topology



Assumptions

-Approx. 24 poles per km
-Average block size 250 m
-Approx. 240 poles in 1 sq. km

Calculations

-Approx. 90 fiber attachments per sq. km
-Approx. 4 node attachments per sq. km

Outside Plant – Wireline CATV or Telecommunications

■ Point of Presence

- Switching or interconnection facility
- Switches
- Routers
- Servers
- Interconnects

Fiber Network

- Copper wire, fiber optic cabling, or coaxial cables

■ Remote Equipment

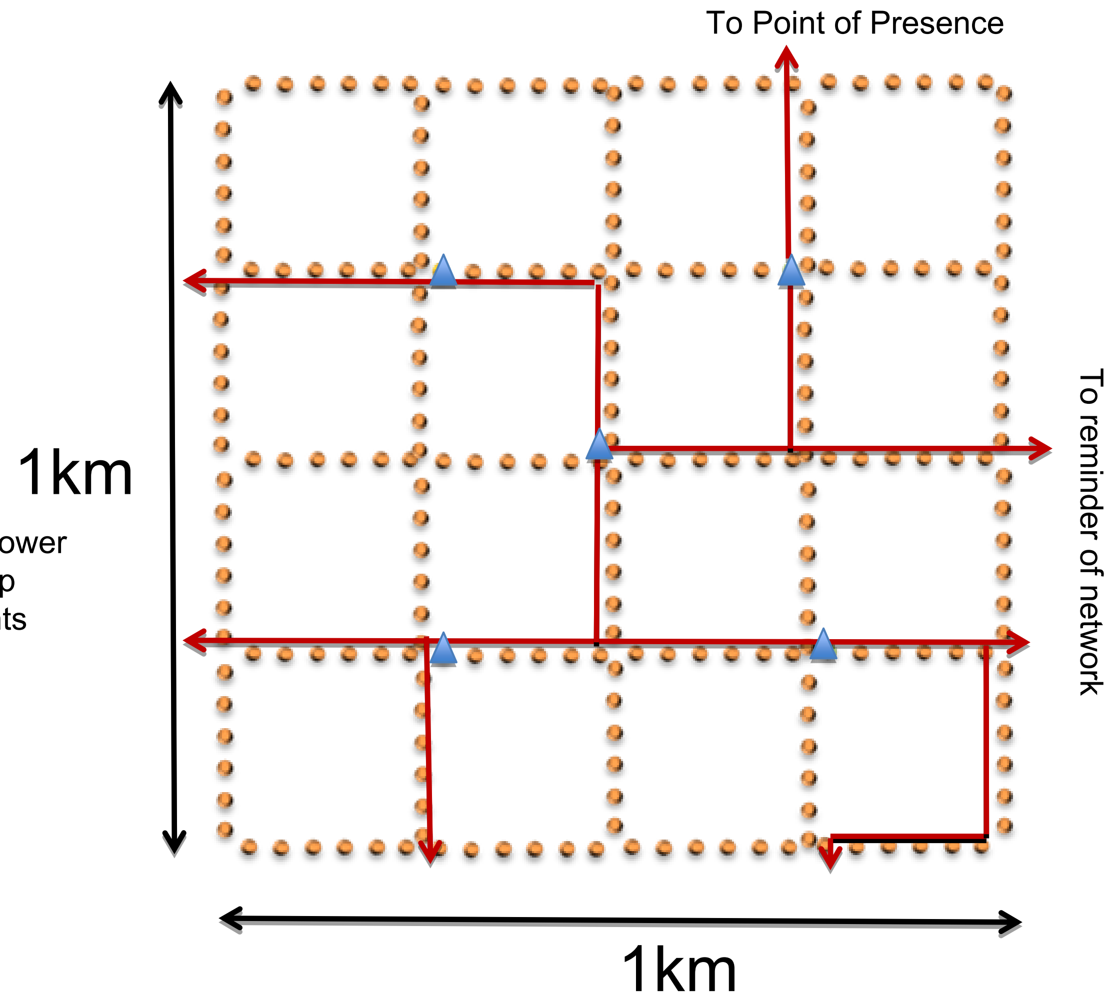
- Back-up power supply
- CATV/T1 amplifiers
- Power Conditioning Units
- Optional WiFi or other telemetry equipment

Outside Plant – Wireline CATV or Telecommunications

▲ CATV rectifiers/back up power units

• • • Utility Poles

— Fiber



Example

Assumptions

-Approx. 24 poles per km
-Average block size 250 m
-Approx. 240 poles in 1 sq. km
-THESL IR(OEB) 21: 2% of wireline telecommunications and CATV poles have power supply (not including CATV amplifier, back-up power and monitoring equipment) attachments (excludes amplifier, back-up power and telemetry/monitoring attachments)

Calculations

-Approx. 90 fiber attachments per sq. km
-Approx. 5 node attachments per sq km

APPENDIX “B”

Reply Evidence

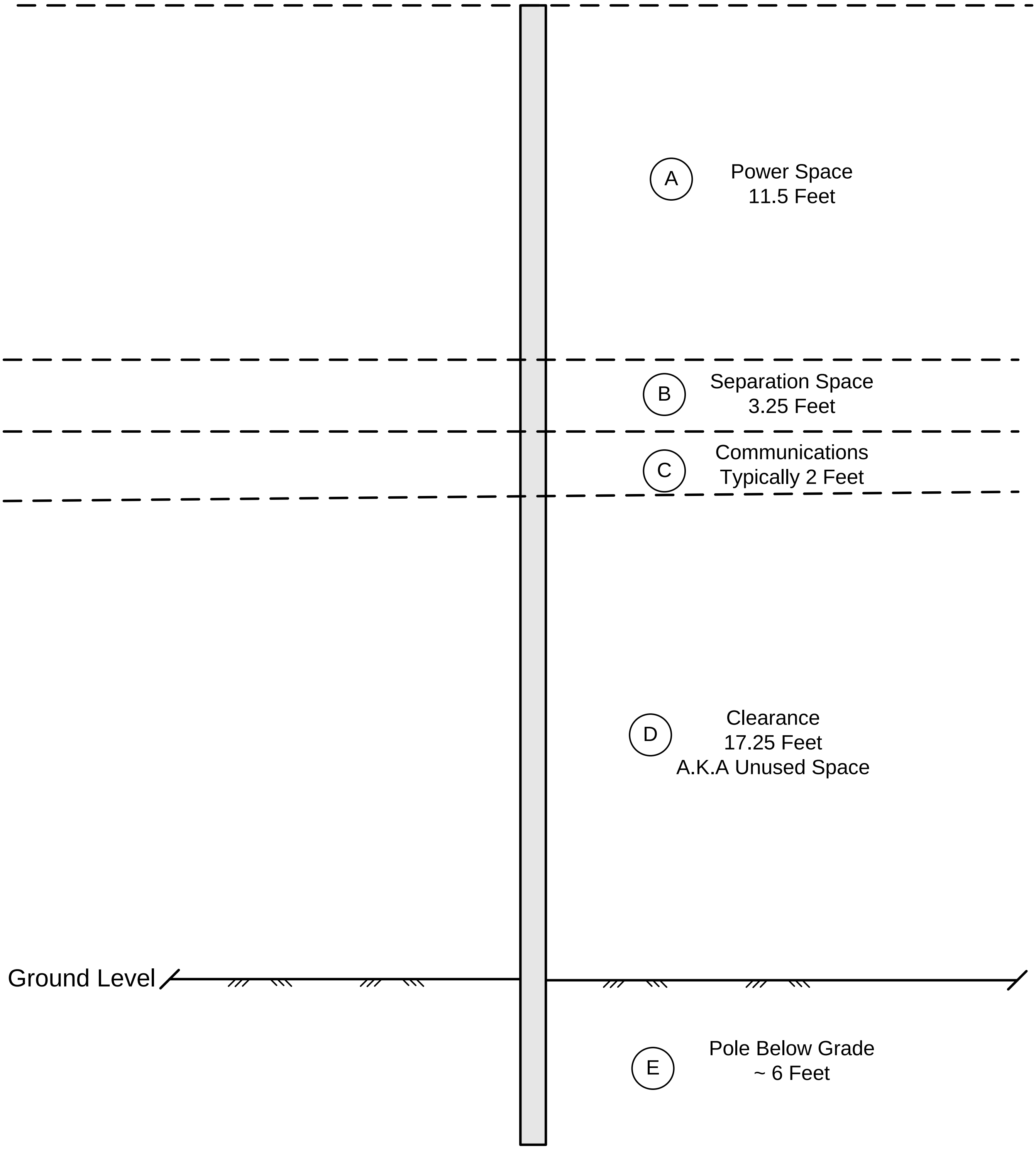
of

Tormod Larsen

11 October 2011

35 ‘ Common Utility Distribution (LDC) Pole

Vertical Zones of a Typical Hydro Pole
(as Portrayed in the CCTA Decision)



35 ‘ Common Utility Distribution (LDC) Pole

Vertical Zones of a Typical Hydro Pole
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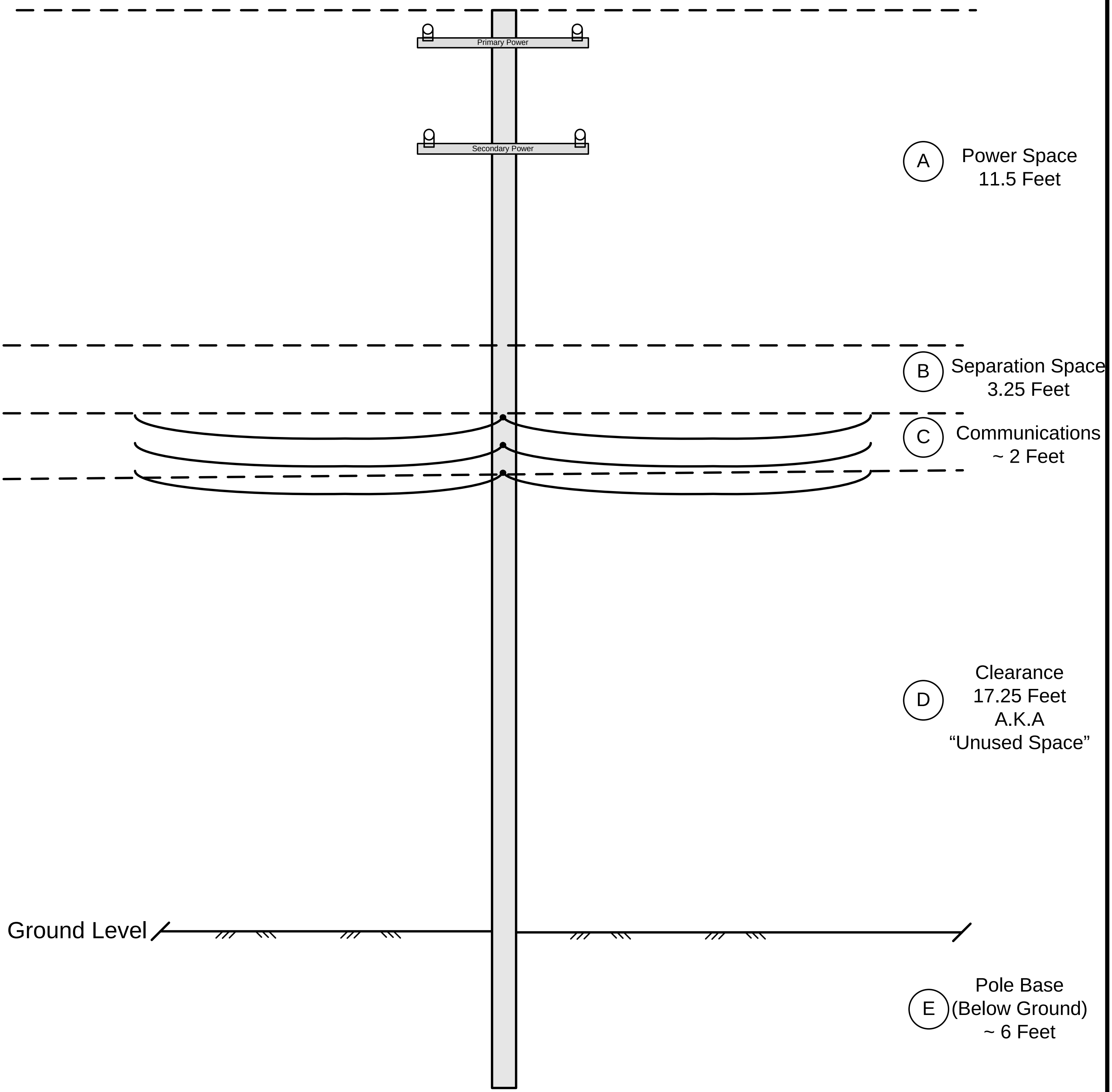
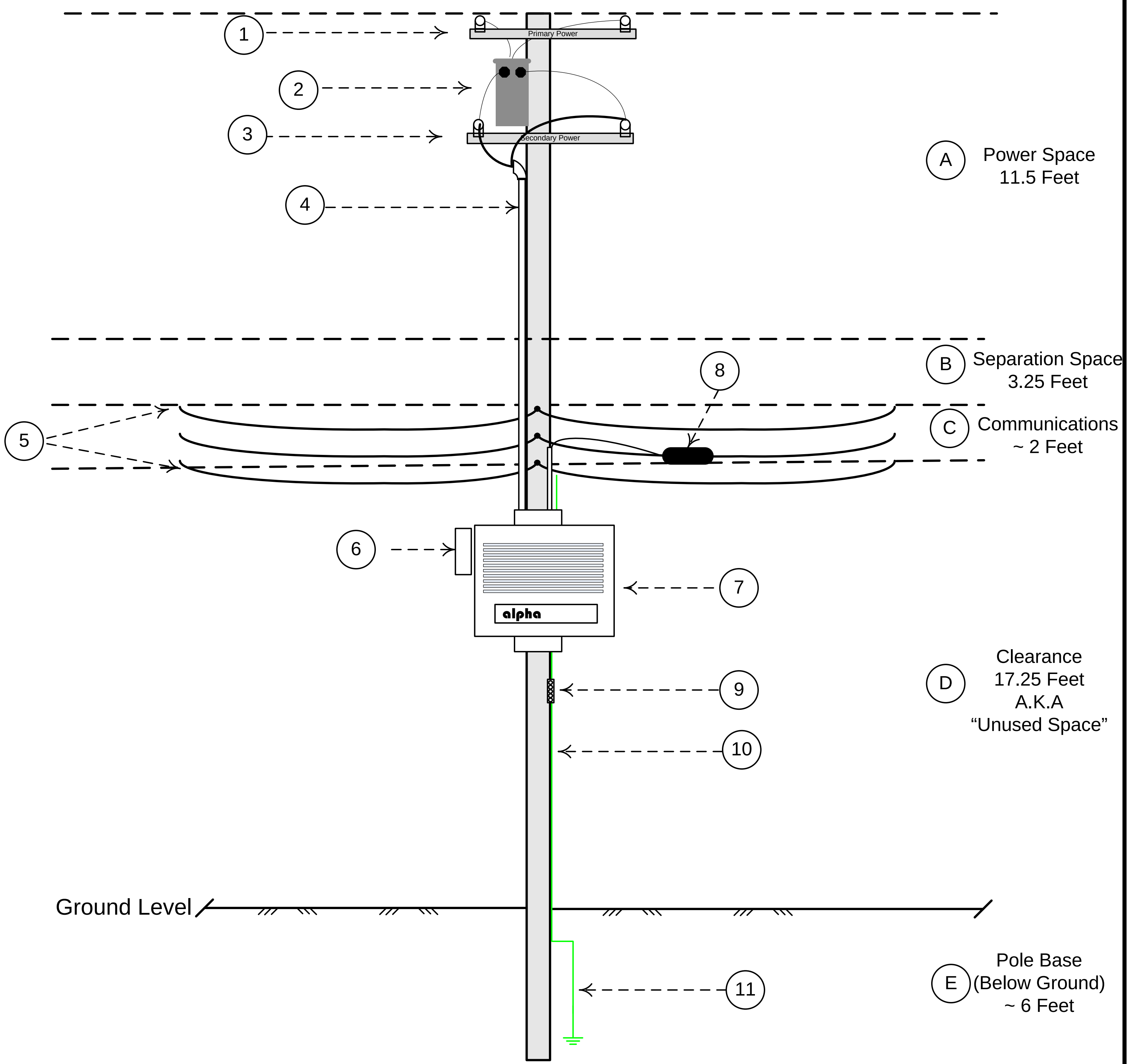


Typical CATV Power Supply Installed on a 35' Common Utility Distribution (LDC) Pole

Equipment Shown Installed on Street Side of Pole

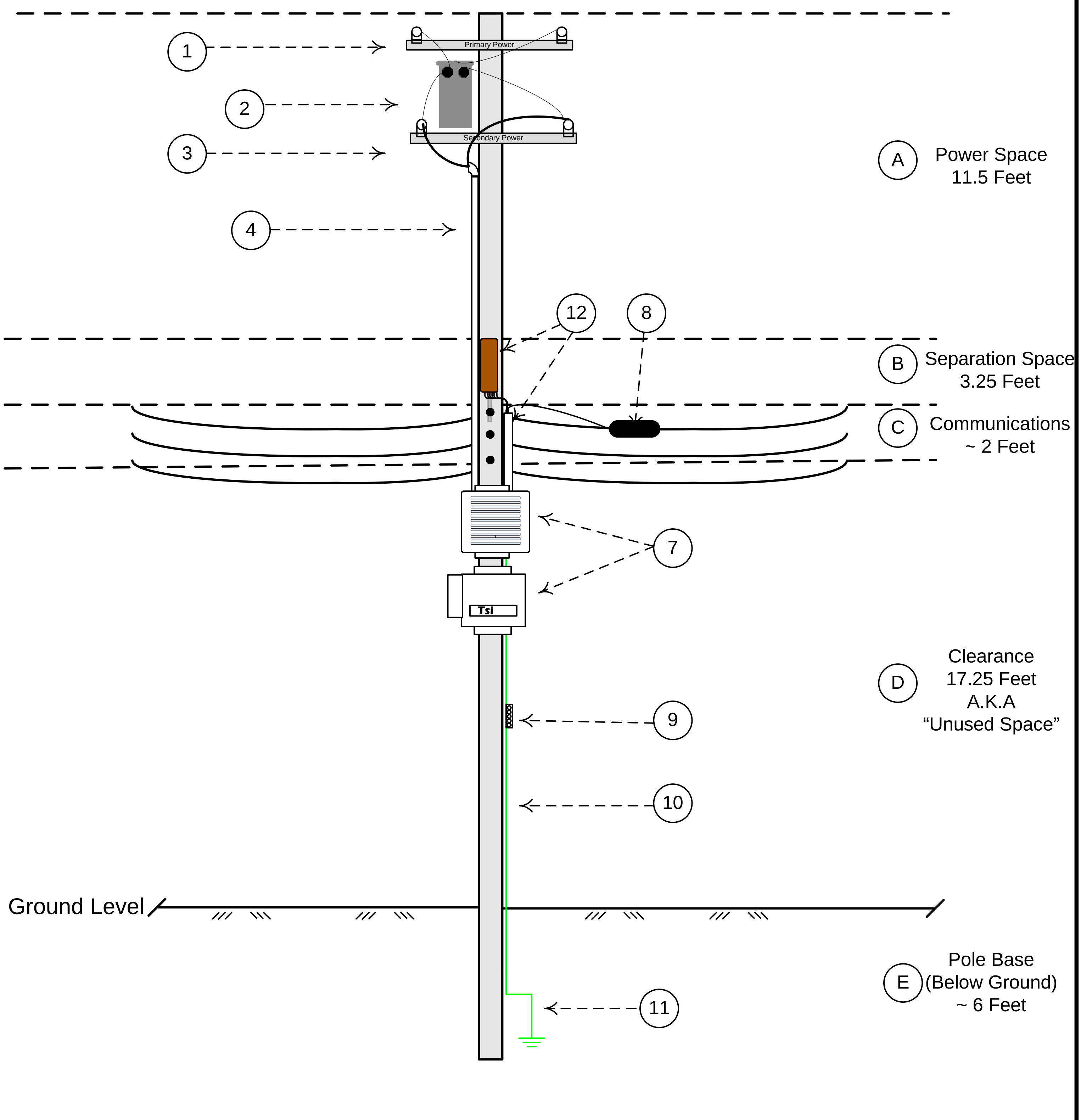


Item Number	Description	Item Number	Description
1	Primary Electric Service Distribution	8	Splice Enclosure and Pigtail Cable
2	Transformer	9	Ground Buss Bar
3	Secondary Electric Service Distribution	10	Ground Cable
4	Power Riser and Weatherhead	11	Ground Rod
5	Communications Cables	12	
6	Electric Service Disconnect	13	
7	CATV Power Supply and Mounting Bracket	14	

Typical Wireless Equipment Attachment Installed on a 35' Common Utility Distribution (LDC) Pole

Equipment Installed on Field Side of Pole

(Opposite the Street Side)



Item Number	Description	Item Number	Description
1	Primary Electric Service Distribution	8	Splice Enclosure and Pigtail Cable
2	Transformer	9	Ground Buss Bar
3	Secondary Electric Service Distribution	10	Ground Cable
4	Power Riser and Weatherhead	11	Ground Rod
5	Communications Cables	12	Antenna, RF Cables and Cable Riser
6	Electric Service Disconnect	13	
7	Optical Repeater and Power Supply	14	