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January 25, 2012

Honorable Mayor Sam Adams and
City Commissioners
City of Portland
1221 SW 4th Ave.
Portland, OR 97204

Re: **Appellant's Expert Testimony and Rebuttal Evidence**
LU 11-125536 CU AD (Verizon Wireless)

Dear Mayor Adams and Commissioners:

I am writing on behalf of Verizon Wireless to provide you with the following expert testimony and other rebuttal evidence in the above-captioned case:

1. Expert Testimony from Mr. Thomas S. Gorton, P.E., Hatfield & Dawson Consulting Engineers. Mr. Gorton's January 25th letter addresses Council's questions regarding ERP. In this letter, Mr. Gorton makes it clear that ERP per channel is the standard method of expressing ERP for purposes of determining compliance with FCC power limits. In his letter, Mr. Gorton specifically states that ERP per antenna (the hearing officer's theory) and ERP for all channels in all directions (the opponents theory) "have no relevance whatsoever for purposes of complying with FCC power limits or limits to human exposure to radiofrequency electromagnetic fields, nor would these numbers have any relevance in the field of radio frequency communication, because they do not relate to any known standard. In short, the relevant basis for expressing ERP, for purposes of determining compliance with FCC power limits, is ERP per channel. In this case, the maximum ERP of any channel at the facility proposed by Verizon Wireless is 759 watts ERP."

2. Expert Testimony from Mr. David J. Pinion, P.E., Hatfield & Dawson Consulting Engineers. Mr. Pinion's January 25th letter rebuts the January 11th letter from Mr. Christopher T. Hill. Mr. Pinion clarifies Mr. Hill's misunderstanding of basic RF concepts, and his misrepresentation of specific information and calculations presented in Mr. Pinion's reports. In this letter, Mr. Pinion discusses the key findings in his reports and explains that "There are no inconsistencies or errors in any of my reports when it comes to describing proposed ERP values." Both Mr. Pinion and Mr. Gorton conclude that ERP per channel is the relevant basis for

expressing ERP for purposes of determining compliance with FCC power limits, and that the maximum ERP per channel for Verizon's proposed facility will be 759 watts.

3. OET Bulletin 56. This FCC Bulletin provides expert answers to common questions regarding RF technology. On pages 20-21, it notes that the FCC regulates ERP by channel.

4. Connecting to Our Future: Portland's Broadband Strategic Plan. This plan was adopted on September 22, 2010 by the City of Portland, by Council Resolution 36816. This plan points out the critically important public benefits of expanding the city's wireless infrastructure. For example, on page 4 of the plan, Council concluded that: "A robust broadband ecosystem of infrastructure, competitive providers, services and devices is necessary for economic growth, job creation, education, livability, sustainability, public safety and civic engagement." Council also noted that: "The future of telecommunications technology is not wireless or fiber optics—it is a combination of both. Fiber and wireless are both essential. " (*See* Plan at 11)

5. Additional Qualifications of Mr. David J. Pinion, P.E.; Mr. Thomas S. Gorton, P.E.; and Hatfield & Dawson Consulting Engineers. Hatfield & Dawson is one of the most respected consulting engineering firms in the country. They have a long history of providing specialized advice on telecommunications and electromagnetic engineering on behalf of public and private clients, including cities, counties, states, federal agencies.

Respectfully submitted,

Davis Wright Tremaine LLP

Phillip E. Grillo

PEG/lkt
Enclosures: Expert Testimony from Thomas S. Gorton, PE
Expert Testimony from David J. Pinion, PE
FCC OET Bulletin 56
City of Portland Broadband Strategic Plan
Bios of Mr. Pinion, Mr. Gorton & Hatfield & Dawson
cc: Client

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January 24, 2012

Honorable Mayor Sam Adams
and the City Council
City of Portland, City Hall
1221 SW 4th Ave.
Portland, OR 97204

Re: Case File LU 11-125536, Verizon Wireless "POR Foster" Proposal

Dear Mayor Adams and Councilmembers,

Hatfield & Dawson Consulting Engineers has been retained to provide testimony on behalf of Verizon Wireless with regard to the case mentioned above. This document attempts to clarify the meaning of the term "Effective Radiated Power" ("ERP") as it is commonly used in the field of radiofrequency communications. In particular, this letter clarifies that for purposes of determining compliance with FCC power limits, the relevant basis for expressing ERP is per channel, not per antenna or per facility.

"Effective Radiated Power" is a technical term used in the field of radio frequency communications. The term ERP is defined by the rules of the Federal Communications Commission, and is applied and expressed in different ways, depending on the purpose of the regulation in which it is used. A short discussion of how electrical energy is used to transmit and receive radio frequency signals may be helpful to your understanding of ERP. In order to send radio signals, antennas are used to convert electrical energy generated by a transmitter and conducted by cables into electro-magnetic fields which can be transmitted through space to a receiver, where another antenna captures the electromagnetic field and reverses the process, allowing a receiver to recover and decode the signal. The most elementary antenna that is practical to construct is a simple dipole, which distributes the electromagnetic field equally in all directions in the horizontal plane, with a radiation pattern shaped like a donut. While the dipole antenna is simple, it is not particularly efficient, as it directs much of the electro-magnetic energy it produces in directions that are of little use. If mounted so that the dipole is vertical, it directs much of the radiofrequency at angles upward toward the sky, and downward toward the ground around the antenna site. More efficient antennas use multiple dipoles mounted in such a way that

more of the electromagnetic field is focused in the horizontal plane (toward the horizon), and less toward the ground. These antennas perform a function similar to the lenses in a lighthouse, which focus the light generated by an incandescent bulb into a concentrated beam directed toward the horizon. This ability to focus electromagnetic energy is quantified as the "gain" factor of the antenna. The gain of an antenna is the amount of signal it produces at a remote receiver compared to the signal produced by a dipole antenna with the same input power. In other words, the "gain" of an antenna is to electromagnetic energy what the "power" of a telescope is to light. As an example, if a dipole antenna with an input of 1 watt produces the same amount of signal at some distant receiver as our "improved" antenna does with an input power of 1/5 watt, then our improved antenna has a power gain factor of 5.

Effective Radiated Power[1] is obtained by multiplying the power applied to the input of an antenna by the antenna's gain. In the example above, if the antenna input power is 1/5 watt, the ERP is 1 watt. (5 x 1/5 = 1). The signal radiated by the improved antenna at a power of 1/5 watt has the same effect as the signal radiated by a dipole antenna at a power of 1 watt, hence the term "Effective Radiated Power". The terms "Gain" and "ERP" are assumed to mean in the direction of maximum gain, i.e. the main beam of the antenna, unless stated otherwise. Antenna manufacturers often publish data sheets for their antennas containing tables of the reduced gain of the antenna in directions and vertical angles other than the direction of the main beam.

The term "ERP" can be used to describe the full power emitted by an antenna (the sum of all channels applied to its input multiplied by the gain of the antenna) or the power of one channel multiplied by the gain of the antenna. Which usage is appropriate must be determined by the context in which it is used. Two common contexts are discussed below.

Prediction of Compliance with FCC Rules regarding Human Exposure to Radio Frequency Electromagnetic Fields

Section §1.1310 of the FCC Rules specify Radiofrequency Radiation Exposure Limits which apply to all FCC licensees. The Office of Engineering & Technology of the Federal Communications Commission has published a document titled *Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields* OET Bulletin 65 (OET-65) which provides guidance in the evaluation, either by calculation or measurements, of possible human exposure to Electromagnetic Fields. The human body is not frequency specific, and will absorb energy from transmitters across the radio frequency spectrum. For this reason, when calculating human exposure to radiofrequency electromagnetic fields, we consider the TOTAL ERP of all channels on all antennas oriented toward whatever location we wish to study, (including those of other providers, and even other services if they are close enough to provide a significant contribution to the radiofrequency environment) generally all antennas in a single

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[1]The reader may observe that some documentation, including some but not all sections of the FCC rules, uses the term EIRP rather than ERP. The difference is that EIRP is referenced to an isotropic antenna rather than a dipole. To convert from one to the other, EIRP = ERP x 1.64.

sector of a site, NEVER all antennas of a sectorized site. This methodology comes directly from OET-65 which states "*For the case of transmitting facilities using sectorized transmitting antennas, applicants and licensees should apply the criteria to all transmitting channels in a given sector, noting that for a highly directional antenna there is relatively little contribution to the ERP or EIRP summation for other directions.*" Note that the previous statement directs that the criteria should be applied to all **channels**, not all **antennas**, in a given sector, and not the entire site.

The text in italics above is also contained in §1.1307(b)(1), however in his written testimony of January 11, 2012, Christopher Hill omits it when quoting from this rule. It should also be noted that neither OET-65 nor §1.1310 specify limits to ERP. Quoting again from OET-65, (page 11) "*Another important point to remember concerning the FCC's exposure guidelines is that they constitute **exposure** limits (not **emission** limits)...*". Similarly, the power levels listed in Table 1 in §1.1307(b)(1) are not limits, but rather thresholds which, if exceeded, trigger the requirement for a routine environmental evaluation in certain cases. Table 1 in §1.1307(b)(1) provides that routine environmental evaluation is not required for Cellular, PCS or Part 27 licensed facilities with non-building-mounted antennas (tower mounted antennas) mounted 10 meters (33 feet) above ground, as is the case at the proposed Verizon Wireless Foster Road site. Hill also chooses to omit this detail in his quotation of this rule.

Rules Specific to Operation in the Cellular, PCS and 700 MHz bands

One of the core functions of the Federal Communications Commission is the regulation and licensing of users of the radiofrequency spectrum. The FCC must ensure that the spectrum is used as efficiently as possible, while preventing (or at least minimizing) interference between users. In the interest of promoting the efficient use of spectrum, the FCC specifies a maximum allowable ERP for all services. By doing so, the FCC limits the size of the area covered by each facility, as the area covered by (or "service area" of) a communications facility is determined to a great extent by its ERP and the height of the antenna. These ERP limits vary among the different services regulated by the FCC. For example, FM broadcast stations, which are designed to cover a relatively large service area, are limited to an ERP of 100,000 watts, while community-based Low Power FM (LPFM) stations are designed to cover very localized areas and are therefore limited to 100 watts ERP. Verizon Wireless operates in three distinct frequency bands, each regulated under a different chapter or "part" of the FCC's rules. The 800 MHz Cellular band is regulated by Part 22, the 1900 MHz PCS band by Part 24 and the 750 MHz band by Part 27.

The ERP limits for each of the three distinct frequency bands that the Verizon Wireless transmitters operate within are found in the following FCC regulations:

§22.913 Effective Radiated Power Limits
(for Cellular bands, 880-890 & 891-894 MHz)

The effective radiated power (ERP) of transmitters in the Cellular Radiotelephone Service must not exceed the limits in this section.

(a) Maximum ERP. In general, the effective radiated power (ERP) of base station transmitters and cellular repeaters must not exceed 500 Watts. (The remainder of the rule applies to systems in rural or unserved areas, which is inapplicable to this case)

§24.232 Power and antenna height limits
(for PCS bands 1965-1970 & 1980-1985 MHz)

(a)

(2) Base stations with an emission bandwidth greater than 1 MHz are limited to 1640 watts/MHZ equivalent isotropically radiated power (EIRP) with an antenna height up to 300 meters HAAT, except as described in paragraph (b) below. Paragraph (b) applies to systems in rural or unserved areas, which is inapplicable to this case. As noted in the footnote on page 2, 1640 watts EIRP = 1000 watts ERP. The term HAAT means "Height Above Average Terrain". "Average Terrain" means the average ground elevation of all points within a 10 mile radius of the antenna. As the antennas at the proposed POR Foster site will be 45 feet above ground, and the site is not located on anything resembling a hilltop, the HAAT in this case is obviously well under 300 meters.

§27.50 Power limits and duty cycle
(for 750 MHz Upper C bands, 746-757 MHz)

(b) The following power and antenna height limits apply to transmitters operating in the 746–763 MHz, 775–793 MHz and 805–806 MHz bands:
(1) Fixed and base stations transmitting a signal in the 757–758 and 775–776 MHz bands must not exceed an effective radiated power (ERP) of 1000 watts and an antenna height of 305 m height above average terrain (HAAT), except that antenna heights greater than 305 m HAAT are permitted if power levels are reduced below 1000 watts ERP in accordance with Table 1 of this section.
(2) Fixed and base stations transmitting a signal in the 746–757 MHz, 758–763 MHz, 776–787 MHz, and 788–793 MHz bands with an emission bandwidth of 1 MHz or less must not exceed an ERP of 1000 watts and an antenna height of 305 m HAAT, except that antenna heights greater than 305 m HAAT are permitted if power levels are reduced below 1000 watts ERP in accordance with Table 1 of this section.
(3) Fixed and base stations located in a county with population density of 100 or fewer persons per square mile, based upon the most recently available population statistics from the Bureau of the Census, and transmitting a signal in the 746–757 MHz, 758–763 MHz, 776–787 MHz, and 788–793 MHz bands with an emission bandwidth of 1 MHz or less must not exceed an ERP of 2000 watts and an antenna height of 305 m HAAT, except that antenna heights greater than 305 m HAAT are permitted if power levels are reduced below 2000 watts ERP in accordance with Table 2 of this section.

(4) Fixed and base stations transmitting a signal in the 746–757 MHz, 758–763 MHz, 776–787 MHz, and 788–793 MHz bands with an emission bandwidth greater than 1 MHz must not exceed an ERP of 1000 watts/MHz and an antenna height of 305 m HAAT, except that antenna heights greater than 305 m HAAT are permitted if power levels are reduced below 1000 watts/MHz ERP accordance with Table 3 of this section.

Does the term "ERP" mean ERP for all channels of all antennas, or ERP for each individual channel (One channel of One antenna)?

As most commonly used by engineers and technicians working in the communications field, the term "ERP" means ERP per channel. When technicians measure or adjust the transmitters at a communications site, either upon installation or under routine maintenance, they measure and adjust one transmitter at a time. In the event of co-location, where multiple service providers operate from a common tower, the incumbent users are not required to reduce their operating power to accommodate a new tenant. This is because receivers for almost all communications systems, including cellular and PCS band wireless devices are designed to receive one channel at a time, while rejecting all others. Therefore the addition or adjustment of a single channel at a communications site will have no effect on the coverage or interference characteristics of any other channel at the site. This conclusion is supported by simple observation of the FCC rules quoted previously. The ERP limit in §22.913 is specified as the "(ERP) of transmitters", not of "antennas" or "facilities". The ERP limit for 800 MHz cellular transmitters is 500 watts, while the limit for 700 MHz and PCS operations is 1000 watts. Thus it makes little sense for the FCC to specify different limits based on frequency if these limits are to be applied to the sum of the powers of frequencies spread across different bands and regulated by different parts of the FCC's rules. If the total ERP were to include the outputs of transmitters regulated by different FCC rules, which rule would be applied if they were in conflict? Further support for this conclusion can be found in another document published by the FCC's Office of Engineering and Technology, titled *Questions and Answers about Biological Effects and Potential Hazards of Radiofrequency Electromagnetic Fields* OET Bulletin 56 (OET-56)[2]. In a section of OET-56 specific to cellular and PCS base stations, the second paragraph on page 21 states "Although the FCC permits an effective radiated power (ERP) of up to 500 watts per channel...". The last line on the previous page, "...depends on the number of radio channels (transmitters) that have been authorized..." demonstrates that the FCC considers the words "channels" and "transmitters" to be interchangeable.

In conclusion, OET-65 and Part 1 of the FCC's rules are broad in scope, and do not include any language limiting the ERP of the wide range of communications facilities they apply to. These documents provide limits to the level of human exposure to radiofrequency electromagnetic fields, guidance in evaluating the levels of these fields, and threshold levels at which this evaluation is required. In contrast, Parts 22, 24 and 27 contain rules which include per-channel

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[2]Both OET-65 and OET-56 are available for download at http://transition.fcc.gov/oet/info/documents/bulletins/

ERP limits specific to the services proposed by Verizon Wireless for the POR Foster facility. The ERPs proposed by Verizon Wireless, as listed in Mr. Pinion's October report (Record Exhibit H28(a)) are below these limits.

To be clear, the maximum ERP of any channel at the facility proposed by Verizon Wireless, as listed in Mr. Pinion's October report (Record Exhibit H28a) is 759 watts. ERP per channel is the standard method of expressing ERP for purposes of determining compliance with FCC power limits, as discussed above.

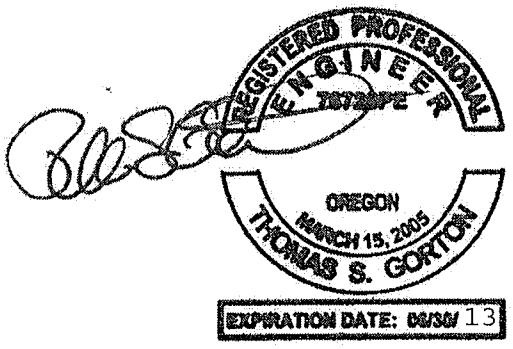
If for some reason the city chooses to express ERP per antenna, then according to Mr. Pinion's October report, the highest total ERP per frequency band under that scenario would be 2,346 watts. This is the sum total of the ERP from all of the channels associated with the two groups of PCS transmitters proposed (1,173 watts for each group of PCS transmitters, times two equals 2,346). As it is impractical to combine different frequency bands into a single transmitting antenna, it is common practice to utilize separate antennas for each frequency band. Therefore the total power in the PCS band, 2,346 watts, will be the highest *per antenna* ERP at this facility. I would stress that this ERP value is calculated from data that is already in the record. We did not express ERP in this way in our previous filings because an expression of ERP per antenna is not relevant to any ERP standard. Furthermore, we are expressing ERP in this way at this time only as an accommodation to the City, so that City Council can see what the ERP would be, if ERP per antenna was relevant to any known standard, which it is not.

If for some reason the city chooses to express ERP for all of the proposed channels, in all directions, then according to Mr. Pinion's October report, the total ERP under that scenario would be 20,172 watts ERP (6,724 watts ERP per sector, times three, equals 20,172). Again, I would stress that this ERP value is based on data already in the record. We have not expressed ERP in this way in previous submissions, because an expression of ERP that is based on adding together the power from all of the channels, in all directions, is not relevant to any known ERP standard. We are expressing ERP in this fashion at this time only as an accommodation to the City.

In conclusion, I would stress that the latter two expressions of ERP (2,346 watts ERP per antenna and 20,172 watts ERP for all channels in all directions) have no relevance whatsoever for purposes of complying with FCC power limits or limits to human exposure to radiofrequency electromagnetic fields, nor would these numbers have any relevance in the field of radio frequency communications, because they do not relate to any known standard. In short, the relevant basis for expressing ERP, for purposes of determining compliance with FCC power limits, is ERP per channel. In this case, the maximum ERP of any channel at the facility proposed by Verizon Wireless is 759 watts.

Qualifications

I am an experienced radio engineer whose qualifications are a matter of record with the Federal Communications Commission. I am an engineer in the firm of Hatfield & Dawson Consulting Electrical Engineers. I am a Registered Professional Engineer in the states of Oregon and Washington. I also hold an FCC General Radio Telephone Operator License, number PG-13-10466. I hold a Bachelor's Degree in Electrical Engineering from Seattle University, and have been employed as an engineer at Hatfield & Dawson since 1999. Prior to joining Hatfield & Dawson I worked as an RF design engineer for a nationwide cellular provider.



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January 25, 2012

Honorable Mayor Sam Adams
and the City Council
City of Portland, City Hall
1221 SW 4th Ave.
Portland, OR 97204

Re: Case File **LU 11-125536 CU AD, Verizon Wireless "POR FOSTER" Proposal**

Dear Mayor Adams and Council members:

Hatfield & Dawson Consulting Engineers has been retained to provide testimony on behalf of Verizon Wireless with regard to the above-mentioned case. I have been asked to review testimony provided by Mr. Christopher T. Hill in his letter to the Council dated January 11, 2012.

INTRODUCTION

Our firm was asked to evaluate the proposed Verizon Wireless personal wireless telecommunication facility "POR FOSTER" for compliance with current Federal Communication Commission (FCC) and City of Portland regulations regarding Effective Radiated Power (ERP) and public exposure to radio frequency (RF) and electromagnetic fields (EMF). As part of that evaluation, I prepared the following documents that have been submitted into the record for this case:

1. Record Exhibit A-2 Engineering Certification, dated March 2011 (superseded)
2. Record Exhibit A-3 Revised Report, dated August 2011
3. Record Exhibit H28(a) Supplement to Revised Report, dated October 2011.

It is apparent from Mr. Hill's recent testimony that he is not an RF engineer. His letter reflects a basic misunderstanding of the concepts of human exposure to RF fields and contains various mis-representations and misunderstandings of the specific information and calculations presented in my reports.

In fact nowhere in the record have I found any criticism of my conclusions from a practicing RF engineer with the qualifications and experience necessary to provide a thoughtful analysis of this important issue. On the contrary, BDS staff, who has expertise in reviewing RF exposure reports, has agreed that my reports have met the City's criteria. (See *"Staff Report and Recommendations to the Hearing Officer,"* September 23, 2011, pp. 14 – 17).

In this letter the underlined headings in bold type include statements from Mr. Hill's letter of January 11. My rebuttal comments follow each of Mr. Hill's statements. I have limited my comments to RF engineering and RF exposure issues, especially those issues previously addressed in my three previously-submitted RF exposure reports.

1)(a) Response to Mr. Hill's argument that the "plain meaning of the word 'Facility' means all channels of all antennas."

There does not seem to be an explicit definition for the term "Facility" in the City code. The dictionary definition of "Facility" is "something that is built, installed, or established to serve a particular purpose." See online Merriam-Webster dictionary, meaning 4.b.

The plural term "facilities" is used in the "Communications Act." The Communications Act refers to the Communications Act of 1934, as amended, 47 U.S.C. § 151 et seq. (Telecommunications Act of 1996, Pub. LA. No. 104-104, 110 Stat. 56, 1996):

Under SEC. 332. [47 U.S.C. § 332] "MOBILE SERVICES." see (c)(7)(C) "DEFINITIONS."

> (i) the term "personal wireless services" means commercial mobile services, unlicensed wireless services, and common carrier wireless exchange access services;
>
> (ii) the term "personal wireless service **facilities**" means **facilities** for the provision of personal wireless services; [Emphasis added.]

Verizon Wireless is a personal wireless service provider, and under federal rules the Verizon Wireless "POR FOSTER" proposal is for a personal wireless service facility.

Facilities, towers and antennas have different definitions in federal rules. An example follows:

APPENDIX A TO PART 1—A PLAN OF COOPERATIVE PROCEDURE IN MATTERS AND CASES UNDER THE PROVISIONS OF SECTION 410 OF THE COMMUNICATIONS ACT OF 1934

> A. The following terms are used in this Nationwide Agreement as defined below:
>
> 1. Antenna. An apparatus designed for the purpose of emitting radio frequency ("RF") radiation, to be operated or operating from a fixed location pursuant to Commission authorization, for the transmission of writing, signs, signals, data, images, pictures, and sounds of all kinds, including the transmitting device and any on-site equipment, switches, wiring, cabling, power sources, shelters or cabinets associated with that antenna and added to a Tower, structure, or building as part of the original installation of the antenna. **For most services, an Antenna will be mounted on or in, and is distinct from, a supporting structure such as a Tower, structure or building.** [Emphasis added.]
>
> B. "Tower" is any structure built for the sole or primary purpose of supporting FCC licensed antennas and their associated facilities.

Therefore within the FCC rules there is usually a clear distinction made between antennas versus towers and other support structures. For personal wireless service facilities, like the one proposed by Verizon Wireless, the antennas are considered as distinct and separate from the support structure. I can find nothing in City or FCC rules that indicates or implies that the word "Facility" means "All Channels of All Antennas" as suggested by Mr. Hill. **In any case, an exact definition of "Facility" has little to do with determining compliance with FCC RF exposure rules and guidelines.**

1)(b) Response to Mr. Hill's argument that "the FCC uses all channels of all antennas on a site."

As far as I know the FCC does not use the phrase "all channels of all antennas on a site" for any technical or administrative purpose. The standard criterion is "one channel of one antenna." That is because allocation, propagation and interference studies are based on the fact that receivers usually intercept RF energy from one channel at a time.

On the other hand, the human body receives RF energy from all channels directed towards it simultaneously. The body does not recognize individual channels. Therefore, for human RF exposure studies, the FCC requires one to consider the energy from all channels from all antennas that are oriented towards an individual. Common sense and the FCC rules make it clear that one need not consider the energy from directional antennas that are pointed away from an individual.

Mr. Hill ignores both the FCC rules and the simple concept of directional antennas when he incorrectly cites 47 CFR part § 1.1307(b)(1) in support of his argument that all channels from all antennas of a facility should be considered for the purpose of environmental assessments.

The rule in question is Section § 1.1307 *"Actions that may have a significant environmental effect, for which Environmental Assessments (EAs) must be prepared."* Section § 1.1307 delineates those actions for which applicants must submit environmental information.

Mr. Hill grossly misinterprets § 1.1307 in several ways. He ignores the fact that the section considers facilities with sectorized antennas differently than facilities with non-sectorized antennas. Then he misconstrues the criteria of *"Table 1 – Transmitters, Facilities and Operations Subject to Routine Environmental Evaluation"* in § 1.1307.

Like most personal wireless facilities, the proposed Verizon Wireless facility will have sectorized antennas. Therefore "...only the total effective radiated power in each direction is considered" (Hill's quotation, page 2 of his letter). Here is the exact wording from the last paragraph in § 1.1307 (b)(1) just before Table 1:

> "For the case of transmitting facilities using sectorized transmitting antennas, applicants and licensees should apply the criteria to all transmitting channels in a given sector, noting that for a highly directional antenna there is relatively little contribution to ERP or EIRP summation for other directions."

On page 65 of OET Bulletin 65 there is identical language: "For the case of transmitting facilities using sectorized transmitting antennas, applicants and licensees should apply the criteria to all transmitting channels in a given sector, noting that for a highly directional antenna there is relatively little contribution to ERP or EIRP summation for other directions."

Here is supporting language from page 7 of *"A Local Government Official's Guide to Transmitting Antenna RF Emission Safety: Rules, Procedures, and Practical Guidance FCC's Local Official's Guide to RF"* (aka "A Local Government Official's Guide") : "If the facility uses sectorized antennas, only the total effective radiated power in each direction is considered."

Here is a surprising quotation from page 2 of Mr. Hill's letter of 11th January: "If the facility uses sectorized antennas, only the total effective radiated power in each direction is considered." Even though Mr. Hill is not an RF engineer, he appreciates the concept of directed energy from sectorized antennas.

All relevant FCC sources state the same thing – for the purposes of environmental assessment, only the total effective radiated power in each direction is considered for facilities with sectorized antennas. It is meaningless from a technical standpoint to consider all of the radiated power from all channels of all antennas of a sectorized facility.

Visualization of the geometry of the sectorized antenna system provides a straightforward explanation as to why this is so. Each antenna sector is oriented to provide maximum RF energy in a specific direction. In the case of the proposed Verizon Wireless facility the three sectors are oriented so that the three directions of maximum emissions are widely spaced around the compass. Thus it is geometrically impossible for an individual to be exposed to the maximum ERP of more than one sector at a time. See discussion at the bottom of page 6 of my October report, exhibit H28(a).

The second error Mr. Hill makes in regards to § 1.1307 is that he misconstrues the criteria of "Table 1 – Transmitters, Facilities and Operations Subject to Routine Environmental Evaluation" in § 1.1307.

This table provides threshold values for the requirement that personal and other wireless facilities perform a Routine Environmental Evaluation (REE). Every entry in that table applicable to Verizon Wireless operations (i.e., cellular, PCS, and Part 27 radio services) indicates that an REE is **not** required if the height of all antennas above ground is greater than 10 meters (about 33 feet). According to Verizon Wireless construction drawings, all antennas for the proposed Verizon Wireless facility will be above 33 feet. Therefore the FCC does not require Verizon Wireless to provide an REE.

The language from Table 1, § 1.1307, lists the configurations where an REE is REQUIRED:

> Cellular: "Non-building-mounted antennas: height above ground level to lowest point of antenna < 10 m and total power of all channels > 1000 W ERP (1640 W EIRP)."
>
> PCS: "Non-building-mounted antennas: height above ground level to lowest point of antenna < 10 m and total power of all channels > 1000 W ERP (1640 W EIRP)."
>
> Part 27 AWS: "Non-building-mounted antennas: height above ground level to lowest point of antenna < 10 m and total power of all channels > 2000 W ERP (3280 W EIRP)."

Note that similar language is given in OET Bulletin 65, pp 69 and 70, and Table 1 in "A Local Government Official's Guide." However the language in the latest § 1.1307 is controlling, and supersedes these older documents.

An REE is required when there is a low antenna height **and** a high ERP. If the antenna is high enough (above 10 m) **or** the ERP is low enough (below 1000 watts or 2000 watts, depending on the service) then there is **no** requirement for an REE.

One does not need to consider the maximum ERP from a personal wireless facility if all of the personal wireless antennas are greater than 33 feet above ground. The facility will be exempt from an REE regardless of the ERP. This makes sense from a technical standpoint because the higher the antennas, the less influence they have on the RF exposure environment.

Here is a quotation from page 14 of OET Bulletin 65: "For antennas mounted higher than 10 meters, measurement data for cellular facilities have indicated that ground-level power densities are typically hundreds to thousands of times below the new MPE limits."

Therefore the proposed Verizon Wireless facility is "categorically excluded" (i.e., exempt) under FCC rules from the requirement for routine environmental assessment regarding RF exposure hazards. See top of page 14, my October report, exhibit H28(a).

1)(c) Response to Mr. Hill's argument that "the proposed Verizon Wireless facility is over 1000 watts ERP."

This is not true in terms of what's important for most RF purposes, and that is the ERP per "one channel of one antenna." Allocation, propagation and interference studies are all based on the ERP per channel in a specific direction.

The proposed Verizon Wireless facility will act in a way that is typical for a personal wireless facility. It will have three sectors of antennas, with each sector having multiple antennas. Mr. Hill offers no reasons why he believes that the proposed facility is atypical.

See the table on page 3 my October report, exhibit H28(a), for details of the "worst-case" (i.e., maximum) ERP per sector. That value is 6,724 watts. This is a typical value for a sectorized Verizon Wireless facility.

Mr. Hill believes that by not stating the number of channels for the proposed facility, Verizon Wireless is somehow underestimating the actual "wattage" (presumably he means ERP). My October report, exhibit H28(a), page 3, **does** show the number of channels per sector based on one channel per transmitter ("TX"), and the maximum number of transmitters expected to be installed at the proposed facility. All of the per-channel power levels will be less than the maximum power limits allowed by FCC rules. Here is my statement:

> "The maximum ERP for any single channel from any of the Verizon Wireless antennas will be less than 759 watts. Therefore the facility will operate at less than 1000 watts based on one channel of one antenna."

FCC rules prohibit the Verizon Wireless facility from operating at greater than 1000 watts per channel in any frequency band. All of the proposed Verizon Wireless PCS band channels will operate at less than 310 watts ERP. Channels in the cellular band will be approximately 301 watts ERP, less than the 500 watt limit specified in § 22.913(a). The proposed facility will have a maximum per channel power of 759

watts in the 700 MHz band, well within the 1000 watt limit authorized by in § 27.50.

Here are the relevant FCC rule parts:

> § 22.913 Effective Radiated Power Limits
>
> The effective radiated power (ERP) of transmitters in the Cellular Radiotelephone Service must not exceed the limits in this section.
>
> (a) Maximum ERP. In general, the effective radiated power (ERP) of base station transmitters and cellular repeaters must not exceed 500 Watts. [The remainder of the rule applies to systems in rural or unserved areas, which is inapplicable to this case].
>
> § 24.232 Power and antenna height limits
>
> (a)(2) Base stations with an emission bandwidth greater than 1 MHz are limited to 1640 watts/MHZ equivalent isotropically radiated power (EIRP) with an antenna height up to 300 meters HAAT, except as described in paragraph (b) below. [Paragraph (b) applies to systems in rural or unserved areas, which is inapplicable to this case. As noted in the footnote on page 1, 1640 watts EIRP = 1000 watts ERP. The term HAAT means "Height Above Average Terrain". "Average Terrain" means the average ground elevation of all points within a 10 mile radius of the antenna. As the antennas at the proposed POR FOSTER site will be 45 feet above ground, and the site is not located on anything resembling a hilltop, the HAAT in this case is obviously well under 300 meters.
>
> § 27.50 Power limits and duty cycle
>
> (b) The following power and antenna height limits apply to transmitters operating in the 746–763 MHz, 775–793 MHz and 805–806 MHz bands:
>
> (1) Fixed and base stations transmitting a signal in the 757–758 and 775–776 MHz bands must not exceed an effective radiated power (ERP) of 1000 watts and an antenna height of 305 m height above average terrain (HAAT), except that antenna heights greater than 305 m HAAT are permitted if power levels are reduced below 1000 watts ERP in accordance with Table 1 of this section.
>
> (2) Fixed and base stations transmitting a signal in the 746–757 MHz, 758–763 MHz, 776–787 MHz, and 788–793 MHz bands with an emission bandwidth of 1 MHz or less must not exceed an ERP of 1000 watts and an antenna height of 305 m HAAT, except that antenna heights greater than 305 m HAAT are permitted if power levels are reduced below 1000 watts ERP in accordance with Table 1 of this section.

1)(d) <u>Response to Mr. Hill's argument that "the 2000 foot rule must be more stringent for facilities over 1000 watts ERP."</u>

Mr. Hill offers no technical argument as to why "facilities over 1000 W ERP have more powerful RF emissions and will generally have more impact in a land use sense..." What does he mean by "in a land use sense"? Some possible land use impacts are aural, visual, and RF exposure.

Antenna type, antenna geometry, number of antennas, their size and height above ground, number of transmitters, frequency of emissions are just a few variables that determine the impact of a facility. That is why each facility must be judged on its own merit. It is possible that a receive-only facility with zero RF emissions could have a greater impact than a transmitting facility.

All wireless and broadcast facilities must conform to federal RF exposure rules and guidelines no matter what their power level. The FCC requires that the impact of RF exposure resulting from any personal wireless facility be less than the maximum exposure limits.

As shown in my October, 2011 report, the proposed facility will comply with FCC RF exposure limits. Therefore, pursuant to 47 U.S.C. § 332 (c)(7)(iv), the City cannot regulate this facility based on RF exposure.

3) Response to Mr. Hill's argument that the "Verizon Wireless' RF consultant report shows the project will exceed the FCC MPE limit for public exposure."

All wireless and broadcast facilities must conform with federal RF exposure rules and guidelines no matter if they submit an environmental assessment or not. Because of the "categorically exempt" nature of the proposed POR FOSTER facility, Verizon Wireless is not required to submit an REE to the FCC.

Contrary to statements made by Mr. Hill, my October report did consider the cumulative effects of all other significant transmitters in the vicinity. See H28(a), pp. 12 and 13, and my conclusion:

> "The results of the recent RF exposure survey indicate that **there will be no excessive cumulative public RF exposure conditions** due to either the existing T-Mobile facility, or the proposed Verizon [Wireless] facility, near either the Verizon [Wireless] or SBA monopole, or in the in the residential areas between the two monopoles. Thus the T-Mobile and Verizon [Wireless] personal wireless facilities will not have a significant environmental impact, as defined by the FCC Public MPE limits." [Emphasis added.]

Nowhere in the record is there any credible evidence or expert testimony that rebuts the above conclusion.

3(a) Response to Mr. Hill's argument that "Verizon Wireless fails to account for the 30 minute limit of public exposure."

Wireless facilities must comply with FCC Maximum Permissible Exposure (MPE) limits. This is true whether or not an applicant submits an environmental assessment. Verizon Wireless is not required to submit an REE for the proposed facility according to FCC rules, but it must still ensure that the proposed facility will comply with FCC MPE limits.

The OET Bulletin 65 describes the methods for determining compliance with **public** FCC MPE limits. Those limits are based on **continuous and indefinite exposure** to a particular exposure environment.

Mr. Hill refers to page 10 of the OET Bulletin 65. This page describes the concept of time-averaged exposure conditions. Time averaging is used to determine compliance only in those situations where exposure conditions may exceed the FCC MPE limits, such as within an occupational environment.

Since the exposure environment in the vicinity of the proposed Verizon Wireless facility is expected to be far less than the public FCC MPE limit on a continuous basis, then no time averaging is necessary.

The predicted public exposure levels in the vicinity of the proposed Verizon Wireless facility are expected to be 7.09% of the Public MPE due to the proposed facility (exhibit H28(a), page 8). Adding the average ambient condition of 0.61% (exhibit H28(a), page 12) gives a worst-case estimate of 7.70% of the Public MPE limit outdoors in the vicinity of the proposed monopole due to all significant RF sources. No time averaging is required since 7.70% is far less than the 100% Public MPE limit.

Mr. Hill makes the extraordinary claim, "...if the exposure time is longer, a proportionally lower exposure power [sic] is allowed." In fact if the exposure conditions are below the 100% MPE limit, then indefinite and continuous exposure is allowed.

Mr. Hill's time-averaged exposure calculations yield nonsensical results. By his calculations the MPE exposure limits would decrease over time. In fact the FCC Public MPE limits do not change over the duration of the exposure provided that short-term exposure levels never exceed the MPE limit.

The following is a relevant quotation from page 14 of *"Questions and Answers about Biological Effects and Potential Hazards of Radiofrequency Electromagnetic Fields"*, OET Bulletin 56, from the FCC Office of Engineering and Technology, Fourth Edition, August 1999:

> "It is very important to remember that time averaging of exposure is only necessary or relevant for situations where temporary exposures might occur that are in excess of the absolute limits for power density or field strength. These situations usually only occur in workplace environments where exposure can be monitored and controlled. For general population/uncontrolled exposures, say in a residential neighborhood, it is seldom possible to have sufficient information or control regarding how long people are exposed, and averaging of exposure over the designated time period (30 minutes) is normally not appropriate. For such public exposure situations, the MPE limits normally apply for continuous exposure. **In other words, as long as the absolute limits are not exceeded, indefinite exposure is allowed.**" [Emphasis added.]

3)(b) <u>Response to Mr. Hill's argument that "Verizon Wireless' numbers changed over time."</u>

The relevant ERP "Numbers" or values necessary for calculating RF exposure conditions in my three reports are consistent from one report to another.

My initial value for the maximum ERP per sector was 10,000 watts. See my March report, page 2, exhibit A-2. That figure was based on my worst-case estimate of ERP from a Verizon Wireless monopole facility of that height. Note that 10,000 watts is the higher threshold value for the appropriate category in Table 274-2.

My March report demonstrated that the proposed Verizon Wireless facility will meet the City's separation distance requirements even when a worst-case (i.e., highest) ERP is assumed. Here is the language from the City's rule part 33.274.040 "Development Standards".

> "6. Antenna requirements.
>
> "a. Generally. The antenna on any tower or support structure must meet the minimum siting distances to habitable areas of structures shown in Table 274-2. Measurements are made from points A and B on the antenna to the nearest habitable area of a structure normally occupied on a regular basis by someone other than the immediate family or employees of the owner/operator of the antenna. **Point A is measured from the highest point of the antenna (not the tower) to the structure, and Point B is measured from the closest point of the antenna to the structure.** [Emphasis added.]
>
> "b. Exceptions. The antenna on any tower or support structure does not have to meet the minimum siting distance from Point A to the habitable areas of structures shown in Table 274-2 if the applicant submits a letter from a qualified licensed engineer showing that the placement of the antennas will not cause any habitable area of a structure to exceed the Federal Communication Commission's (FCC's) limits for human exposure to radio frequency electromagnetic fields."

The above City rule implies that if the antenna separation distance criteria are met, then that in itself is necessary and sufficient to prove that the proposed facility will meet the FCC MPE limits for human exposure. A similar table appears in "Local Government Official's Guide" Appendix B.

The separation distance criteria are met even if one assumes 10,000 watts per antenna, a gross exaggeration of the planned ERP for any of the proposed Verizon Wireless antennas.

Note that Table 274-2 appears to reference the ERP from an antenna, and not a facility. Appendix B in "A Local Government Official's Guide" references per-channel ERP, and not ERP from a facility.

Mr. Culley provided detailed information that allowed me to determine that the ERP from the highest-powered sector will be 6,724 watts ERP **towards the horizon**. This refinement, based on client-furnished data, is not inconsistent with my statement in March that the ERP "will be less than 10,000 watts" (exhibit A-2, page 2), and my statement in October that the ERP is 6,724 watts (exhibit H28(a), page 3). After all, it is correct and consistent to say that 6,724 watts is in fact less than 10,000 watts.

Mr. Hill cites an MPE limit of 0.459 mW/cm^2. This value appears nowhere in any of my three reports. The correct MPE limit is 0.497 mW/cm^2 at 746 MHz, the lowest Verizon Wireless base-station transmit frequency. This MPE limit is used consistently in my August (exhibit A-3, page 5) and October (exhibit H28(a), page 7) reports.

Other ERP values given in my reports are in **downward directions, below the horizon, and towards specific buildings**. It is inappropriate to use horizontal ERP values for a public RF exposure analysis because no member of the public will be able to stand in any nearby physical location and be within the aperture heights of the proposed antennas. All accessible portions of all nearby buildings appear to be below the proposed antenna heights.

Therefore, when I predict ground-level exposure conditions, or the exposure conditions inside nearby buildings, I must use ERP values that differ from the maximum horizontal ERP value of 6,724 watts. The downward ERPs will be substantially less than the horizontal ERP due to the nature of the Verizon Wireless antennas. The proposed antennas are highly directional, and suppress downward ERP. Energy directed downwards from an antenna is wasted because it is does not enhance coverage.

Here is an excerpt from my August report (exhibit A-3, page 4) describing the downward suppression of the vertical antenna patterns towards the adjacent commercial building and nearby ground level areas:

> "The calculations assume that the vertical patterns of all Verizon [Wireless] personal wireless antennas at this site suppress the maximum ERP downwards towards the adjacent occupancy by a factor of 100 (i.e., 20dB) at 700 MHz and cellular frequencies, and 50 (i.e., 17dB) at PCS frequencies."

I estimate that the downward ERP from the Verizon Wireless 700 MHz and cellular operations will be 39.28 watts (exhibit A-3, page 5). This is based on the maximum ERP towards the horizon of 3,928 watts ERP, divided by the antenna suppression factor of 100.

The same maximum ERP value for the 700 MHz and cellular bands was used for the calculations in my October report. The maximum horizontal ERP of 3,928 watts ERP equals the sum of 1,517 watts for the 700 MHz band plus plus 2,411 watts for the cellular band (exhibit H28(a), ERP table on page 3).

The downward ERP from the Verizon Wireless PCS operations is predicted to be 46.92 watts (exhibit A-3, page 5). This is based on the maximum ERP towards the horizon for those bands, 2,346 watts ERP, divided by a suppression factor of 50. This is the same ERP value given in my October report for the sum of two PCS bands, two times 1,173 watts (exhibit H28(a), page 3).

So there are no inconsistencies or changes in these maximum horizontal ERP values from August to October. What has changed are the directional ERP values. That is because a new exposure environment, in a new location, is the focus of my October report.

My August report predicted the exposure environment at an adjacent occupancy, the commercial building north of the project site. The October report predicts the exposure environment at the apartment building to the west of the project area. These apartments, at 4906 SE 67th Ave, are the closest residences to the proposed facility.

The single-story apartment building is farther from the project site than the commercial building. Therefore the vertical pattern suppression of the antennas is lower towards the apartments. Here is an excerpt from my October report (exhibit H28(a), page 6) describing the ERP suppression:

> "The calculations assume that the vertical patterns of all Verizon [Wireless] personal wireless antennas at this site suppress the maximum ERP downwards towards the apartments by a factor of 10 (10dB) at 700 MHz and cellular frequencies, and 5 (7dB) at PCS frequencies."

These suppression values are ten-times less than those shown in my August report (exhibit A-3, page 4). Thus the directional ERP towards the apartments is ten times greater then the directional ERP towards the commercial building. That is why 39.28 watts ERP was used in my August report, and 392.8 watts ERP in my October report (exhibit H28(a), page 7).

Once again there are no inconsistencies or errors in the August and October reports with regards to the prediction of RF exposure conditions in different areas. The study of each area of interest requires a careful consideration of antenna geometry, distance from antenna, directional antenna suppression, and directional ERP values. Mr. Hill has not shown a sufficient appreciation for these considerations.

Mr. Hill points out that the "MPE estimate of 0.02263 mW/cm^2" in my August report (exhibit A-3, page 5) differs from the "lower power density of 0.0221 mW/cm^2" in my October report (exhibit H28(a), page 7). He considers these values "questionable" although he doesn't state why they should be suspect.

Of course they are different. They describe different exposure environments in different locations. The first number 0.02263 mW/cm^2 is the predicted unattenuated power density at the adjacent commercial occupancy due to the proposed 700 MHz and cellular operations. The second number 0.0221 mW/cm^2 represents the same parameter for the apartment building to the west.

Mr. Hill considers my stated ERP numbers to be "questionable" as well. In my August and October reports the maximum **per channel per antenna** ERP is stated as 759 watts (exhibit A-3, page 3, and exhibit H28(a), page 3). This is not inconsistent with the calculated ERP **summed for all channels** as 6,724 watts, or "over 6,000W" as described by Mr. Hill.

Examination of the first line in my ERP table shows that in the 746 - 757 MHz band there are two channels (or two transmitters), each having 758.7 watts ERP. I simply rounded that number up to the stated 759 watts ERP per channel. All other channels have significantly less ERP. There are no inconsistencies or errors in any of my reports when it comes to describing proposed ERP values.

CONCLUSIONS

The proposed Verizon Wireless personal wireless telecommunications facility will be in compliance with current FCC and local rules regarding public exposure to radiofrequency electromagnetic fields.

After reading the recent testimony provided by Mr. Hill and others, I find no reason to modify or retract the following statement from my October report, exhibit (H28(a), page 13):

> "The results of the recent RF exposure survey indicate that there will be no excessive cumulative public RF exposure conditions due to either the existing T-Mobile facility, or the proposed Verizon [Wireless] facility, near either the Verizon [Wireless] or SBA monopole, or in the in the residential areas between the two monopoles. Thus the T-Mobile and Verizon [Wireless] personal wireless facilities will not have a significant environmental impact, as defined by the FCC Public MPE limits."

Nowhere in the record is there any credible evidence or expert testimony that contradicts the above conclusion.

QUALIFICATIONS

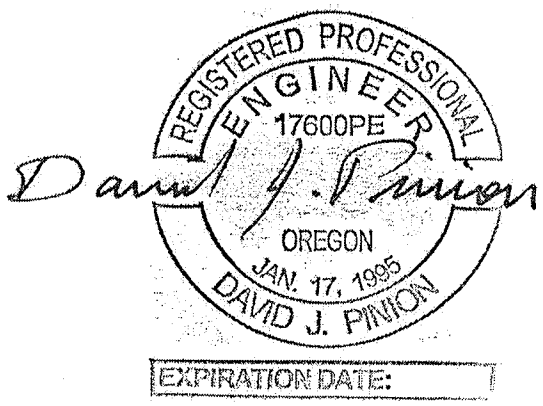
I am an experienced radio engineer whose qualifications are a matter of record with the Federal Communications Commission. I am a partner in the firm of Hatfield & Dawson Consulting Engineers, I am registered as a Professional Engineer in the States of Oregon, Washington, California and Hawaii, and I hold an FCC General Radiotelephone Operator License PG-12-21740. .

I also hold a Bachelor's Degree in Electrical Engineering from the University of Maryland, and a Master's of Science Degree in Electrical Engineering from Johns Hopkins University. I have been a Registered Professional Engineer for 30 years.

My qualifications are In conformance with City code 33.274.040(C)(6)(B) and 33.274.070(A).

All representations contained herein are true to the best of my knowledge.

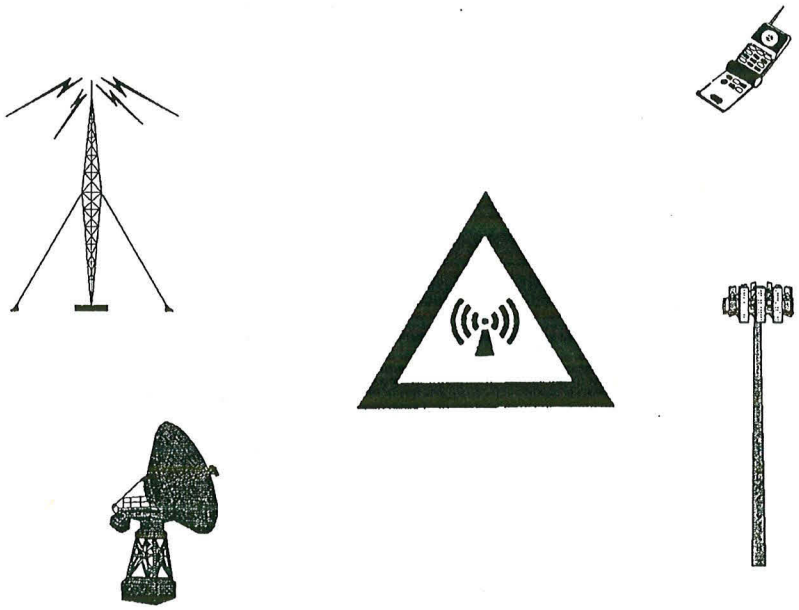
25 January 2012



David J. Pinion, P.E. Expires 12/31/2012

Federal Communications Commission
Office of Engineering & Technology

Questions and Answers about Biological Effects and Potential Hazards of Radiofrequency Electromagnetic Fields



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Questions and Answers about Biological Effects and Potential Hazards of Radiofrequency Electromagnetic Fields

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INTRODUCTION

Many consumer and industrial products and applications make use of some form of electromagnetic energy. One type of electromagnetic energy that is of increasing importance worldwide is radiofrequency (or "RF") energy, including radio waves and microwaves, which is used for providing telecommunications, broadcast and other services. In the United States the Federal Communications Commission (FCC) authorizes or licenses most RF telecommunications services, facilities, and devices used by the public, industry and state and local governmental organizations. Because of its regulatory responsibilities in this area the FCC often receives inquiries concerning whether there are potential safety hazards due to human exposure to RF energy emitted by FCC-regulated transmitters. Heightened awareness of the expanding use of RF technology has led some people to speculate that "electromagnetic pollution" is causing significant risks to human health from environmental RF electromagnetic fields. This document is designed to provide factual information and to answer some of the most commonly asked questions related to this topic.[1]

WHAT IS RADIOFREQUENCY ENERGY?

Radio waves and microwaves are forms of electromagnetic energy that are collectively described by the term "radiofrequency" or "RF." RF emissions and associated phenomena can be discussed in terms of "energy," "radiation" or "fields." Radiation is defined as the propagation of energy through space in the form of waves or particles. Electromagnetic "radiation" can best be described as waves of electric and magnetic energy moving together (i.e., radiating) through space as illustrated in **Figure 1.** These waves are generated by the movement of electrical charges such as in a conductive metal object or antenna. For example, the alternating movement of charge (i.e., the "current") in an antenna used by a radio or television broadcast station or in a cellular base station antenna generates electromagnetic waves that radiate away from the "transmit" antenna and are then intercepted by a "receive" antenna such as a rooftop TV antenna, car radio antenna or an antenna integrated into a hand-held device such as a cellular telephone. The term "electromagnetic field" is used to indicate the presence of electromagnetic energy at a given location. The RF field can be described in terms of the electric and/or magnetic field strength at that location.[2]

Like any wave-related phenomenon, electromagnetic energy can be characterized by a wavelength and a frequency. The wavelength (λ) is the distance covered by one complete

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[1] Exposure to low-frequency electromagnetic fields generated by electric power transmission has also been the subject of public concern. However, because the FCC does not have regulatory authority with respect to power-line electromagnetic fields, this document only addresses questions related to **RF** exposure. Information about exposure due to electrical power transmission can be obtained from several sources, including the following Internet World Wide Web site: **http://www.niehs.nih.gov/emfrapid**

[2] The term "EMF" is often used to refer to electromagnetic fields, in general. It can be used to refer to either power-line frequency fields, radiofrequency electromagnetic fields or both.

electromagnetic wave cycle, as shown in **Figure 1**. The frequency is the number of electromagnetic waves passing a given point in one second. For example, a typical radio wave transmitted by an FM radio station has a wavelength of about three (3) meters and a frequency of about 100 million cycles (waves) per second or "100 MHz." One "hertz" (abbreviated "Hz") equals one cycle per second. Therefore, in this case, about 100 million RF electromagnetic waves would be transmitted to a given point every second.

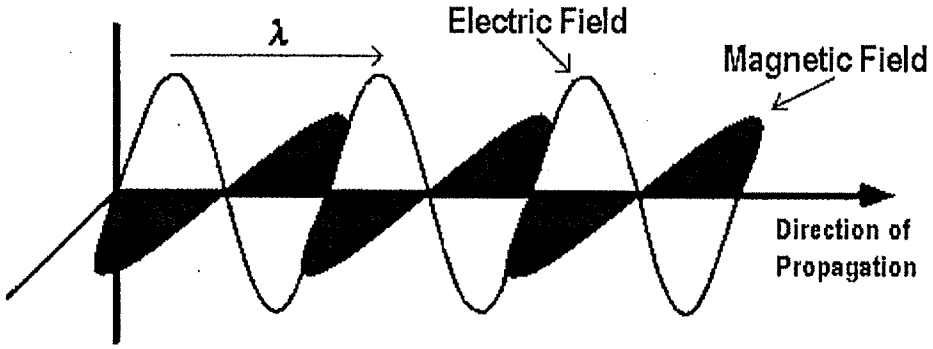

FIGURE 1. ***Electromagnetic Wave***

Electromagnetic waves travel through space at the speed of light, and the wavelength and frequency of an electromagnetic wave are inversely related by a simple mathematical formula: frequency (*f*) times wavelength (λ) = the speed of light (*c*), or $f \times \lambda = c$. This simple equation can also be expressed as follows in terms of either frequency or wavelength:

$$f = \frac{c}{\lambda} \quad or \quad \lambda = \frac{c}{f}$$

Since the speed of light in a given medium or vacuum does not change, high-frequency electromagnetic waves have short wavelengths and low-frequency waves have long wavelengths. The electromagnetic "spectrum" (**Figure 2**) includes all the various forms of electromagnetic energy from extremely low frequency (ELF) energy, with very long wavelengths, to X-rays and gamma rays, which have very high frequencies and correspondingly short wavelengths. In between these extremes are radio waves, microwaves, infrared radiation, visible light, and ultraviolet radiation, in that order. The RF part of the electromagnetic spectrum is generally defined as that part of the spectrum where

electromagnetic waves have frequencies in the range of about 3 kilohertz to 300 gigahertz. One kilohertz (kHz) equals one thousand hertz, one megahertz (MHz) equals one million hertz, and one gigahertz (GHz) equals one billion hertz. Thus, when you tune your FM radio to 101.5, it means that your radio is receiving signals from a radio station emitting radio waves at a frequency of 101.5 million cycles (waves) per second, or 101.5 MHz.

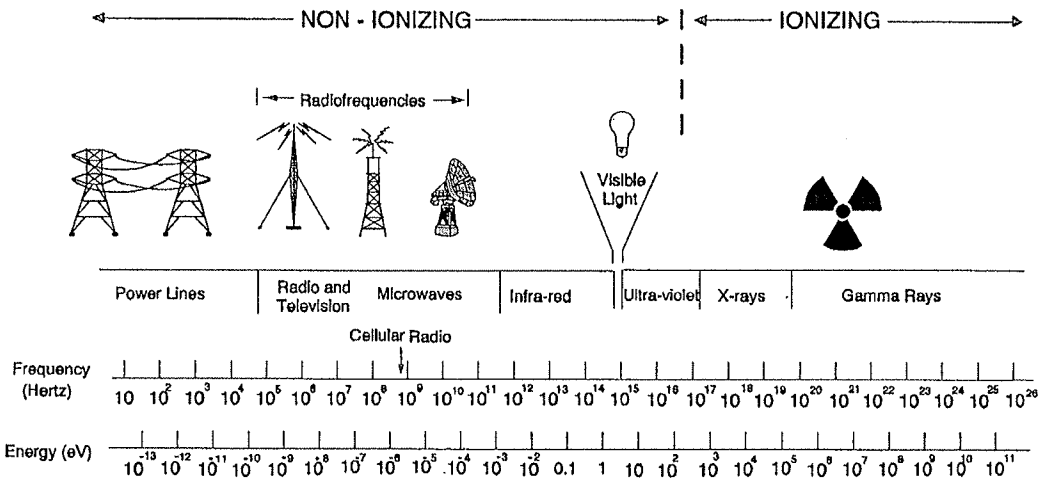

FIGURE 2. ***The Electromagnetic Spectrum***

HOW DO WE USE RADIOFREQUENCY ENERGY?

Probably the most important use for RF energy is in providing telecommunications services to the public, industry and government. Radio and television broadcasting, cellular telephones, personal communications services (PCS), pagers, cordless telephones, business radio, radio communications for police and fire departments, amateur radio, microwave point-to-point radio links and satellite communications are just a few of the many applications of RF energy for telecommunications.

Microwave ovens and radar are examples of non-communications uses of RF energy. Also important are uses of RF energy in industrial heating and sealing where electronic devices generate RF radiation that rapidly heats the material being processed in the same way that a microwave oven cooks food. RF heaters and sealers have many uses in industry,

including molding plastic materials, gluing wood products, sealing items such as shoes and pocketbooks, and processing food products.

There are a number of medical applications of RF energy, including a technique called *diathermy*, that take advantage of the ability of RF energy to rapidly heat tissue below the body's surface. Tissue heating ("hyperthermia") can be beneficial in the therapeutic treatment of injured tissue and cancerous tumors (*see* References 17 & 18).

WHAT ARE MICROWAVES?

Microwaves are a specific category of radio waves that can be defined as radiofrequency radiation where frequencies range upward from several hundred megahertz (MHz) to several gigahertz (GHz). One of the most familiar and widespread uses of microwave energy is found in household microwave ovens, which operate at a frequency of 2450 MHz (2.45 GHz).

Microwaves are also widely used for telecommunications purposes such as for cellular radio, personal communications services (PCS), microwave point-to-point communication, transmission links between ground stations and orbiting satellites, and in certain broadcasting operations such as studio-to-transmitter (STL) and electronic news gathering (ENG) radio links. Microwave radar systems provide information on air traffic and weather and are extensively used in military and police applications. In the medical field microwave devices are used for a variety of therapeutic purposes including the selective heating of tumors as an adjunct to chemotherapy treatment (microwave hyperthermia).

Radiofrequency radiation, especially at microwave frequencies, efficiently transfers energy to water molecules. At high microwave intensities the resulting energetic water molecules can generate heat in water-rich materials such as most foods. The operation of microwave ovens is based on this principle. This efficient absorption of microwave energy via water molecules results in rapid heating throughout an object, thus allowing food to be cooked more quickly than in a conventional oven.

WHAT IS NON-IONIZING RADIATION?

As explained earlier, electromagnetic radiation is defined as the propagation of energy through space in the form of waves or particles. Some electromagnetic phenomena can be most easily described if the energy is considered as waves, while other phenomena are more readily explained by considering the energy as a flow of particles or "photons." This is known as the "wave-particle" duality of electromagnetic energy. The energy associated with a photon, the elemental unit of an electromagnetic wave, depends on its frequency (or

wavelength). The higher the frequency of an electromagnetic wave (and the shorter its corresponding wavelength), the greater will be the energy of a photon associated with it. The energy content of a photon is often expressed in terms of the unit "electron-volt" or "eV".

Photons associated with X-rays and gamma rays (which have very high electromagnetic frequencies) have a relatively large energy content. At the other end of the electromagnetic spectrum, photons associated with low-frequency waves (such as those at ELF frequencies) have many times less energy. In between these extremes ultraviolet radiation, visible light, infrared radiation, and RF energy (including microwaves) exhibit intermediate photon energy content. For comparison, the photon energies associated with high-energy X-rays are billions of times ***more*** energetic than the energy of a 1-GHz microwave photon. The photon energies associated with the various frequencies of the electromagnetic spectrum are shown in the lower scale of **Figure 2.**

Ionization is a process by which electrons are stripped from atoms and molecules. This process can produce molecular changes that can lead to damage in biological tissue, including effects on DNA, the genetic material. This process requires interaction with photons containing high energy levels, such as those of X-rays and gamma rays. A single quantum event (absorption of an X-ray or gamma-ray photon) can cause ionization and subsequent biological damage due to the high energy content of the photon, which would be in excess of 10 eV (considered to be the minimum photon energy capable of causing ionization). Therefore, X-rays and gamma rays are examples of ***ionizing*** radiation. Ionizing radiation is also associated with the generation of nuclear energy, where it is often simply referred to as "radiation."

The photon energies of RF electromagnetic waves are not great enough to cause the ionization of atoms and molecules and RF energy is, therefore, characterized as ***non-ionizing*** radiation, along with visible light, infrared radiation and other forms of electromagnetic radiation with relatively low frequencies. It is important that the terms "ionizing" and "non-ionizing" not be confused when discussing biological effects of electromagnetic radiation or energy, since the mechanisms of interaction with the human body are quite different.

HOW ARE RADIOFREQUENCY FIELDS MEASURED?

Because an RF electromagnetic field has both an electric and a magnetic component (electric field and magnetic field), it is often convenient to express the intensity of the RF field in terms of units specific for each component. The unit "volts per meter" (V/m) is often used to measure the strength ("field strength") of the electric field, and the unit "amperes per meter" (A/m) is often used to express the strength of the magnetic field.

Another commonly used unit for characterizing an RF electromagnetic field is "power density." Power density is most accurately used when the point of measurement is far enough

away from the RF emitter to be located in what is commonly referred to as the "far-field" zone of the radiation source, e.g., more than several wavelengths distance from a typical RF source. In the far field, the electric and magnetic fields are related to each other in a known way, and it is only necessary to measure one of these quantities in order to determine the other quantity or the power density. In closer proximity to an antenna, i.e., in the "near-field" zone, the physical relationships between the electric and magnetic components of the field are usually complex. In this case, it is necessary to determine both the electric and magnetic field strengths to fully characterize the RF environment. (Note: In some cases equipment used for making field measurements displays results in terms of "far-field equivalent" power density, even though the measurement is being taken in the near field.) At frequencies above about 300 MHz it is usually sufficient to measure only the electric field to characterize the RF environment if the measurement is not made too close to the RF emitter.

Power density is defined as power per unit area. For example, power density can be expressed in terms of milliwatts per square centimeter (mW/cm^2) or microwatts per square centimeter ($\mu W/cm^2$). One mW equals 0.001 watt of power, and one μW equals 0.000001 watt. With respect to frequencies in the microwave range and higher, power density is usually used to express intensity since exposures that might occur would likely be in the far-field. More details about the physics of RF fields and their analysis and measurement can be found in References 2, 3, 8, 21, 33, 34 and 35.

WHAT BIOLOGICAL EFFECTS CAN BE CAUSED BY RF ENERGY?

A biological effect occurs when a change can be measured in a biological system after the introduction of some type of stimuli. However, the observation of a biological effect, in and of itself, does not necessarily suggest the existence of a biological ***hazard***. A biological effect only becomes a safety hazard when it "causes detectable impairment of the health of the individual or of his or her offspring" (Reference 25).

There are many published reports in the scientific literature concerning possible biological effects resulting from animal or human exposure to RF energy. The following discussion only provides highlights of current knowledge, and it is not meant to be a complete review of the scientific literature in this complex field. A number of references are listed at the end of this document that provide further information and details concerning this topic and some recent research reports that have been published (References 1, 3, 6, 7, 9, 14, 15-19, 21, 25, 26, 28-31, 34, 36, 39-41, 47, 49 and 53).

Biological effects that result from heating of tissue by RF energy are often referred to as "thermal" effects. It has been known for many years that exposure to high levels of RF radiation can be harmful due to the ability of RF energy to heat biological tissue rapidly. This is the principle by which microwave ovens cook food, and exposure to very high RF power densities, i.e., on the order of 100 mW/cm^2 or more, can clearly result in heating of

biological tissue and an increase in body temperature. Tissue damage in humans could occur during exposure to high RF levels because of the body's inability to cope with or dissipate the excessive heat that could be generated. Under certain conditions, exposure to RF energy at power density levels of 1-10 mW/cm^2 and above can result in measurable heating of biological tissue (but not necessarily tissue damage). The extent of this heating would depend on several factors including radiation frequency; size, shape, and orientation of the exposed object; duration of exposure; environmental conditions; and efficiency of heat dissipation.

Two areas of the body, the eyes and the testes, are known to be particularly vulnerable to heating by RF energy because of the relative lack of available blood flow to dissipate the excessive heat load (blood circulation is one of the body's major mechanisms for coping with excessive heat). Laboratory experiments have shown that short-term exposure (e.g., 30 minutes to one hour) to very high levels of RF radiation (100-200 mW/cm^2) can cause cataracts in rabbits. Temporary sterility, caused by such effects as changes in sperm count and in sperm motility, is possible after exposure of the testes to high-level RF radiation (or to other forms of energy that produce comparable increases in temperature).

Studies have shown that environmental levels of RF energy routinely encountered by the general public are *far below* levels necessary to produce significant heating and increased body temperature (References 32, 37, 45, 46, 48 and 54). However, there may be situations, particularly workplace environments near high-powered RF sources, where recommended limits for safe exposure of human beings to RF energy could be exceeded. In such cases, restrictive measures or actions may be necessary to ensure the safe use of RF energy.

In addition to intensity, the frequency of an RF electromagnetic wave can be important in determining how much energy is absorbed and, therefore, the potential for harm. The quantity used to characterize this absorption is called the "specific absorption rate" or "SAR," and it is usually expressed in units of watts per kilogram (W/kg) or milliwatts per gram (mW/g). In the far-field of a source of RF energy (e.g., several wavelengths distance from the source) whole-body absorption of RF energy by a standing human adult has been shown to occur at a maximum rate when the frequency of the RF radiation is between about 80 and 100 MHz, depending on the size, shape and height of the individual. In other words, the SAR is at a maximum under these conditions. Because of this "resonance" phenomenon, RF safety standards have taken account of the frequency dependence of whole-body human absorption, and the most restrictive limits on exposure are found in this frequency range (the very high frequency or "VHF" frequency range).

Although not commonly observed, a microwave "hearing" effect has been shown to occur under certain very specific conditions of frequency, signal modulation, and intensity where animals and humans may perceive an RF signal as a buzzing or clicking sound. Although a number of theories have been advanced to explain this effect, the most widely-accepted hypothesis is that the microwave signal produces thermoelastic pressure within the head that is perceived as sound by the auditory apparatus within the ear. This effect is not recognized as a health hazard, and the conditions under which it might occur

would rarely be encountered by members of the public. Therefore, this phenomenon should be of little concern to the general population. Furthermore, there is no evidence that it could be caused by telecommunications applications such as wireless or broadcast transmissions.

At relatively low levels of exposure to RF radiation, i.e., field intensities lower than those that would produce significant and measurable heating, the evidence for production of harmful biological effects is ambiguous and unproven. Such effects have sometimes been referred to as "non-thermal" effects. Several years ago publications began appearing in the scientific literature, largely overseas, reporting the observation of a wide range of low-level biological effects. However, in many of these cases further experimental research was unable to reproduce these effects. Furthermore, there has been no determination that such effects might indicate a human health hazard, particularly with regard to long-term exposure.

More recently, other scientific laboratories in North America, Europe and elsewhere have reported certain biological effects after exposure of animals ("*in vivo*") and animal tissue ("*in vitro*") to relatively low levels of RF radiation. These reported effects have included certain changes in the immune system, neurological effects, behavioral effects, evidence for a link between microwave exposure and the action of certain drugs and compounds, a "calcium efflux" effect in brain tissue (exposed under very specific conditions), and effects on DNA.

Some studies have also examined the possibility of a link between RF and microwave exposure and cancer. Results to date have been inconclusive. While some experimental data have suggested a possible link between exposure and tumor formation in animals exposed under certain specific conditions, the results have not been independently replicated. In fact, other studies have failed to find evidence for a causal link to cancer or any related condition. Further research is underway in several laboratories to help resolve this question.

In general, while the possibility of "non-thermal" biological effects may exist, whether or not such effects might indicate a human health hazard is not presently known. Further research is needed to determine the generality of such effects and their possible relevance, if any, to human health. In the meantime, standards-setting organizations and government agencies continue to monitor the latest experimental findings to confirm their validity and determine whether alterations in safety limits are needed in order to protect human health.

WHAT RESEARCH IS BEING DONE ON RF BIOLOGICAL EFFECTS?

For many years research into possible biological effects of RF energy has been carried out in government, academic and industrial laboratories all over the world, and such research is continuing. Past research has resulted in a very large number of scientific publications on this topic, some of which are listed in the reference section of this document. For many years the U.S. Government has sponsored research into the biological effects of RF energy. The majority of this work has been funded by the Department of Defense, due, in part, to the

extensive military interest in using RF equipment such as radar and other relatively high-powered radio transmitters for routine military operations. In addition, some U.S. civilian federal agencies responsible for health and safety, such as the Environmental Protection Agency (EPA) and the U.S. Food and Drug Administration (FDA), have sponsored and conducted research in this area in the past, although relatively little civilian-sector RF research is currently being funded by the U.S. Government. At the present time, much of the non-military research on biological effects of RF energy in the U.S. is being funded by industry organizations such as Motorola, Inc. In general, relatively more research is being carried out overseas, particularly in Europe.

In 1996, the World Health Organization (WHO) established a program (the International EMF Project) designed to review the scientific literature concerning biological effects of electromagnetic fields, identify gaps in knowledge about such effects, recommend research needs, and work towards international resolution of health concerns over the use of RF technology. (*see* Reference 40) The WHO and other organizations maintain Internet Web sites that contain additional information about their programs and about RF biological effects and research (see list of Web sites in **Table 3** of this bulletin). The FDA, the EPA and other federal agencies responsible for public health and safety are working with the WHO and other organizations to monitor developments and identify research needs related to RF biological effects. For example, in 1995 the EPA published the results of a conference it sponsored to assess the current state of knowledge of RF biological effects and to address future research needs in this area (Reference 53).

WHAT LEVELS ARE SAFE FOR EXPOSURE TO RF ENERGY?

Development of Exposure Guidelines

Exposure standards and guidelines have been developed by various organizations and countries over the past several decades. In North America and most of Europe exposure standards and guidelines have generally been based on exposure levels where effects considered harmful to humans occur. Safety factors are then incorporated to arrive at specific levels of exposure to provide sufficient protection for various segments of the population.

Not all standards and guidelines throughout the world have recommended the same limits for exposure. For example, some published exposure limits in Russia and some eastern European countries have been generally more restrictive than existing or proposed recommendations for exposure developed in North America and other parts of Europe. This discrepancy may be due, at least in part, to the possibility that these standards were based on exposure levels where it was believed no biological effects *of any type* would occur. This philosophy is inconsistent with the approach taken by most other standards-setting bodies which base limits on levels where recognized hazards may occur and then incorporate appropriate safety margins to ensure adequate protection.

In the United States, although the Federal Government has never itself developed RF exposure standards, the FCC has adopted and used recognized safety guidelines for evaluating RF environmental exposure since 1985. Federal health and safety agencies, such as the Environmental Protection Agency (EPA), the Food and Drug Administration (FDA), the National Institute for Occupational Safety and Health (NIOSH) and the Occupational Safety and Health Administration (OSHA) have also been actively involved in monitoring and investigating issues related to RF exposure. For example, the FDA has issued guidelines for safe RF emission levels from microwave ovens, and it continues to monitor exposure issues related to the use of certain RF devices such as cellular telephones. NIOSH conducts investigations and health hazard assessments related to occupational RF exposure.

In 1971, a federal RF radiation protection guide for workers was issued by OSHA based on the 1966 American National Standards Institute (ANSI) RF exposure standard. However, the OSHA regulation was later ruled to be advisory only and not enforceable. Presently, OSHA enforcement actions related to RF exposure of workers are undertaken using OSHA's "general duty clause," which relies on the use of widely-supported voluntary "consensus" standards such as those discussed below.[3]

U.S. federal, state and local governmental agencies and other organizations have generally relied on RF exposure standards developed by expert non-government organizations such as ANSI, the Institute of Electrical and Electronics Engineers (IEEE) and the National Council on Radiation Protection and Measurements (NCRP).[4] For example, in 1966, 1974, and 1982, ANSI issued protection guides for RF exposure developed by committees of experts. These earlier ANSI standards recommended limits for exposure of the public that were the same as those recommended for exposure of workers.

In 1986, the NCRP issued exposure criteria for the workplace that were the same as the 1982 ANSI recommended levels, but the NCRP also recommended more restrictive limits for exposure of the general public. Therefore, the NCRP exposure criteria included ***two*** tiers of recommended limits, one for the general population and another for occupational exposure. In 1987, the ANSI committee on RF exposure standards (Standards Coordinating Committee 28) became a committee of the IEEE, and, in 1991, revised its earlier standard and issued its own two-tiered standard that had been developed over a period of several years.

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[3] For information about OSHA RF-related activities and RF protection programs for workers, see the OSHA Internet Web site (case sensitive): www.osha-slc.gov/SLTC/ (select subject: "radiofrequency radiation").

[4] ANSI is a non-profit, privately funded, membership organization that coordinates development of voluntary national standards. The IEEE is a non-profit technical and professional engineering society. The NCRP is a non-profit corporation chartered by the U.S. Congress to develop information and recommendations concerning radiation protection. Several government agencies, including the FCC, and non-government organizations have established relationships with NCRP as "Collaborating Organizations."

The ANSI/IEEE standards have been widely used and cited and have served as the basis for similar standards in the United States and in other countries. Both the NCRP and ANSI/IEEE guidelines were developed by scientists and engineers with a great deal of experience and knowledge in the area of RF biological effects and related issues. These individuals spent a considerable amount of time evaluating published scientific studies relevant to establishing safe levels for human exposure to RF energy.

In addition to NCRP and ANSI/IEEE, other organizations and countries have issued exposure guidelines. For example, several European countries are basing guidelines on exposure criteria developed by the International Committee on Nonionizing Radiation Protection (ICNIRP, Reference 25). The ICNIRP guidelines are also derived from an SAR threshold of 4 W/kg (for adverse effects) and are similar to the 1992 ANSI/IEEE and NCRP recommendations with certain exceptions. For example, ICNIRP recommends somewhat different exposure levels in the lower and upper frequency ranges and for localized exposure due to such devices as hand-held cellular telephones. Many, but not all, countries have based exposure recommendations on the same general concepts and thresholds as those used by the NCRP, ANSI/IEEE and ICNIRP. Because of differences in international standards, the World Health Organization (WHO), as part of its EMF Project (discussed earlier), has initiated a program to try and develop an international framework for RF safety standards.

FCC Exposure Guidelines

In 1985, the FCC adopted the 1982 ANSI guidelines for purposes of evaluating exposure due to RF transmitters licensed and authorized by the FCC. This decision was in response to provisions of the National Environmental Policy Act of 1969 requiring all Federal Government agencies to evaluate the impact of their actions on the "quality of the human environment."[5] In 1992, ANSI adopted the 1991 IEEE standard as an American National Standard (a revision of its 1982 standard) and designated it ANSI/IEEE C95.1-1992.[6]

In 1993, the FCC proposed to update its rules and adopt the new ANSI/IEEE guidelines. After a lengthy period to allow for the filing of comments and for deliberation the FCC decided, in 1996, to adopt a modified version of its original proposal.[7] The FCC's

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[5] The National Environmental Policy Act of 1969, 42 USC Section 4321, *et seq.*

[6] ANSI/IEEE C95.1-1992 (originally issued as IEEE C95.1-1991), "IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz," (Reference 3).

[7] *See Report and Order* and *Second Memorandum Opinion and Order and Notice of Proposed Rulemaking*, ET Docket 93-62, (References 55 and 56). In 1997, the FCC released a technical bulletin entitled, "Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields," OET Bulletin 65 (Reference 57) that contains detailed information on methods for compliance with FCC guidelines. These documents can be accessed at the FCC's Web site: **http://www.fcc.gov/oet/rfsafety.**

action also fulfilled requirements of the Telecommunications Act of 1996 for adopting new RF exposure guidelines.[8]

The FCC considered a large number of comments submitted by industry, government agencies and the public. In particular, the FCC considered comments submitted by the EPA, FDA, NIOSH and OSHA, which have primary responsibility for health and safety in the Federal Government. The guidelines the FCC adopted were based on the recommendations of those agencies, and they have sent letters to the FCC supporting its decision and endorsing the FCC's guidelines as protective of public health.

In its 1996 Order, the FCC noted that research and analysis relating to RF safety and health is ongoing and changes in recommended exposure limits may occur in the future as knowledge increases in this field. In that regard, the FCC will continue to cooperate with industry and with expert agencies and organizations with responsibilities for health and safety in order to ensure that the FCC's guidelines continue to be appropriate and scientifically valid.

The FCC's guidelines are based on recommended exposure criteria issued by the NCRP and ANSI/IEEE. The NCRP exposure guidelines are similar to the ANSI/IEEE 1992 guidelines except for differences in recommended exposure levels at the lower frequencies and higher frequencies of the RF spectrum. Both ANSI/IEEE and NCRP recommend two different tiers of exposure limits. The NCRP designates one tier for occupational exposure and the other for exposure of the general population while ANSI/IEEE designates exposure tiers in terms of "environments," one for "controlled" environments and the other for "uncontrolled" environments. Over a broad range of frequencies, NCRP exposure limits for the public are generally one-fifth those for workers in terms of power density.[9]

The NCRP and ANSI/IEEE exposure criteria identify the same threshold level at which harmful biological effects may occur, and the values for Maximum Permissible Exposure (MPE) recommended for electric and magnetic field strength and power density in

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[8] The Telecommunications Act of 1996, enacted on February 8, 1996, required that: "Within 180 days after the enactment of this Act, the Commission shall complete action in ET Docket 93-62 to prescribe and make effective rules regarding the environmental effects of radio frequency emissions." *See* Section 704(b) of the Telecommunications Act of 1996, Pub. L. No. 104-104, 110 Stat. 56 (1996).

[9] The FCC adopted limits for field strength and power density that are based on Sections 17.4.1 and 17.4.2, and the time-averaging provisions of Sections 17.4.1.1 and 17.4.3, of "Biological Effects and Exposure Criteria for Radiofrequency Electromagnetic Fields," NCRP Report No. 86, for frequencies between 300 kHz and 100 GHz (Reference 34). With the exception of limits on exposure to power density above 1500 MHz, and limits for exposure to lower frequency magnetic fields, these MPE limits are also based on the guidelines developed by the IEEE and adopted by ANSI. *See* Section 4.1 of ANSI/IEEE C95.1-1992, "Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz" (Reference 3).

both documents are based on this threshold level.[10] In addition, both the ANSI/IEEE and NCRP guidelines are frequency dependent, based on findings (discussed earlier) that whole-body human absorption of RF energy varies with the frequency of the RF signal. The most restrictive limits on exposure are in the frequency range of 30-300 MHz where the human body absorbs RF energy most efficiently when exposed in the far field of an RF transmitting source. Although the ANSI/IEEE and NCRP guidelines differ at higher and lower frequencies, at frequencies used by the majority of FCC licensees the MPE limits are essentially the same regardless of whether ANSI/IEEE or NCRP guidelines are used.

Most radiofrequency safety limits are defined in terms of the electric and magnetic field strengths as well as in terms of power density. For lower frequencies, limits are more meaningfully expressed in terms of electric and magnetic field strength values, and the indicated power densities are actually "far-field equivalent" power density values. The latter are listed for comparison purposes and because some instrumentation used for measuring RF fields is calibrated in terms of far-field or plane-wave equivalent power density. At higher frequencies, and when one is actually in the "far field" of a radiation source, it is usually only necessary to evaluate power density. In the far field of an RF transmitter power density and field strength are related by standard mathematical equations.[11]

The exposure limits adopted by the FCC in 1996 expressed in terms of electric and magnetic field strength and power density for transmitters operating at frequencies from 300 kHz to 100 GHz are shown in **Table 1**. The FCC also adopted limits for localized ("partial body") absorption in terms of SAR, shown in **Table 2**, that apply to certain portable transmitting devices such as hand-held cellular telephones.[12]

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[10] These exposure limits are based on criteria quantified in terms of specific absorption rate (SAR). SAR is a measure of the rate at which the body absorbs RF energy. Both the ANSI/IEEE and NCRP exposure criteria are based on a determination that potentially harmful biological effects can occur at an SAR level of 4 W/kg as averaged over the whole-body. Appropriate safety factors have been incorporated to arrive at limits for both whole-body exposure (0.4 W/kg for "controlled" or "occupational" exposure and 0.08 W/kg for "uncontrolled" or "general population" exposure, respectively) and for partial-body (localized SAR), such as might occur in the head of the user of a hand-held cellular telephone. The new MPE limits are more conservative in some cases than the limits specified by ANSI in 1982. However, these more conservative limits do not arise from a fundamental change in the SAR threshold for harm, but from a precautionary desire to add an additional margin of safety for exposure of the public or exposure in "uncontrolled' environments.

[11] See OET Bulletin 65 (Reference 57) for details.

[12] These guidelines are based on those recommended by ANSI/IEEE and NCRP. *See* Sections 4.2.1 and 4.2.2 of ANSI/IEEE C95.1-1992 and Section 17.4.5 of NCRP Report No. 86. For purposes of evaluation, the FCC has designated these devices as either "portable" or "mobile" depending on how they are to be used. Portable devices are normally those used within 20 centimeters of the body and must be evaluated with respect to SAR limits. Mobile devices are normally used 20 centimeters or more away from the body and can be evaluated in terms of either SAR or field intensity. Detailed information on FCC requirements for evaluating portable and mobile devices can be found in OET Bulletin 65 and in the FCC's Rules and Regulations, 47 CFR 2.1091 and 2.1093.

Time Averaging of Exposure

The NCRP and ANSI/IEEE exposure criteria and most other standards specify ***"time-averaged"*** MPE limits. This means that it is permissible to exceed the recommended limits for short periods of time as long as the ***average*** exposure (over the appropriate period specified) does not exceed the limit. For example, Table 1 shows that for a frequency of 100 MHz the recommended power density limit is 1 mW/cm^2 with an averaging time of six minutes (any six-minute period) for occupational/controlled exposure.

The time-averaging concept can be illustrated as follows for exposure in a workplace environment. The sum of the product (or products) of the actual exposure level(s) multiplied by the actual time(s) of exposure must not be greater than the allowed (average) exposure limit times the specified averaging time. Therefore, for 100 MHz, exposure at 2 mW/cm^2 would be permitted for three minutes in any six-minute period as long as during the remaining three minutes of the six-minute period the exposure was at or near "zero" level of exposure. Therefore, in this example:

(2 mW/cm^2) X (3 min.) + (0 mW/cm^2) X (3 min.) = (1 mW/cm^2) X (6 min.)

Of course, other combinations of power density and time are possible. It is *very important* to remember that time averaging of exposure is only necessary or relevant for situations where temporary exposures might occur that are *in excess of* the absolute limits for power density or field strength. These situations usually only occur in workplace environments where exposure can be monitored and controlled. For general population/uncontrolled exposures, say in a residential neighborhood, it is seldom possible to have sufficient information or control regarding how long people are exposed, and averaging of exposure over the designated time period (30 minutes) is normally not appropriate. For such public exposure situations, the MPE limits normally apply for continuous exposure. In other words, as long as the absolute limits are not exceeded, indefinite exposure is allowed.

Induced and Contact Currents

In addition to limits on field strength, power density and SAR, some standards for RF exposure have incorporated limits for currents induced in the human body by RF fields. For example, the 1992 ANSI/IEEE standard (Reference 3), includes specific restrictions that apply to "induced" and "contact" currents (the latter, which applies to "grasping" contact, is more related to shock and burn hazards). The limits on RF currents are based on experimental data showing that excessive SAR levels can be created in the body due to the presence of these currents. In its 1996 Order adopting new RF exposure guidelines the FCC declined to adopt limits on induced and contact currents due primarily to the difficulty of reliably determining compliance, either by prediction methods or by direct measurement. However, the FCC may reconsider this decision in the future because of the development of new instrumentation and analytical techniques that may be more reliable indicators of exposure.

Table 1. *FCC Limits for Maximum Permissible Exposure (MPE)*

(A) Limits for Occupational/Controlled Exposure

Frequency Range (MHz)	Electric Field Strength (E) (V/m)	Magnetic Field Strength (H) (A/m)	Power Density (S) (mW/cm^2)	Averaging Time $\|E\|^2$, $\|H\|^2$ or S (minutes)
0.3-3.0	614	1.63	(100)*	6
3.0-30	1842/f	4.89/f	($900/f^2$)*	6
30-300	61.4	0.163	1.0	6
300-1500	--	--	f/300	6
1500-100,000	--	--	5	6

(B) Limits for General Population/Uncontrolled Exposure

Frequency Range (MHz)	Electric Field Strength (E) (V/m)	Magnetic Field Strength (H) (A/m)	Power Density (S) (mW/cm^2)	Averaging Time $\|E\|^2$, $\|H\|^2$ or S (minutes)
0.3-1.34	614	1.63	(100)*	30
1.34-30	824/f	2.19/f	($180/f^2$)*	30
30-300	27.5	0.073	0.2	30
300-1500	--	--	f/1500	30
1500-100,000	--	--	1.0	30

f = frequency in MHz *Plane-wave equivalent power density

NOTE 1: Occupational/controlled limits apply in situations in which persons are exposed as a consequence of their employment provided those persons are fully aware of the potential for exposure and can exercise control over their exposure. Limits for occupational/controlled exposure also apply in situations when an individual is transient through a location where occupational/controlled limits apply provided he or she is made aware of the potential for exposure.

NOTE 2: General population/uncontrolled exposures apply in situations in which the general public may be exposed, or in which persons that are exposed as a consequence of their employment may not be fully aware of the potential for exposure or can not exercise control over their exposure.

Table 2. ***FCC Limits for Localized (Partial-body) Exposure***

Specific Absorption Rate (SAR)	
Occupational/Controlled Exposure (100 kHz - 6 GHz)	**General Uncontrolled/Exposure (100 kHz - 6 GHz)**
< 0.4 W/kg whole-body **≤ 8 W/kg partial-body**	**< 0.08 W/kg whole-body** **≤ 1.6 W/kg partial-body**

WHY HAS THE FCC ADOPTED GUIDELINES FOR RF EXPOSURE?

The FCC authorizes and licenses devices, transmitters and facilities that generate RF and microwave radiation. It has jurisdiction over all transmitting services in the U.S. except those specifically operated by the Federal Government. However, the FCC's primary jurisdiction does not lie in the health and safety area, and it must rely on other agencies and organizations for guidance in these matters.

Under the National Environmental Policy Act of 1969 (NEPA), the FCC has certain responsibilities to consider whether its actions will "significantly affect the quality of the human environment." Therefore, FCC approval and licensing of transmitters and facilities must be evaluated for significant impact on the environment. Human exposure to RF radiation emitted by FCC-regulated transmitters is one of several factors that must be considered in such environmental evaluations.

Major RF transmitting facilities under the jurisdiction of the FCC, such as radio and television broadcast stations, satellite-earth stations, experimental radio stations and certain cellular, PCS and paging facilities are required to undergo routine evaluation for RF compliance whenever an application is submitted to the FCC for construction or modification of a transmitting facility or renewal of a license. Failure to comply with the FCC's RF exposure guidelines could lead to the preparation of a formal Environmental Assessment, possible Environmental Impact Statement and eventual rejection of an application. Technical

guidelines for evaluating compliance with the FCC RF safety requirements can be found in the FCC's OET Bulletin 65 (Reference 57).

Low-powered, intermittent, or inaccessible RF transmitters and facilities are normally "categorically excluded" from the requirement for ***routine*** evaluation for RF exposure. These exclusions are based on calculations and measurement data indicating that such transmitting stations or devices are unlikely to cause exposures in excess of the guidelines under normal conditions of use.[13] The FCC's policies on RF exposure and categorical exclusion can be found in Section 1.1307(b) of the FCC's Rules and Regulations.[14] It should be emphasized, however, that these exclusions are ***not*** exclusions from compliance, but, rather, only exclusions from routine evaluation. Furthermore, transmitters or facilities that are otherwise categorically excluded from evaluation may be required, on a case-by-case basis, to demonstrate compliance when evidence of potential non-compliance of the transmitter or facility is brought to the Commission's attention [*see* 47 CFR §1.1307(c) and (d)].

The FCC's policies with respect to environmental RF fields are designed to ensure that FCC-regulated transmitters do not expose the public or workers to levels of RF radiation that are considered by expert organizations to be potentially harmful. Therefore, if a transmitter and its associated antenna are regulated by the FCC, they must comply with provisions of the FCC's rules regarding human exposure to RF radiation. In its 1997 Order, the FCC adopted a provision that all transmitters regulated by the FCC, regardless of whether they are excluded from routine evaluation, are expected to be in compliance with the new guidelines on RF exposure by September 1, 2000 (Reference 56).

In the United States some local and state jurisdictions have also enacted rules and regulations pertaining to human exposure to RF energy. However, the Telecommunications Act of 1996 contained provisions relating to federal jurisdiction to regulate human exposure to RF emissions from certain transmitting devices.. In particular, Section 704 of the Act states that, "No State or local government or instrumentality thereof may regulate the placement, construction, and modification of personal wireless service facilities on the basis of the environmental effects of radio frequency emissions to the extent that such facilities comply with the Commission's regulations concerning such emissions." Further information on FCC policy with respect to facilities siting is available in a factsheet from the FCC's Wireless Telecommunications Bureau.[15]

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[13] The Council on Environmental Quality, which has oversight responsibility with regard to NEPA, permits federal agencies to categorically exclude certain actions from routine environmental processing when the potential for individual or cumulative environmental impact is judged to be negligible (40 CFR §§ 1507, 1508.4 and "Regulations for Implementing the Procedural Provisions of NEPA, 43 Fed. Reg. 55,978, 1978).

[14] 47 Code of Federal Regulations 1.1307(b).

[15] "Fact Sheet 2", September 17, 1997, entitled, "*National Wireless Facilities Siting Policies*," from the FCC's Wireless Telecommunications Bureau. This factsheet can be viewed and downloaded from the bureau's Internet World Wide Web Site: http://www.fcc.gov/wtb/.

ARE EMISSIONS FROM RADIO AND TELEVISION ANTENNAS SAFE?

Radio and television broadcast stations transmit their signals via RF electromagnetic waves. There are currently approximately 14,000 radio and TV stations on the air in the United States. Broadcast stations transmit at various RF frequencies, depending on the channel, ranging from about 550 kHz for AM radio up to about 800 MHz for some UHF television stations. Frequencies for FM radio and VHF television lie in between these two extremes. Operating powers ("effective radiated power") can be as little as a few hundred watts for some radio stations or up to millions of watts for certain television stations. Some of these signals can be a significant source of RF energy in the local environment, and the FCC requires that broadcast stations submit evidence of compliance with FCC RF guidelines.

The amount of RF energy to which the public or workers might be exposed as a result of broadcast antennas depends on several factors, including the type of station, design characteristics of the antenna being used, power transmitted to the antenna, height of the antenna and distance from the antenna. Since energy at some frequencies is absorbed by the human body more readily than energy at other frequencies, the frequency of the transmitted signal as well as its intensity is important. Calculations can be performed to predict what field intensity levels would exist at various distances from an antenna.

Public access to broadcasting antennas is normally restricted so that individuals cannot be exposed to high-level fields that might exist near antennas. Measurements made by the FCC, EPA and others have shown that ambient RF radiation levels in inhabited areas near broadcasting facilities are typically well below the exposure levels recommended by current standards and guidelines (References 32, 46, 48, 51, 52). There have been a few situations around the country where RF levels in publicly accessible areas have been found to be higher than those recommended by applicable safety standards (e.g., see Reference 50). But, in spite of the relatively high operating powers of many stations, such cases are unusual, and members of the general public are unlikely to be exposed to RF levels from broadcast towers that exceed FCC limits. Wherever such situations have arisen corrective measures have been undertaken to ensure that areas promptly come into compliance with the applicable guidelines.

In cases where exposure levels might pose a problem, there are various steps a broadcast station can take to ensure compliance with safety standards. For example, high-intensity areas could be posted and access to them could be restricted by fencing or other appropriate means. In some cases more drastic measures might have to be considered, such as re-designing an antenna, reducing power, or station relocation.

Antenna maintenance workers are occasionally required to climb antenna structures for such purposes as painting, repairs, or beacon replacement. Both the EPA and OSHA have reported that in these cases it is possible for a worker to be exposed to high levels of RF energy if work is performed on an active tower or in areas immediately surrounding a

radiating antenna (e.g., see Reference 42, 43, 45, and 51). Therefore, precautions should be taken to ensure that maintenance personnel are not exposed to unsafe RF fields. Such precautions could include temporarily lowering power levels while work is being performed, having work performed only when the station is not broadcasting, using auxiliary antennas while work is performed on the main antenna, and establishing work procedures that would specify the minimum distance that a worker should maintain from an energized antenna.

HOW SAFE ARE MICROWAVE AND SATELLITE ANTENNAS?

Point-to-Point Microwave Antennas

Point-to-point microwave antennas transmit and receive microwave signals across relatively short distances (from a few tenths of a mile to 30 miles or more). These antennas are usually rectangular or circular in shape and are normally found mounted on a supporting tower, on rooftops, sides of buildings or on similar structures that provide clear and unobstructed line-of-sight paths between both ends of a transmission path or link. These antennas have a variety of uses such as transmitting voice and data messages and serving as links between broadcast or cable-TV studios and transmitting antennas.

The RF signals from these antennas travel in a directed beam from a transmitting antenna to a receiving antenna, and dispersion of microwave energy outside of the relatively narrow beam is minimal or insignificant. In addition, these antennas transmit using very low power levels, usually on the order of a few watts or less. Measurements have shown that ground-level power densities due to microwave directional antennas are normally a thousand times or more below recommended safety limits. (e.g., *see* Reference 38) Moreover, as an added margin of safety, microwave tower sites are normally inaccessible to the general public. Significant exposures from these antennas could only occur in the unlikely event that an individual were to stand directly in front of and very close to an antenna for a period of time.

Satellite-Earth Stations

Ground-based antennas used for satellite-earth communications typically are parabolic "dish" antennas, some as large as 10 to 30 meters in diameter, that are used to transmit ("uplinks") or receive ("downlinks") microwave signals to or from satellites in orbit around the earth. The satellites receive the signals beamed up to them and, in turn, retransmit the signals back down to an earthbound receiving station. These signals allow delivery of a variety of communications services, including long distance telephone service. Some satellite-earth station antennas are used only to ***receive*** RF signals (i.e., just like a rooftop television antenna used at a residence), and, since they do not transmit, RF exposure is not an issue.

Since satellite-earth station antennas are directed toward satellites above the earth, transmitted beams point skyward at various angles of inclination, depending on the particular satellite being used. Because of the longer distances involved, power levels used to transmit these signals are relatively large when compared, for example, to those used by the microwave point-to-point antennas discussed above. However, as with microwave antennas, the beams used for transmitting earth-to-satellite signals are concentrated and highly directional, similar to the beam from a flashlight. In addition, public access would normally be restricted at station sites where exposure levels could approach or exceed safe limits.

Although many satellite-earth stations are "fixed" sites, portable uplink antennas are also used, e.g., for electronic news gathering. These antennas can be deployed in various locations. Therefore, precautions may be necessary, such as temporarily restricting access in the vicinity of the antenna, to avoid exposure to the main transmitted beam. In general, however, it is unlikely that a transmitting earth station antenna would routinely expose members of the public to potentially harmful levels of microwaves.

ARE CELLULAR AND PCS TOWERS AND ANTENNAS SAFE? WHAT ABOUT CAR PHONES AND HAND-HELD PHONES?

Base Stations

Cellular radio systems use frequencies between 800 and 900 megahertz (MHz). Transmitters in the Personal Communications Service (PCS) use frequencies in the range of 1850-1990 MHz. The antennas for cellular and PCS transmissions are typically located on towers, water tanks or other elevated structures including rooftops and the sides of buildings. The combination of antennas and associated electronic equipment is referred to as a cellular or PCS "base station" or "cell site." Typical heights for free-standing base station towers or structures are 50-200 feet. A cellular base station may utilize several "omni-directional" antennas that look like poles, 10 to 15 feet in length, although these types of antennas are becoming less common in urban areas.

In urban and suburban areas, cellular and PCS service providers now more commonly use "sector" antennas for their base stations. These antennas are rectangular panels, e.g., about 1 by 4 feet in dimension, typically mounted on a rooftop or other structure, but they are also mounted on towers or poles. The antennas are usually arranged in three groups of three each. One antenna in each group is used to transmit signals to mobile units (car phones or hand-held phones), and the other two antennas in each group are used to receive signals from mobile units.

The FCC authorizes cellular and PCS carriers in various service areas around the country. At a cell site, the total RF power that could be transmitted from each transmitting antenna at a cell site depends on the number of radio channels (transmitters) that have been

authorized and the power of each transmitter. Typically, for a cellular base station, a maximum of 21 channels per sector (depending on the system) could be used. Thus, for a typical cell site utilizing sector antennas, each of the three transmitting antennas could be connected to up to 21 transmitters for a total of 63 transmitters per site. When omni-directional antennas are used, up to 96 transmitters could be implemented at a cell site, but this would be unusual. While a typical base station could have as many as 63 transmitters, not all of the transmitters would be expected to operate simultaneously thus reducing overall emission levels. For the case of PCS base stations, fewer transmitters are normally required due to the relatively greater number of base stations.

Although the FCC permits an ***effective radiated power*** (ERP) of up to 500 watts per channel (depending on the tower height), the majority of cellular base stations in urban and suburban areas operate at an ERP of 100 watts per channel or less. An ERP of 100 watts corresponds to an ***actual*** radiated power of about 5-10 watts, depending on the type of antenna used (ERP is not equivalent to the power that is radiated but, rather, is a quantity that takes into consideration transmitter power and antenna directivity). As the capacity of a system is expanded by dividing cells, i.e., adding additional base stations, lower ERPs are normally used. In urban areas, an ERP of 10 watts per channel (corresponding to a radiated power of 0.5 - 1 watt) or less is commonly used. For PCS base stations, even lower radiated power levels are normally used.

The signal from a cellular or PCS base station antenna is essentially directed toward the horizon in a relatively narrow pattern in the vertical plane. The radiation pattern for an omni-directional antenna might be compared to a thin doughnut or pancake centered around the antenna while the pattern for a sector antenna is fan-shaped, like a wedge cut from a pie. As with all forms of electromagnetic energy, the power density from a cellular or PCS transmitter decreases rapidly (according to an inverse square law) as one moves away from the antenna. Consequently, normal ground-level exposure is much less than exposures that might be encountered if one were very close to the antenna and in its main transmitted beam.

Measurements made near typical cellular and PCS installations, especially those with tower-mounted antennas, have shown that ground-level power densities are well below limits recommended by RF/microwave safety standards (References 32, 37, and 45). For example, for a base-station transmitting frequency of 869 MHz the FCC's RF exposure guidelines recommend a Maximum Permissible Exposure level for the public ("general population/uncontrolled" exposure) of about 580 microwatts per square centimeter ($\mu W/cm^2$). This limit is many times greater than RF levels found near the base of typical cellular towers or in the vicinity of lower-powered cellular base station transmitters, such as might be mounted on rooftops or sides of buildings. Measurement data obtained from various sources have consistently indicated that "worst-case" ground-level power densities near typical cellular towers are on the order of 1 $\mu W/cm^2$ or less (usually significantly less). Calculations corresponding to a "worst-case" situation (all transmitters operating simultaneously and continuously at the maximum licensed power) show that in order to be exposed to levels near the FCC's limits for cellular frequencies, an individual would essentially have to remain in

the main transmitting beam (at the height of the antenna) and within a few feet from the antenna. This makes it extremely unlikely that a member of the general public could be exposed to RF levels in excess of these guidelines due to cellular base station transmitters. For PCS base station transmitters, the same type of analysis holds, except that at the PCS transmitting frequencies (1850-1990 MHz) the FCC's exposure limits for the public are 1000 $\mu W/cm^2$. Therefore, there would typically be an even greater safety margin between actual public exposure levels and recognized safety limits.

When cellular and PCS antennas are mounted at rooftop locations it is possible that ambient RF levels greater than 1 $\mu W/cm^2$ could be present on the rooftop itself. However, exposures approaching or exceeding the safety guidelines are only likely to be encountered very close to or directly in front of the antennas. For sector-type antennas RF levels to the side and in back of these antennas are insignificant.

Even if RF levels were higher than desirable on a rooftop, appropriate restrictions could be placed on access. Factoring in the time-averaging aspects of safety standards could also be used to reduce potential exposure of workers who might have to access a rooftop for maintenance tasks or other reasons. The fact that rooftop cellular and PCS antennas usually operate at lower power levels than antennas on free-standing towers makes excessive exposure conditions on rooftops unlikely. In addition, the significant signal attenuation of a building's roof minimizes any chance for persons living or working within the building itself to be exposed to RF levels that could approach or exceed applicable safety limits.

Vehicle-Mounted Antennas

Vehicle-mounted antennas used for cellular communications normally operate at a power level of 3 watts or less. These cellular antennas are typically mounted on the roof, on the trunk, or on the rear window of a car or truck. Studies have shown that in order to be exposed to RF levels that approach the safety guidelines it would be necessary to remain very close to a vehicle-mounted cellular antenna for an extended period of time (Reference 20).

Studies have also indicated that exposure of vehicle occupants is reduced by the shielding effect of a vehicle's metal body. Some manufacturers of cellular systems have noted that proper installation of a vehicle-mounted antenna is an effective way to maximize this shielding effect and have recommended antenna installation either in the center of the roof or the center of the trunk. With respect to rear-window-mounted cellular antennas, a minimum separation distance of 30-60 cm (1 to 2 feet) has been suggested to minimize exposure to vehicle occupants that could result from antenna mismatch.

Therefore, properly installed, vehicle-mounted, personal wireless transceivers using up to 3 watts of power result in maximum exposure levels in or near the vehicle that are well below the FCC's safety limits. This assumes that the transmitting antenna is at least 15 cm

(about 6 inches) or more from vehicle occupants. Time-averaging of exposure (as appropriate) should result in even lower values when compared with safety guidelines.

Mobile and Portable Phones and Devices

The FCC's exposure guidelines, and the ANSI/IEEE and NCRP guidelines upon which they are based, specify limits for human exposure to RF emissions from hand-held RF devices in terms of *specific absorption rate (SAR)*. For exposure of the general public, e.g., exposure of the user of a cellular or PCS phone, the FCC limits RF absorption (in terms of SAR) to 1.6 watts/kg (W/kg), as averaged over one gram of tissue. Less restrictive limits, e.g., 2 W/kg averaged over 10 grams of tissue, are specified by guidelines used in some other countries (Reference 25).

Measurements and computational analysis of SAR in models of the human head and other studies of SAR distribution using hand-held cellular and PCS phones have shown that the 1.6 W/kg limit is unlikely to be exceeded under normal conditions of use (References 4, 16, 27). The same can be said for cordless telephones used in the home. Lower frequency (46-49 MHz) cordless telephones operate at very low power levels that could not result in exposure levels that even come close to the 1.6 W/kg level. Higher frequency cordless phones operating near 900 MHz (near the frequencies used for cellular telephones) operate with power levels similar to or less than those used for cell phones. They are also unlikely to exceed the SAR limits specified by the FCC under normal conditions of use.

In any case, compliance with the 1.6 W/kg safety limit must be demonstrated before FCC approval can be granted for marketing of a cellular or PCS phone. Testing of hand-held phones is normally done under conditions of maximum power usage. However, normal power usage is less since it depends on distance of the user from the base station transmitter. Therefore, typical exposure to a user would actually be expected to be less than that indicated by testing for compliance with the limit.

In recent years, publicity, speculation, and concern over claims of possible health effects due to RF emissions from hand-held wireless telephones prompted industry-sponsored groups to initiate research programs to investigate whether there is any risk to users of these devices. Organizations such as Wireless Technology Research (funded by the cellular radio service industry) and wireless equipment manufacturers, such as Motorola, Inc., have been investigating potential health effects from the use of hand-held cellular telephones and other wireless telecommunications devices.

In 1994, the U.S. General Accounting Office (GAO) issued a report that addressed the status of research on the safety of cellular telephones and encouraged U.S. Government agencies to work closely with industry to address wireless safety issues (Reference 59). In that regard, the Federal Government has been monitoring the results of ongoing research through an inter-agency working group led by the EPA and the FDA's Center for Devices and

Radiological Health. In a 1993 "Talk Paper," the FDA stated that it did not have enough information at that time to rule out the possibility of risk, but if such a risk exists, "it is probably small" (Reference 58). The FDA concluded that there is no proof that cellular telephones can be harmful, but if individuals remain concerned several precautionary actions could be taken, including limiting conversations on hand-held cellular telephones and making greater use of telephones with vehicle-mounted antennas where there is a greater separation distance between the user and the radiating antennas.

HOW SAFE ARE FIXED AND MOBILE RADIO TRANSMITTERS USED FOR PAGING AND "TWO-WAY" COMMUNICATIONS?

"Land-mobile" communications include a variety of communications systems which require the use of portable and mobile RF transmitting sources. These systems operate in narrow frequency bands between about 30 and 1000 MHz. Radio systems used by the police and fire departments, radio paging services and business radio are a few examples of these communications systems. They have the advantage of providing communications links between various fixed and mobile locations.

As with cellular and PCS communications, there are three types of RF transmitters associated with land-mobile systems: base-station transmitters, vehicle-mounted transmitters, and hand-held transmitters. The antennas used for these various transmitters are adapted for their specific purpose. For example, a base-station antenna must radiate its signal to a relatively large area, and, therefore, its transmitter generally has to use much higher power levels than a vehicle-mounted or hand-held radio transmitter.

Although these base-station antennas usually operate with higher power levels than other types of land-mobile antennas, they are normally inaccessible to the public since they must be mounted at significant heights above ground to provide for adequate signal coverage. Also, many of these antennas transmit only intermittently. For these reasons, such base-station antennas have generally not been of concern with regard to possible hazardous exposure of the public to RF radiation. However, studies at rooftop locations have indicated that high-powered paging antennas may increase the potential for exposure to workers or others with access to such sites, e.g., maintenance personnel (Reference 12). This could be a concern especially when multiple transmitters are present. In such cases, restriction of access or other corrective actions may be necessary.[16]

Transmitting power levels for vehicle-mounted land-mobile antennas are generally less than those used by base-station antennas but higher than those used for hand-held units. As with cellular transmitters, some manufacturers recommend that users and other nearby

[16] Methods and techniques for controlling exposure are discussed in OET Bulletin 65 (Reference 57).

individuals maintain a minimum distance (e.g., 1 to 2 feet) from a vehicle-mounted antenna during transmission or mount the antenna in such a way as to provide maximum shielding for vehicle occupants. Studies have shown that this is probably a conservative precaution, particularly when the "duty factor" (percentage of time an antenna is actually radiating) is taken into account since safety standards are "time-averaged." Unlike cellular telephones, which transmit continuously throughout a call, two-way radios normally transmit only when the "press-to-talk" button is depressed. The extent of any possible exposure would also depend on the actual power level and frequency used by the vehicle-mounted antenna. In general, there is no evidence that there would be a safety hazard associated with exposure from vehicle-mounted, two-way antennas when the manufacturer's recommendations are followed.

Hand-held "two-way" portable radios such as walkie-talkies are low-powered devices used to transmit and receive messages over relatively short distances. Because of the relatively low power levels used (usually no more than a few watts) and, especially, because of the intermittency of transmissions (low duty factor) these radios would normally not be considered to cause hazardous exposures to users. As with vehicle-mounted mobile units, time averaging of exposure can normally be considered when evaluating two-way radios for compliance with safety limits, since these units are "push to talk.". Laboratory measurements have been made using hand-held radios operating at various frequencies to determine the amount of RF energy that might be absorbed in the head of a user. In general, the only real possibility of a potential hazard would occur in the unlikely event that the tip of the transmitting antenna were to be placed directly at the surface of the eye, contrary to manufacturers' recommended precautions, or if for some reason continuous exposure were possible over a significant period of time, which is unlikely. If hand-held radios are used properly there is no evidence that they could cause hazardous exposure to RF energy (References 5, 11, 13, and 27).

ARE RF EMISSIONS FROM AMATEUR RADIO STATIONS HARMFUL?

There are hundreds of thousands of amateur radio operators ("hams") worldwide. Amateur radio operators in the United States are licensed by the FCC. The Amateur Radio Service provides its members with the opportunity to communicate with persons all over the world and to provide valuable public service functions, such as making communications services available during disasters and emergencies. Like all FCC licensees, amateur radio operators are expected to comply with the FCC's guidelines for safe human exposure to RF fields. Under the FCC's rules, amateur operators can transmit with power levels of up to 1500 watts. However, most hams use considerably less power than this. Studies by the FCC and others have shown that most amateur radio transmitters would not normally expose persons to RF levels in excess of safety limits. This is primarily due to the relatively low operating powers used by most amateurs, the intermittent transmission characteristics typically used and the relative inaccessibility of most amateur antennas. As long as appropriate

distances are maintained from amateur antennas, exposure of nearby persons should be well below safety limits. This has been demonstrated by studies carried out by the FCC and others (Reference 54). If there were any opportunity for significant RF exposure, it would most likely apply to the amateur operator and his or her immediate household. To help ensure compliance of amateur radio facilities with RF exposure guidelines, both the FCC and American Radio Relay League (ARRL) have developed technical publications to assist operators in evaluating compliance of their stations (References 23 and 57).

CAN IMPLANTED ELECTRONIC CARDIAC PACEMAKERS BE AFFECTED BY NEARBY RF DEVICES SUCH AS MICROWAVE OVENS OR CELLULAR TELEPHONES?

Over the past several years there has been concern that signals from some RF devices could interfere with the operation of implanted electronic pacemakers and other medical devices. Because pacemakers are electronic devices, they could be susceptible to electromagnetic signals that could cause them to malfunction. Some allegations of such effects in the past involved emissions from microwave ovens. However, it has never been shown that signals from a microwave oven are strong enough to cause such interference.

The FDA requires pacemaker manufacturers to test their devices for susceptibility to electromagnetic interference (EMI) over a wide range of frequencies and to submit the results as a prerequisite for market approval. Electromagnetic shielding has been incorporated into the design of modern pacemakers to prevent RF signals from interfering with the electronic circuitry in the pacemaker. The potential for the "leads" of pacemakers to be susceptible to RF radiation has also been of some concern, but this does not appear to be a serious problem.

Recently there have been reports of possible interference to implanted cardiac pacemakers from digital RF devices such as cellular telephones. An industry-funded organization, Wireless Technology Research, LLC (WTR), working with the FDA, sponsored an investigation as to whether such interference could occur, and, if so, what corrective actions could be taken. The results of this study were published in 1997 (*see* Reference 24), and WTR and the FDA have made several recommendations to help ensure the safe use of wireless devices by patients with implanted pacemakers. One of the primary recommendations is that digital wireless phones be kept at least six inches from the pacemaker and that they not be placed directly over the pacemaker, such as in the breast pocket, when in the "on" position. Patients with pacemakers should consult their physician or the FDA if they believe that they may have a problem related to RF interference.

WHICH OTHER FEDERAL AGENCIES HAVE RESPONSIBILITIES RELATED TO POTENTIAL RF HEALTH EFFECTS?

Various agencies in the Federal Government have been involved in monitoring, researching or regulating issues related to human exposure to RF radiation. These agencies include the Food and Drug Administration (FDA), the Environmental Protection Agency (EPA), the Occupational Safety and Health Administration (OSHA), the National Institute for Occupational Safety and Health (NIOSH), the National Telecommunications and Information Administration (NTIA) and the Department of Defense (DOD).

By authority of the Radiation Control for Health and Safety Act of 1968, the Center for Devices and Radiological Health (CDRH) of the FDA develops performance standards for the emission of radiation from electronic products including X-ray equipment, other medical devices, television sets, microwave ovens, laser products and sunlamps. The CDRH established a product performance standard for microwave ovens in 1971 limiting the amount of RF leakage from ovens. However, the CDRH has not adopted performance standards for other RF-emitting products. The FDA is, however, the lead federal health agency in monitoring the latest research developments and advising other agencies with respect to the safety of RF-emitting products used by the public, such as cellular and PCS phones.

The FDA's microwave oven standard is an ***emission*** standard (as opposed to an ***exposure*** standard) that allows leakage (measured at five centimeters from the oven surface) of 1 mW/cm^2 at the time of manufacture and a maximum level of 5 mW/cm^2 during the lifetime of the oven.[17] The standard also requires ovens to have two independent interlock systems that prevent the oven from generating microwaves the moment that the latch is released or the door of the oven is opened. The FDA has stated that ovens that meet its standards and are used according to the manufacturer's recommendations are safe for consumer and industrial use.

The EPA has, in the past, considered developing federal guidelines for public exposure to RF radiation. However, EPA activities related to RF safety and health are presently limited to advisory functions. For example, the EPA now chairs an Inter-agency Radiofrequency Working Group, which coordinates RF health-related activities among the various federal agencies with health or regulatory responsibilities in this area.

OSHA is responsible for protecting workers from exposure to hazardous chemical and physical agents. In 1971, OSHA issued a protection guide for exposure of workers to RF radiation [29 CFR 1910.97]. The guide, covering frequencies from 10 MHz to 100 GHz, stated that exposure of workers should not exceed a power density of ten milliwatts per square centimeter (10 mW/cm^2) as averaged over any 6-minute period of the workday. However, this guide was later ruled to be only advisory and not mandatory. Moreover, it was

[17] 21 Code of Federal Regulations 1030.10.

based on an earlier (1966) American National Standards Institute (ANSI) RF protection guide that has been superseded by revised versions in 1974, 1982 and 1992 (see previous discussion of standards). OSHA personnel have recently stated that OSHA uses the ANSI/IEEE 1992 guidelines for enforcement purposes under OSHA's "general duty clause" (see OSHA's Internet Web Site, listed in Table 3, for further information).

NIOSH is part of the U.S. Department of Health and Human Services. It conducts research and investigations into issues related to occupational exposure to chemical and physical agents. NIOSH has, in the past, undertaken to develop RF exposure guidelines for workers, but final guidelines were never adopted by the agency. NIOSH conducts safety-related RF studies through its Physical Agents Effects Branch.

The NTIA is an agency of the U.S. Department of Commerce and is responsible for authorizing Federal Government use of the RF electromagnetic spectrum. Like the FCC, the NTIA also has NEPA responsibilities and has considered adopting guidelines for evaluating RF exposure from U.S. Government transmitters such as radar and military facilities.

The Department of Defense (DOD) has conducted research on the biological effects of RF energy for a number of years. This research is now conducted primarily at the DOD facility at Brooks Air Force Base, Texas. In addition, the DOD uses the ANSI/IEEE 1992 standard as a guide for protecting military personnel from excessive exposure to RF electromagnetic fields.

WHERE CAN I OBTAIN INFORMATION ON RF EXPOSURE AND HEALTH EFFECTS?

Although relatively few offices or agencies within the Federal Government routinely deal with the issue of human exposure to RF fields, it is possible to obtain information and assistance on certain topics from the following federal agencies. Most of these agencies also have Internet Web sites.

FDA: For information about radiation from microwave ovens and other consumer and industrial products contact: Center for Devices and Radiological Health (CDRH), Food and Drug Administration, Rockville, MD 20857.

EPA: The Environmental Protection Agency's Office of Radiation and Indoor Air is responsible for monitoring potential health effects due to public exposure to RF fields. Contact: Environmental Protection Agency, Office of Radiation and Indoor Air, 401 M Street, S.W., Washington, D.C. 20460.

OSHA: The Occupational Safety and Health Administration's (OSHA) Health Response Team (1781 South 300 West, Salt Lake City, Utah 84165) has been involved in studies related to occupational exposure to RF radiation. OSHA also maintains an Internet World

Wide Web site that may be of interest. The URL (case sensitive) is: http://www.osha-slc.gov/SLTC/ (select subject: radiofrequency radiation).

NIOSH: The National Institute for Occupational Safety and Health (NIOSH) monitors RF-related safety issues as they pertain to the workplace. Contact: NIOSH, Physical Agents Effects Branch, Mail Stop C-27, 4676 Columbia Parkway, Cincinnati, Ohio 45226. Toll-free number: 1-800-35-NIOSH (1-800-356-4674).

DOD: Questions regarding Department of Defense activities related to RF safety and its biological research program can be directed to the Radio Frequency Radiation Branch, Air Force Research Laboratory, Brooks Air Force Base, TX 78235.

FCC: Questions regarding potential RF hazards from FCC-regulated transmitters can be directed to the RF Safety Program, Office of Engineering and Technology, Technical Analysis Branch, Federal Communications Commission, 445 Twelfth Street, S.W., Washington, D.C. 20554. The telephone number for inquiries on RF safety issues is: 1-202-418-2464. Calls for routine information can also be directed to the FCC's toll-free number: 1-888-CALL-FCC (225-5322). Another source of information is the FCC's RF Safety Internet Web site (http://www.fcc.gov/oet/rfsafety) where FCC documents and notices can be viewed and downloaded. Questions can also be sent via e-mail to: rfsafety@fcc.gov.

In addition to government agencies, there are other sources of information and possible assistance regarding environmental RF energy. Some states also maintain non-ionizing radiation programs or, at least, some expertise in this field, usually in a department of public health or environmental control. The list of references at the end of this bulletin can be consulted for detailed information on specific topics, and **Table 3** provides a list of some relevant Internet Web sites.

TABLE 3: *INTERNET WEB SITES FOR FURTHER INFORMATION*

Note: All Internet addresses below preceded by "http://"
Also, some URL's may be case sensitive

***American Radio Relay League*: www.arrl.org**

***American National Standards Institute:* www.ansi.org**

***Bioelectromagnetics Society*: www.bioelectromagnetics.org**

***COST 244 (Europe)*: www.radio.fer.hr/cost244**

***DOD:* www.brooks.af.mil/AFRL** *(select radiofrequency radiation)*

***European Bioelectromagnetics Association:* www.ebea.org**

***Electromagnetic Energy Association*: www.elecenergy.com**

***Federal Communications Commission:* www.fcc.gov/oet/rfsafety**

***ICNIRP (Europe)*: www.icnirp.de**

***IEEE:* www.ieee.org**

***IEEE Committee on Man & Radiation:* www.seas.upenn.edu/~kfoster/comar.htm**

***International Microwave Power Institute:* www.impi.org**

***Microwave News:* www.microwavenews.com**

***J.Moulder, Med.Coll.of Wisc.*: www.mcw.edu/gcrc/cop/cell-phone-health-FAQ/toc.html**

***National Council on Radiation Protection & Measurements:* www.ncrp.com**

***NJ Dept Radiation Protection:* www.state.nj.us/dep/rpp** *(select non-ionizing radiation)* ***Richard Tell Associates*: www.radhaz.com**

***US OSHA*: www.osha-slc.gov/SLTC** *(select subject: radiofrequency radiation)*

***Wireless Industry (CTIA):* www.wow-com.com**

***Wireless Industry (PCIA):* www.pcia.com**

***World Health Organization EMF Project*: www.who.ch/peh-emf**

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This list is not meant to be a complete bibliography, but, rather it provides a selection of some of the more relevant and recent references and publications related to this topic.

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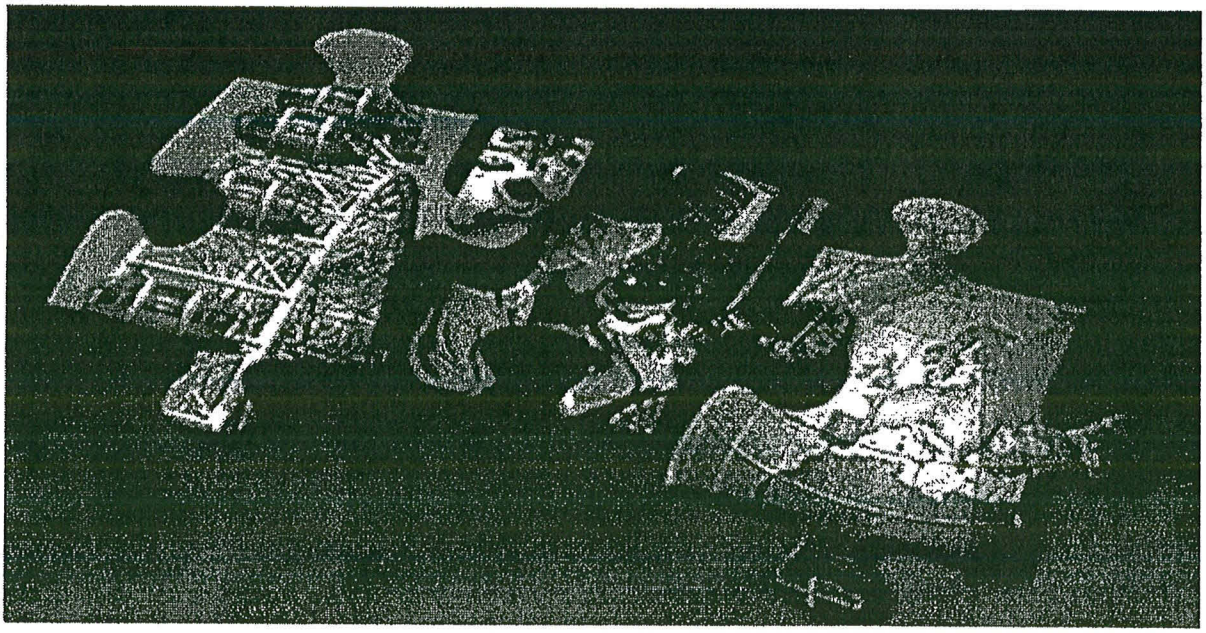
Connecting to Our Future: Portland's Broadband Strategic Plan



City of Portland

Prepared by the Office of Cable Communications & Franchise Management

September 6, 2011

CONNECTING TO OUR FUTURE: PORTLAND'S BROADBAND STRATEGIC PLAN

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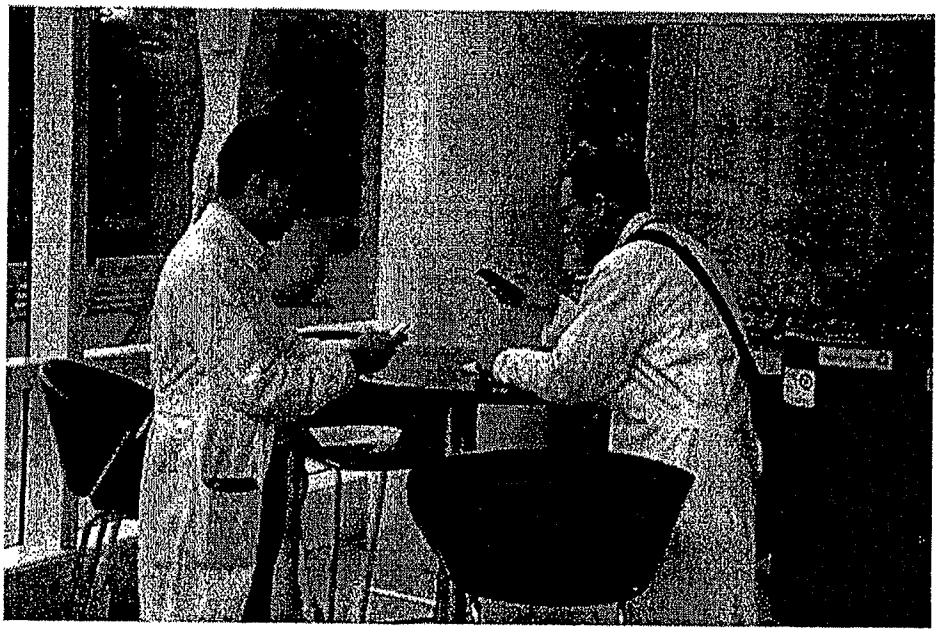

IBI Group with affiliate NetCity Inc. provided consulting for the Portland Broadband Strategic Plan under the direction of the Office of Cable Communications and Franchise Management. Nancy Jesuale, NetCity Inc. and IBI Group, was the Project Consultant.

SEPTEMBER 6, 2011

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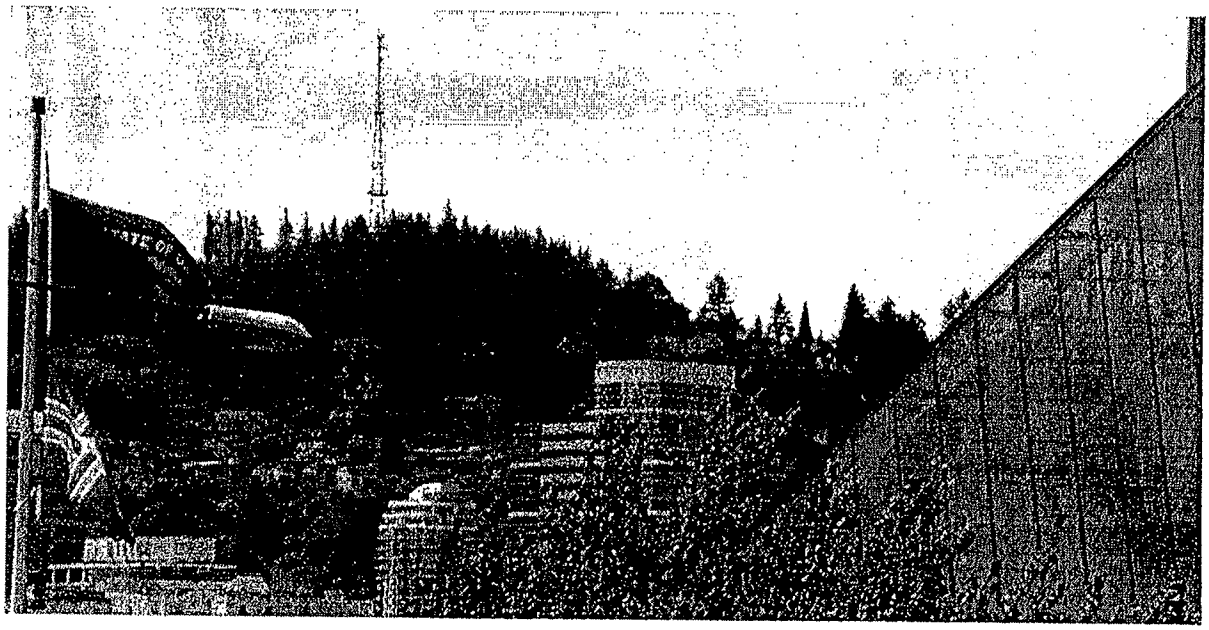
CONNECTING TO OUR FUTURE: PORTLAND'S BROADBAND STRATEGIC PLAN

Introduction

> Understanding the impacts of enhanced Broadband Networks on the city of Portland and its citizens leads to strategic investment, partnerships and policymaking to protect our economy, society, jobs and the livability of Portland.

The advancement of technologies and infrastructure associated with Broadband will play a key role in Portland's economic future and quality of life. We are at a critical juncture where establishing an effective Broadband policy has the potential to create more jobs for Portlanders, increase opportunities for the region's companies, enhance public safety, and provide greater educational opportunities throughout our community[1]. The creation of a Broadband Strategic Plan is about keeping Portland competitive so that our workforce can continually innovate locally and collaborate globally. This requires robust, affordable broadband infrastructure plus realistic adoption and utilization strategies. Broadband Networks (including the Internet, as well as infrastructure and devices) are producing cataclysmic change in global, national and local societies, markets and institutions around the world. These networks are interconnected and pervasive in their reach, and for the purposes of this plan will be referred to as simply "the Network." The Network allows change to happen so quickly that we are often surprised by the deep societal changes we see and are unaware of great impacts that are just around the corner. Yet, the Network is transforming societies, threatening national and local boundaries, challenging markets, and impacting wealth, work, education, health and public safety. So it is important for us to learn what the Network is, how it impacts society, and set a strategic course for our economic and social development.

Like the introduction of electricity, Broadband Networks are fundamentally changing our environment and society in ways that were not anticipated. Much like electricity, which was invented to turn on the lights but powered the transformation to an industrial society, the Network is powering another transformational global shift into a technological and informational society. It was impossible to know in advance that electrification would provide the critical infrastructure to power computers, radio and television, financial markets, home appliances, manufacturing, electric vehicles and many more unforeseen innovations.

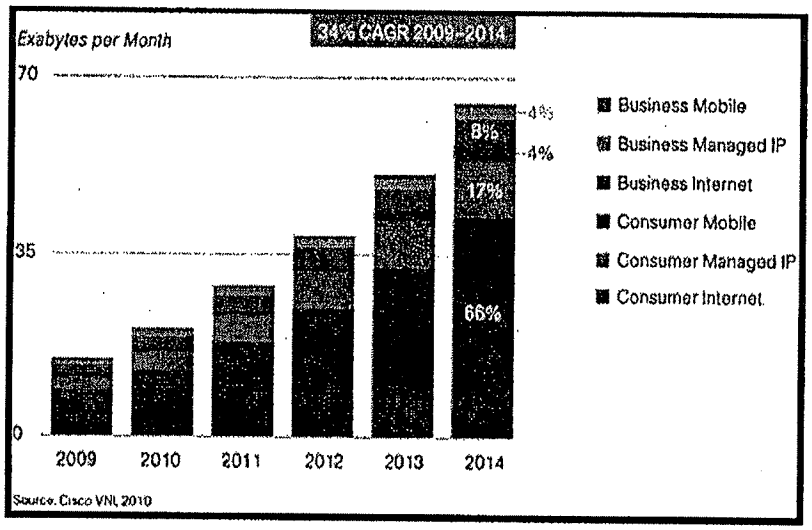


1 The Future of Cities, Information and Inclusion http://www.portlandonline.com/cable/index.cfm?c=54038&a=334344

Broadband is Critical Infrastructure

Broadband provides the high-capacity Internet connections which have rapidly become fundamental infrastructure. Just as electricity was the pivotal innovation in the last century, broadband networks are having rapid, widespread and dramatic impacts on our society in this century. The Network has become integral to both the working and personal lives of most households, families and businesses. This has been demonstrated by these functions now moving online:[2]

- The majority of job listings
- Most higher education admissions applications and requests for references
- Critical health care functionality, including benefits claims
- Many billing statements, bank statements, etc. that a household receives
- Bus schedules, traffic information, and road conditions
- Ordering, shipping and postal tracking
- News, particularly newspaper content



Broadband refers to the capacity of the networks to carry data traffic (the size of the access "lanes" on the Network). A broadband network has large capacity to transmit information globally, although the definition of Broadband is changing quickly too. The Federal Communications Commission (FCC) has proposed in the *National Broadband Plan (NBP)*[3] that broadband should be defined as 50 Mbps "downstream" (to the consumer) and 20 Mbps "upstream" (from the consumer into the network) by 2015. Given the growth trends in network traffic this definition is conservative (See Figure 1 above). Cisco and other scientific companies talk about the network in terms of "terabytes" of capacity in the network center, or "core". Businesses today routinely require symmetrical gigabit service between their locations. Global Internet traffic grew 45 percent during 2009 alone. **Global network traffic will quadruple from 2009 to 2014.** The average monthly traffic in 2014 will be equivalent to 32 million people streaming Avatar in 3D, continuously for the entire month. Overall, as projected by Cisco Systems, Internet Protocol (IP) traffic will grow at a compound annual growth rate (CAGR) of 34 percent[4].

For the City's Broadband Strategic Plan, the NBP's capacity goals represent a "floor" rather than a ceiling. While these are higher than Portland's basic and mid-tier services today, the goals set forth in this plan will require greater capacity in the future. **A shortage or deficit of broadband capacity will cause Portland to be at a competitive disadvantage in meeting economic development goals**[5]. This plan does not suggest a specific broadband capacity target for Portland in the future. This plan does, however recognize Broadband service as a **necessary service** (both wireless and wireline) to sustain economic growth, maintain quality educational and governance institutions, protect citizens and property and to create employment opportunity.

2 See the Broadband Briefing Book provided by the Office of Cable and Telecommunications Franchise Management, City of Portland (2011) at http://www.portlandonline.com/cable/index.cfm?c=54013 (last accessed 7-18-2011)

3 National Broadband Plan, Federal Communications Commission, Washington, D.C. (2010) see http://www.broadband.gov/plan/ (last accessed 7-18-2011)

4 www.cisco.com

5 http://www.sngroup.com/what-exactly-are-we-stimulating/

Fiber and Wireless Broadband: The Technological Future

The future of telecommunications technology is not wireless or fiber optics—it is a combination of both. **Fiber and wireless are both essential**[6]. These two technologies inherently complement each other and work together. Fiber offers theoretically infinite capacity, which is essential for institutional and high bandwidth users, and for the backhaul of wireless data and voice from cellular towers to the network infrastructure. The key advantage of wireless is that it offers mobility and connectivity during movement, untethering the user and giving them network accessability anywhere. Wireless can be used to connect to an ambulance, a bus, or a resident's laptop in a public park. The emerging standard for wireless is 4G, or fourth-generation wireless; it is on the short-term horizon for commercial deployment in Portland, and will also be an essential part of Portland's public safety wireless future.

Fiber is the international standard for very high speed broadband for businesses and institutions. In many areas it has also been deployed in residential networks.

This is not on the immediate horizon for Portland, given the known deployment plans of the private sector. However, Verizon (now Frontier) deployed FTTP in the communities surrounding Portland. FTTP is being deployed on a national basis in almost every developed Asian country, as well as in China, and it is also being deployed extensively in our competitor nations and cities across Europe.

Scope of the Broadband Strategic Plan

The objectives of the planning effort are:

- To positively affect how broadband infrastructure and service is likely to develop in Portland over the next ten years.
- To plan for optimal broadband adoption and deployment for Portland.
- To identify key short (3-year), mid (7-year) and long-term (10-year) broadband policies and initiatives that the City can put in place that coordinate and guide the actions of City Bureaus, Offices and Committees toward a unified technology policy direction.
- To positively impact the policies, actions and directions of other Oregon communities and of the state as a whole.

Five Goals of the Broadband Strategic Plan

Through the strategic planning process, the following five goals were identified for the Broadband Strategic Plan.

1. Strategically invest in broadband infrastructure to attract innovative broadband-intensive businesses and institutions that create knowledge jobs in Portland.
2. Eliminate broadband capacity, equity, access and affordability gaps so Portland achieves near universal adoption of broadband services for all residents, small businesses and community-based organizations.
3. Develop highly technology-skilled and employable residents, students, small businesses and workforce.
4. Promote and plan for the use and wide-spread adoption of broadband technologies in government, energy conservation, transportation, health, education and public safety.
5. Create future-oriented broadband policy, modernize government organizations and institutionalize digital inclusion values throughout the region.

> The Broadband Strategic Plan is a vision for Portland's future that recognizes the social, economic and political importance of Broadband in our livability, prosperity, sustainability, and equity goals.
>
> *The Portland Broadband Strategic Plan Vision Statement*

6 Columbia Telecommunications Corporation (CTC), various documents. See http://ctcnet.us/

Requirements for Success: Vision, Partnerships and Leadership

This Broadband Strategic Plan represents a milestone in urban planning for the City of Portland. For the first time, the City has taken steps to include Broadband as an essential, critical infrastructure in the planning fabric, along with transportation, telecommunications, parks, power, and water/sewer infrastructure. A robust broadband ecosystem of infrastructure, competitive providers, services and devices is necessary for economic growth, job creation, education, livability, sustainability, public safety and civic engagement. However, achieving the goals outlined in this plan cannot be accomplished by City policy and actions alone. The City must engage a host of regional and statewide players with its vision, and must create partnerships that can move together in a strategic direction. The partnerships require both public and private sector entities.

Effective policy changes and transformation of the City government and its institutions requires strong and committed leadership. The Broadband Strategic Plan describes significant changes in government structures, relationships and technology. These cannot be implemented easily, and the steadfast commitment of the City's elected officials and top managers is necessary throughout the change process.

Strategic Planning Process

The City of Portland began its Strategic Planning for Broadband in late 2010, after the City Council passed a resolution recognizing "high-speed, accessible and affordable broadband is now mission-critical infrastructure for job creation, education, health care, the enhancement of safe and connected communities, civic engagement, government transparency and responsiveness, reduced carbon emissions, and emergency preparedness[7]".

The Portland City Council directed the Office of Cable Communications and Franchise Management to work with the Portland Development Commission, the Bureau of Technology Services, the Fire Bureau, the Police Bureau, the Public Safety Systems Revitalization Program, the Office of Planning and Sustainability, and Mayor and Council Offices to ensure that a comprehensive, informed and inclusive broadband planning effort was undertaken that emphasizes equitable provision of services, business vitality and job creation. The Office of Cable Communications and Franchise Management engaged a consultant, IBI Group and its affiliate Nancy Jesuale of NetCity Inc., to assist with the Plan. A leadership team composed of staff from each City Council Office and the Bureau Directors of key City Bureaus was formed. Phase I of the work plan called for the formation of five sector workgroups (economic development, education and health, digital equity and inclusion, planning/transportation/sustainability and public safety) to participate in an eight-week facilitated planning process. This process was kicked- off with a session in City Hall in January 2011 that included presentations by Commissioners Dan Saltzman and Amanda Fritz, City Officials, community representatives and telecommunications providers offering broadband services in Portland. The five sector workgroups included City Bureau Managers, Directors and executive employees, Council Office liaisons, Multnomah County, Tri-Met, Metro, non-profits, small and large businesses, social activists, K-12 and higher education representatives and health professionals. This report represents the outcomes of those meetings, engagement with the community and research and consultation with broadband experts on best practices.

Economic Development

The City of Portland's economic goal is job creation, including providing access to a skilled workforce. The City recognizes four traded-sector industry clusters in the Economic Development Strategy, including advanced manufacturing, athletic and outdoor, clean tech, and software, as well as a fifth, functional cluster focused on research and commercialization.[8] The City's Economic Development Strategy also recognizes the importance of vibrant communities and small neighborhood businesses to Portland's economy.[9] Wilf Pinfold, Director of Extreme Scale Projects at Intel said "if we really want to create an engine for job creation, Portland must have particular competence in Broadband. We need to look at standards and best practices." Sheldon Renan, a consultant in technology issues said "we have to address infrastructure. It doesn't have to be, and probably shouldn't be either publicly owned or privately controlled, but rather we should be setting up cooperative partnerships between the

7 http://www.portlandonline.com/cable/index.cfm?c=54013&a=334327

8 These are described at http://pdxeconomicdevelopment.com/industries.html

9 See the Portland Development Commission's Neighborhood Economic Development Strategy at http://www.pdc.us/bus_serv/ned.asp

public and private sectors to improve infrastructure and access to broadband generally for businesses and the workforce." Business needs broadband as its lifeblood. Local government has an enormous role to play to ensure that broadband resources get placed in our communities, by providing funding, support, and resources. Skip Newberry, of the Mayor's Office noted that the City "wants to help entrepreneurs, very small businesses (11-99 employees) and micro businesses (under 10 employees) because these businesses create most of the new jobs in Portland. Certain parts of the city, like the central eastside, have a concentration of start-ups and PDC is looking at ways to direct urban renewal and other resources to help these small businesses grow." The economic development workgroup wanted to find incentives for developers to include broadband in their buildings, and for providers to extend high bandwidth services in areas where business clusters. They discussed both regulatory and financial incentives to developers and providers. Rich Bader, CEO of EasyStreet OnLine Services suggested the need to "marry high tech businesses and anchor institutions, such as government and universities" to leverage their demand for very high bandwidth into "markets" for broadband providers. Wilf and Sheldon proposed that the City should actively work to attract research and development institutions, with very high bandwidth requirements to pump demand into the City and establish the City as a research-friendly high bandwidth ecosystem.

> Portland must innovate by establishing partnerships with industry, education, and other government bodies, and by reforming our government institutions.

Broadband and the Transformation of Working and Employment

According to the Aspen Institute's Communications and Society Program's recent publication, "The Future of Work", (2011)[10] "Work in the future will be organized in ways that are far more decentralized." Work is no longer confined to a specific time and place. Technology is blurring the lines between work and home and between work and personal life. Tens of millions of people now work at home offices, telecommute or participate in "virtual companies" whose members are scattered across the country or the globe. Many others work for startup firms in improvised settings. Open platforms for the "crowdsourcing" of work mean that work is becoming an activity that can occur anywhere, and at any time. The implications of this transformation affect our urban architecture (who will occupy high-rise buildings?), tax structure (what is the correct structure for taxing business when its location is the Network, not the City) and our economic development strategies (how can we attract companies to locate in Portland, if they are in fact virtual rather than physical?) The Aspen Institute report predicts the transformation of corporations or "firms" into markets, where skills are outsourced and workers are much more likely to be contractors or affiliated with markets than specific firms. Particularly in scientific, cognitive and creative work, the knowledge worker may work for employers who are not located within the region at all. Conversely, employers located in Portland may hire workers from anywhere on the globe, depending on their skills rather than their ability to report to a specific location at a specific time.

Broadband and the Transformation of the Worker

Employees will be expected to be highly conversant with digital networking and virtual collaboration on the platform referred to as "cloud computing."[11] As cloud computing becomes more pervasive, Peter Jackson, Chief Scientist and Vice President of Corporate Research and Development at Thomson Reuters, envisions that "once the cloud becomes a reality and people have raw, undifferentiated computing power available to them as a utility, they will be able to stop worrying about infrastructure and platforms. Then they will be able to start thinking about intangibles: innovation and imagination – the things that build higher quality services. This will raise everybody's game." (Aspen, p.17) This is the new reality that Portland must develop a strategy to accomplish. Our city must be a location among the first and best in the Country to provide the computing power and platforms as a utility, to attract the innovation and imagination of the economic markets. Portland's economy cannot prosper without institutions that innovate, and infrastructure that allows global connectivity wherever those institutions and their workers choose to locate. Legacy hierarchies and institutional structures are bottlenecks to developing the new economy. Portland

10 http://www.aspeninstitute.org/publications/future-of-work

11 "Cloud Computing" is defined as the use of network connections to access most data and applications from servers provided by a third party that reside in cyberspace, rather than using servers and applications locally to store and access data and applications.

must innovate in both, by establishing partnerships with industry, education, and other government bodies, and by reforming our government institutions and policies to root out silos of control and resistance to change.

The Aspen Report points out that in the networked environment, the mindset and disposition of workers will matter more than ever (p. 22). Workers must be prepared to embrace change. They must desire to be "on the edge" of breaking developments, and must have passion to probe a question or problem (a passion for inquiry). These mindsets and dispositions cannot be taught, but must be cultivated, according to John Seely Brown, of the Deloitte Center for the Edge. Work is becoming a lifestyle and identity, not just a paycheck (Aspen p.24).

Sustainability, Transportation and Urban Planning

The Network will have pervasive effects on our social networks and our physical habits, perhaps most notably our commutes. The increase in available capacity to do work and make social and political contacts on the network, combined with the increasing real and social costs of commuting means that more work will be performed without requiring commuting. Home offices, neighborhood "office-environments" (like the coffee shop, library or community center) will draw workers when commuting is inconvenient or impossible. Beyond convenience, knowledge workers who are based "on the net" will choose to live where they want, in social and physical environments that enhance their lifestyle and are affordable, since work can and does take place anywhere, and at all hours. Families will seek communities offering a lifestyle, knowing that their work is portable. Affordability will be critical, but also access to cultural activities, recreation, educational opportunities and community for children and adults, and the ability to shop, dine, and interact will attract knowledge workers.

Aging: Our society is also aging, and families will be concerned with the care of seniors as well as children. Telemedicine will advance to the household, offering health worker visual and auditory monitoring of seniors, medication inventories, vital sign monitoring, motion detection, and other types of in-home monitoring and assessment using the network[12]. Today many seniors take most of their outings out of the home to physician appointments. Many of these check-ups will be performed via the network, allowing seniors to function for days and weeks and months without visiting a hospital or doctor's office for care. Seniors separated from their family members will be able to visit daily and check in with children and grandchildren as well as caregivers through the network.

> Legacy hierarchies and institutional structures are bottlenecks to developing the new economy.

Internet of Things: Household systems will be connected to the network, not just for communication, entertainment or work, but in an "Internet of Things". Devices will connect and communicate their status and health, monitoring and controlling energy consumption, making shopping lists of items running low in the fridge, and scheduling events, maintenance, and replacement of everything from tires to furnace filters without human intervention. The power grid itself will be a "smart-grid" managing demand according to available supplies in an automated effort to control power consumption[13].

Transportation: Urban travel will be most convenient and affordable on public transportation, but even private automobiles will be connected to a network. The network will monitor their status and performance, notifying drivers of hazards, delays and mechanical issues. Anti-collision technology will brake and steer through road hazards, and prevent operation of vehicles by inebriated drivers.

Urban Planning: For Portland planners, understanding the power the network will have on urban form and function is critical. Neighborhoods will be designed around affordable and sustainable transportation options, and network access will be as important to the function, form and livability as power, roads and water. Tim McHugh, Chief Information Officer of TriMet notes that there will be three layers of communications infrastructure in the transit system; the equipment imbedded in vehicles, systems for vehicle tracking and real time information on conditions and location, and customer information access and applications. These three layers will also apply to buildings,

> "High bandwidth nodes are just like freeway interchanges"

12 See for instance http://www.nursingcenter.com/library/JournalArticle.asp?Article_ID=425466 (last accessed 7-18-2011)
13 http://www.infoworld.com/print/167184 July 18, 2011

homes and other structures. An "Internet of Things" will tie the systems within the structures together to monitor and control energy use, inventories, locks and security, temperature, etc. Control systems will be accessible through the network "cloud", which will aggregate information for trending and real-time energy-load, transportation and supply chain control. Consumers will access their systems real time, through mobile devices wherever they are to turn the lights on or off, defrost dinner, or say hello to their children when they put their key in the lock after school. Gary Odenthal, Senior Planner for the City, noted that "everything is going mobile. The network has to go where people go." Brendan Finn, Chief of Staff for Commissioner Dan Saltzman noted that "Infrastructure is driving where people are going to locate. It drives where companies are locating. High bandwidth nodes are just like freeway interchanges." Chris Smith of the Portland Planning and Sustainability Commission noted that Broadband networks could be "commons goods" or "private goods." Chris advocates for broadband to be a commons good in Portland, something all have access to as a privilege of being here, and not something that is a luxury available only at a premium. Scott Robinson, Deputy Chief Operating Officer of Metro suggests that broadband should be included in every regional planning effort from climate action to transportation to housing, community development and education. Alex Bejarano of the Portland Bureau of Transportation noted that "Broadband is essential to our quality of life and vision of the future. It's a utility, and so much more." Don Stastny, an architect from StastnyBrun Architects in Portland was very concerned about equity issues. "Broadband, if not ubiquitous will create further divides between the haves and have-nots. Broadband access is a matter of social equity and social policy, indivisible from modeling neighborhoods. We have to consider the impact on individual citizens."

Digital Inclusion and Civic Engagement

Don Stastny's concerns were echoed throughout the workshop sessions and in every workgroup in the Portland process. According to the Aspen Report, "New sorts of government leadership are needed to address social inequality, education and training, and improvements in governments services... There is a keen imperative, in short, for serious institutional innovation."

The biggest dangers are greater inequalities of wealth and potentially destructive social polarization. These trends make it imperative that government, education and social institutions learn how to respond to the emerging networked environment.

Civic Engagement: Brian Hoop, of the Office of Neighborhood Involvement (ONI) shared ONI's goals for improving civic engagement: increasing and diversifying access to government, strengthening the capacity of community organizations, expanding public impact on government (improving transparency) and improving neighborhood livability and safety. Cece Hughley, Executive Director of Portland Community Media noted that a major part of their role is to promote digital literacy. She notes that it is a natural role for non-profits to help cities accomplish transparency. She also noted that video storytelling provides a powerful context when discussing policy. Without broadband, individuals and communities have limitations on their ability to see and distribute video communications. Russell Senior of Personal Telco commented that the overarching goal is to facilitate everyone to be a producer of Internet content as well as a consumer.

Transparency: Julie Omelchuck, of the Portland Office of Cable Communications and Franchise Management noted that broadband technologies are "the only way to make transparency affordable." She commented that all city government documents should be on-line for public access. However, Rick Nixon, Technology Manager for the City's Bureau of Technology Services suggests that that idea doesn't go far enough. Government documents need to be on-line but they need to be in a useful, standardized format, that is searchable, indexed, and where data can be lifted or exported to other programs and platforms for analyses and general use. Rick also noted that the City has outdated policies for maintaining the City's web site, and for access to technology. Julie and Rick emphasized that the City needs to provide more transactional opportunities for citizens to do all of their business with government over the Network. Public records laws, public meeting laws and other standing policies and regulations need to be reformed. Public meetings will not continue to be "physical in a given place and time" but will be conducted over a period of time over the network, to allow residents with all kinds of schedules to participate in dialog and decision-making." Portland could be a leader in instituting these improvements.

Culture: Abdiasis Mohamed, Program Coordinator for IRCO spoke about trends in Portland's immigrant communities. He notes that there is a generational difference among these communities, where youth are adapting

mobile Internet and smart phone technologies very quickly, but older populations don't adapt to the networked society. Access and affordability of broadband are key for these communities to be able to connect and engage with civic life, and to remain connected with their native cultures. Julie noted that it is important to focus on mobile applications, because mobile internet is being adopted faster and is more pervasive through smart phones than fixed internet.

There was extended discussion of the role of the City in ensuring affordable access to broadband for residents of Portland. Many participants felt that broadband access is becoming a right, not a luxury, and that access is an equity issue. Some supported the idea of a publically funded open access infrastructure platform over which private entities could compete. There were many other proposals to find ways to subsidize needy and low income households to pay for broadband including requiring public buildings to offer free broadband service and providing incentives to carriers to serve low income neighborhoods. Digital literacy continued to emerge as a necessary element to empower communities and individuals. Access to broadband, while necessary, is not sufficient in itself.

> Broadband technologies are "the only way to make transparency affordable."

Public Safety

Several public safety leaders in Portland participated in the Broadband and Public Safety work group. Mark Ellwood, IT Manager for the Portland Police Bureau noted that "everything" is moving to video for law enforcement, including camera-equipped police cars, video interrogation, traffic stops and speeding tickets, and live ambulance links to hospitals. Mark Greinke, Portland's Chief Technology Officer commented that the systems in use already are limited by the lack of broadband wireless capacity. The group noted the benefits that sensor-nets can provide for situational awareness in fires, emergencies, car wrecks and other events, but that current networks and devices don't support the City's ability to activate even the sensors they already have. Chief Klum, the Portland Fire Chief points out that firefighters need building plans, maps and videos of locations to provide "a Google street view of a building, only from the inside." Firefighters should have access to private WiFi systems that exist in buildings when they respond. The 911 system cannot receive or process videos from citizens, even though as Carmen Merlo, Director of the Portland Office of Emergency Management (POEM) points out, "the public is our eyes and ears" in emergencies. Though mobile network costs are high, the cost of not having high availability of information is response time, mistakes and delay. Karl Larson of the Public Safety Regional Radio Project (PSSRP) points out that broadband is "cheaper than gas." The participants discussed the specific needs and standards of the first responder community. "Our needs for reliability and ubiquitous coverage demand are higher standards than commercial networks have met in the past. Moreover, we require interoperability between networks, and priority access to networks. This group would like to see policies which develop seamless roaming and regional reliability, coverage and availability of networks with pre-emption for public safety." The group notes that there are publicly owned assets that could be leveraged to help commercial providers build reliable networks with better coverage, such as City-owned towers, buildings, fiber plant and spectrum. They would like to find technology companies willing to launch pilot projects to develop better public safety networks.

> Though mobile network costs are high, the cost of not having high availability of information is response time, mistakes and delay.

Education and Health

Workers cannot expect to enjoy a "steady job" with a lifelong employer in the future. The concept of a single company giving an employee the skills they need as work changes is gone. Workers will need continuous training and mentorship, but new sources for their education and affiliations must develop. The Aspen report notes that new types of private/public partnerships to help address the need for education, training and lifelong learning must develop. It was also noted that it is an open question where and how education should happen, when "exceptional competencies occur where human knowledge is created, at the cutting edge, in a community of practice." Dr. Miles Ellenby of OHSU Pediatric Medicine notes that digital literacy and digital skills should be taught to young children

as early as possible. Such education programs could focus on teaching independent problem solving and inquiry while also teaching about privacy and safety on-line. Nick Jwayad, Chief Information Officer of Portland Public Schools noted that K-12's key outcome in this conversation is ensuring access for ALL kids and families. A single example of the schools' dependency on the Internet from home is the PPS "EdBox"; a suit of online teacher tools that includes a grade book, curriculum planner, data dashboard, collaboration portal and professional development planner. The EdBox is designed to connect teachers to students, teachers to parents and teachers to teachers in a new and meaningful way via the Internet. The EdBox is just one example of many dependencies schools have on the Internet to improve student outcomes, close the achievement gap and deliver better learning opportunities for all the students we serve.

Dr. Sharon Blanton, Chief Information Officer of Portland State University noted that distance learning, or network-centered learning is the future of higher education, providing students with the ability to integrate learning with work and lifestyle, without requiring commuting. As networking and computer power grow, the virtual classroom, including engagement with other students will begin to be an experience much closer to being in the same room at the same time. Workforce training and education is moving toward an on-line virtual experience as well. In fact, Dr. Blanton, Nick Jwayad and others in the Education and Health focus group note that like firms and corporations, educational institutions must adapt to the networked world, offering education when people can use it, rather than at a specific time and place, and making sure it is culturally relevant to the communities served. The group suggested that we need the "digital education equivalent of drivers ed" for all students.

Key Themes

The questions raised in the course of Portland's workgroup discussion process are more numerous than the answers. There are many interconnected issues, although clearly a profound transformation of local civic life, opportunity and work is underway, both in Portland and globally. The challenge that faces us is to identify the ways the powerful forces unleashed by the new networked economy can be directed toward inclusion, equity, sustainability and prosperity through public policy and civic action. As the participants focused on action proposals, several key themes emerged:

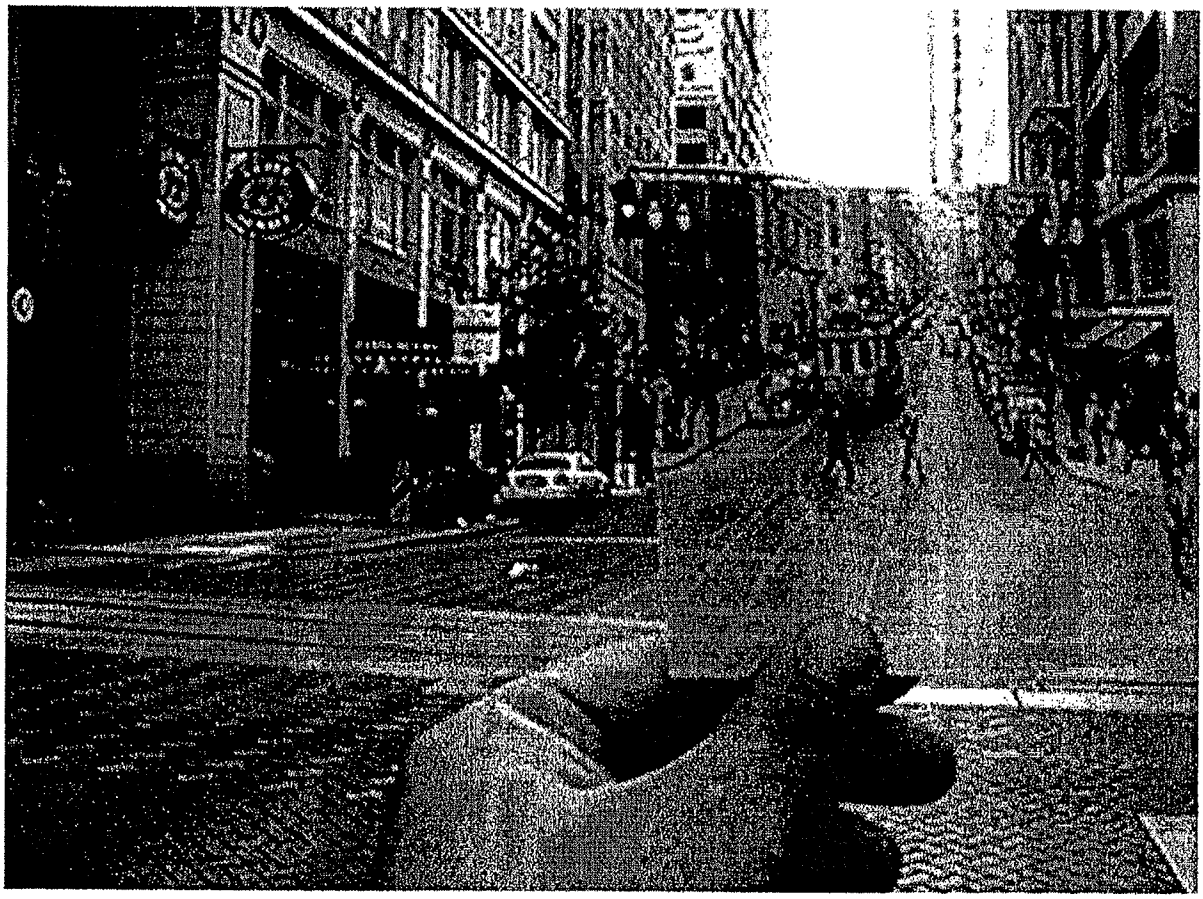
- ✓ Portland and its partners must take bold actions to ensure the development of world-class network infrastructure in the City.
- ✓ Affordability and ubiquitous availability are keys to adoption.
- ✓ Adoption across all age groups, cultures, races and economic classes is crucial to relieve social and economic inequities
- ✓ Economic and societal health depends on education, training and mentoring to create lifelong learners who can embrace rapid change and work and prosper in the new economy
- ✓ Portland must become a technology-centered economy, attracting innovators, research and development centers and employers seeking a tech-savvy environment

The conclusion of the Aspen report notes, "Government and public policy can play a tremendously helpful role in guiding the forces that are emerging. But historically, government and public policy have tended to be more reactive and short-term oriented, not pro-active and visionary... New sorts of government leadership are needed to address social inequality, education and training, and improvements in governments services...There is a keen imperative, in short, for serious institutional innovation."

The imperative for leadership and institutional innovation is central to the goals and strategies included in the Portland Broadband Plan. We have also tried to focus both on the "low hanging fruit", by identifying short-term, high-impact actions that the City can take to make a big difference in government transparency and broadband availability and affordability, as well as remain focused on long-term strategic change and vision.

Portland's Strategic Broadband Goals and Key Strategies

Portland's five Strategic Broadband Goals, and the fourteen key strategies, which will accomplish these goals are outlined below. Following the summary table, each goal is discussed along with the key strategies that will enable the goal to be met. Specific actions recommended for the short-term, medium-term and long-term are provided for each goal.

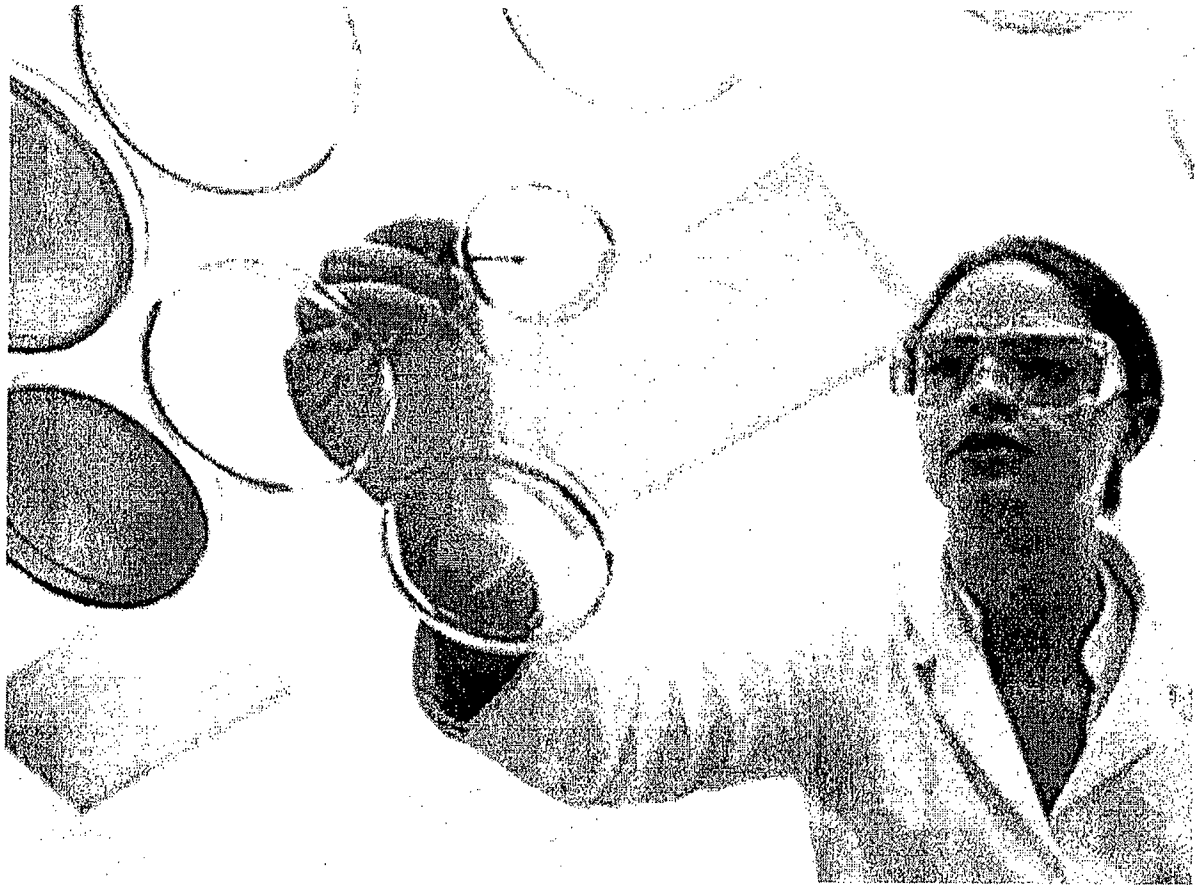


BROADBAND STRATEGIC GOALS AND KEY STRATEGIES

STRATEGIC GOAL	KEY STRATEGIES
Strategically invest in broadband infrastructure to attract innovative broadband-intensive business and institutions that create knowledge jobs in Portland.	• **Prioritize "Big Pipe" Capacity:** Plan and incentivize very high bandwidth Broadband deployment through clustering and co-locating very large capacity users, and providing economic incentives to providers to serve these areas. • **Attract R&D:** Work with institutional partners, including OHSU, PSU, PDC, the State and others to attract at least one major research and development facility whose work requires very high capacity broadband infrastructure and globally-based research. • **Standards and Best Practices:** Partner with Education, Industry and Research Organizations to encourage involvement in standards development, open architecture and the evolution of work and markets
Eliminate broadband capacity, equity, access and affordability gaps so Portland achieves near universal adoption of broadband services for all residents, small businesses and community-based organizations.	• **Establish Neighborhood Broadband Hubs:** Create high-capacity access points within neighborhood community centers. • **Expand City Capacity to Address Digital Equity:** Improve equity through dedicated funding and staff resources and community partnerships. • **Facilitate Marketplace Competition:** Advocate for and facilitate robust competition in Portland's Broadband marketplace.
Develop highly technology-literate and employable residents, students, small businesses and workforce.	• **Create Broadband Centers of Excellence:** Create innovative alliances, partnerships and incentives to develop advanced services and applications locally. • **Promote Technical Literacy and Skills:** Leverage existing and support new investment in life-long technology education and training. • **Modernize and Adopt Telecommuting and Remote Work Strategies and Policies.**

BROADBAND STRATEGIC GOALS AND KEY STRATEGIES

STRATEGIC GOAL	KEY STRATEGIES
Promote and plan for the use and wide-spread adoption of broadband technologies in government, energy conservation, transportation, health, education and public safety.	• **Energize a Dynamic City Technology Culture:** Foster a change in the culture of City bureaus so that the use of technology and civic engagement is facilitated, embraced and cultivated. • **Adopt Information Technology Standards:** to improve the efficiency and effectiveness of the buildings, streets, parks and health services in the City. • **Adopt Regional Public Safety Standards for Wireless Networks:** that incorporate Public Safety's needs for reliability and ubiquitous coverage, interoperability and priority access.
Create future-oriented broadband policy, modernize government organizations and institutionalize digital inclusion values throughout the region.	• **Establish a Regional Task Force on Digital Inclusion Policy.** • **Advocate for legislation, regulation and adoption of open network platforms and open data standards.**



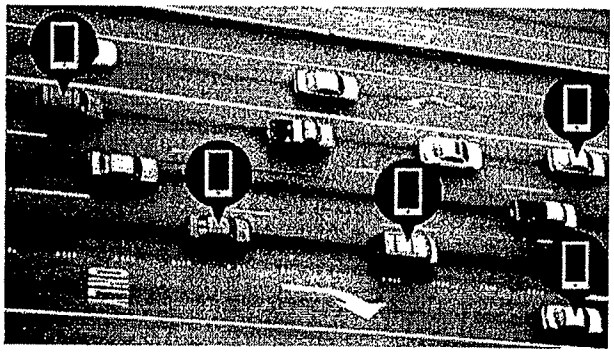
Discussion of Broadband Key Strategies

Goal 1

GOAL 1	KEY STRATEGIES
Strategically invest in broadband infrastructure to attract innovative broadband-intensive business and institutions that create knowledge jobs in Portland	• **Prioritize "Big Pipe" Capacity:** Plan and incentivize very high bandwidth broadband deployment through clustering and co-locating very large capacity users, and providing economic incentives to providers to serve these areas. • **Attract R&D:** Work with institutional partners, including OHSU, PSU, PDC and the State and others to attract at least one major research and development facility whose work requires very high capacity broadband infrastructure and globally-based research. • **Standards and Best Practices:** Partner with Education, Industry and Research Organizations to encourage involvement in Standards development and the evolution of work and markets.

Broadband service has developed in Portland for most of the "Middle Market", defined as businesses located in the urban core, small businesses in most neighborhood business centers in Portland, where business needs for Internet service are for relatively moderate speeds, and middle-to-high-income residential users. However, Portland is still a "Tier 2" City, where broadband providers do not see a market for expansion of high-speed, high-capacity infrastructure equal to Tier 1 Cities.[14] To accomplish the goal of attracting innovation, new businesses and jobs that are based on the new networked economy, Portland must have Tier 1 Infrastructure, including ubiquitous wireless coverage, and very high capacity broadband to industrial centers and clusters. Portland must also modernize its development standards to recognize that networking is an infrastructure equivalent to power, water and sewer when it comes to attracting tenants within developments.

These three key strategies address Portland's need to ensure that very high capacity broadband infrastructure is developed in strategic corridors or "geographic clusters" that will anchor new industries and improve employment. The two prongs of this strategy are "pipes" and "tenants" (supply and demand).



Deploy High-Capacity "Pipes": Fiber connections are available for some high-capacity users in facilities within the urban core. However, the cost to extend fiber infrastructure to new locations is high. Fiber is necessary to achieve high-end service anticipated in the National Broadband Plan. PDC has noted that: "[D]rivers of the knowledge economy such as high tech and creative services, as well as more traditional manufacturing industries...require cutting edge communications technologies to enhance productivity and maintain competitiveness." To encourage the deployment of very high capacity broadband deeper into areas of the City where market forces have not attracted providers, the City should provide economic incentives including tax breaks, zoning and permit assistance, construction assistance, and conduit placement in rights-of-way. To the

14 For our purpose, Tier 1 Cities refer to those with fiber-to-the-home infrastructure and 4-G LTE mobile infrastructure. Tier 2 Cities have copper infrastructure to the home (which carries much less bandwidth) and 3-G mobile infrastructure.

extent allowable by Federal law, the City should work with providers to subsidize, waive or reduce building entry fees to establish fiber connectivity, and should work with building developers and owners to participate in the industry cluster strategy.

Attract Broadband Anchor Tenants: Locating one or more very large anchor tenant in strategic cluster areas will spur the development of broadband infrastructure by providing demonstrable demand for a higher level of speed and capacity. The City must attract research institutions, data centers, media companies or other entities that require broadband skilled workforces and high quality broadband services to create the anchor tenancy for a cluster area.

Standards and Best Practices: Standards and Best Practices for industrial buildings, commercial developments and neighborhood planning need to be updated to reflect the new necessities for accessibility that exist for large businesses today and tomorrow. Today, a business locating in a building is responsible for bringing any information technology it needs to the site. Tomorrow's standards will require that buildings are pre-wired for both mobile and fixed networking, with much higher standards of wiring and in-building coverage for wireless networking. The City should work with building owners and developers to ramp up connectivity in the City's urban infrastructure and commercial centers.

Goal 1 Action Recommendations

By 2013

- Identify urban development areas for high capacity broadband infrastructure deployment.
- Establish a policy to drop conduit into all street trenching in identified areas.
- Create a program with Industry to identify economic incentives to encourage fiber core build-outs to cluster areas. Such a package might include low cost power, free or reduced cost access to City owned or financed assets (such as conduit, roof-tops, permits, etc.).

By 2017

- Create an assistance program for very high capacity users to finance initial installation of fiber infrastructure, and to provide subsidies for high capacity bandwidth to spur job creation, and industry relocation to the clusters.
- Include Broadband infrastructure development in public works projects, such as streets, sewers, etc. to diffuse high capacity infrastructure throughout the City and region.
- Leverage the IRNE fiber assets, City streets, sewers and other rights of way to place publically owned infrastructure assets at the disposal of service providers who agree to deploy very high bandwidth services at lower than market cost to industry and employers.

By 2020

- Work with PDC, Higher Education, the State and other potential partners to incentivize research partnerships that require large pipe broadband. Develop projects that will anchor a large pipe "campus" such as a genomic research project, Central Eastside URA for mid-to-small business cluster projects, and/or other URAs such as North Macadam and Interstate.
- Actively recruit "Network Centric" businesses and workers to Portland through an innovative program of incentives and marketing.

Goal 2

GOAL 2	KEY STRATEGIES
Eliminate broadband capacity, equity, access and affordability gaps so Portland achieves near universal adoption of broadband services for all residents, small businesses and community-based organizations.	• **Establish Neighborhood Broadband Access Centers:** Create high-capacity access points within neighborhood community centers. • **Expand City Capacity to Address Digital Equity:** Dedicate funding and staff resources and develop community partnerships. • **Facilitate Marketplace Competition:** Advocate for and facilitate robust competition in Portland's broadband marketplace.

Until recently, not having affordable broadband was an inconvenience. Now, broadband is a prerequisite to economic opportunity for individuals, small businesses and communities. Those without broadband and the skills to use broadband-enabled technologies are becoming more isolated from the modern American economy. Broadband provides students and families access to global and local educational resources, immigrant and minority communities access to cultural connections, and small businesses the ability to achieve operational scale more quickly.

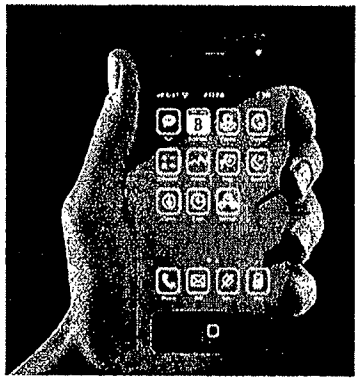
NEIGHBORHOOD ACCESS

The vision for neighborhood broadband access centers includes state of the art mobile and fixed broadband services, with training and affordable access close enough to residents and small business that they don't have to commute to it. These can be extended within existing centers, such as neighborhood libraries, community centers, shopping centers, parks or schools. Providing access to advanced services and training at the neighborhood level will help reduce pollution and energy consumption caused by travel.

The first key strategy adds high capacity broadband access to the Portland Plan's vision for "healthy connected neighborhoods" where all services necessary for livability are within a 20- minute walking distance of home.

Broadband access centers provide tools to those who cannot afford, or do not have access to them in their household. It allows communities to "move information not people," connect diverse communities, promote tele-medicine and telework, level inequities in civic participation and educational opportunities, and reduce geographic and economic challenges including commuting and other travel.

DIGITAL EQUITY AND INCLUSION



The difference between those with no or very limited access to communications technology and those in the higher access categories is the "digital divide". Attempting to create an environment to counteract the divide is often known as "digital inclusion".

Portland should continue its critical role in working to overcome inequities in access to communications technology – Multiple communities in Multnomah County have indicated the need for local government to continue its current central role in providing public access to communications technology and the internet, such as through the Public Library and through public access organizations[15]. Without increased access, many in the community will have even less opportunity to learn the skills necessary to work and participate in

15 http://www.mhcrc.org/docs/MHCRC_Communications_Technology_Needs_Ascert_Report(04-21-10)FINAL.pdf

the networked society. Companion actions needed include dedicated funding and staff resources to assist non-profit organizations to provide digital content, access to technology and training to those with limited resources, and wireless broadband access.

Community groups and non-profits need to continue to work for digital inclusion, but need increased support from City government to fulfill that role – For example, representatives of immigrant and refugee organizations in Multnomah County talk about the value of public access at government locations like libraries and schools. These groups also need to have greater support to increase literacy skills, education, employment, civic engagement, cultural participation and healthcare.

The second key strategy establishes dedicated funding and City staff to support community groups and institutions that can work in partnership with the City to close the digital divide. This strategy will establish practices and policies to create equity for all communities to access broadband services.

INCREASED COMPETITION

Competition provides consumers the benefits of choice, higher bandwidth, better service and lower prices. Building broadband networks—especially wireline—requires large sunk investments. Policies decreasing the fixed cost of infrastructure and spurring greater demand may encourage new network expansion and new competitors.

The National Broadband Plan notes that broadband competition is both fragile and insufficient to keep pricing affordable, and to push advanced services into all markets and neighborhoods. The NBP also notes that current Federal policies may be ineffective at driving true competition in broadband, and that local public policy is a determinant of the level of competition locally.

The third key strategy addresses ways that the City of Portland can leverage its public assets (rights-of-way, IRNE, spectrum), fiscal and franchising policy, tax incentives and its substantial public sector market demand to encourage a robust broadband marketplace served by multiple, competitive providers.

The greatest deterrent to competitive broadband is the cost of deploying infrastructure. Broadband providers can expand high capacity infrastructure when access to land and property costs are reduced, bringing down the provider's fixed cost of plant. The City and its infrastructure partners (TriMet, ODOT) together own miles of fiber plant that is underutilized. These include conduit, building entries, fiber termination points and dark fiber that, to date, are reserved under several layers of local and Federal policy for the exclusive use of the public sector. The City should investigate ways to change these policies and leverage these assets to help expand broadband services to the City's residents through public/private partnerships. Much of the new residential construction in Portland in the next 25 years will be multi-family. The per-door economics of getting fiber to multi-family new construction are much more favorable than for single family. The City should consider policies to incent a fiber to the dwelling standard for multi-family new construction.

Broadband providers appear to invest more heavily in network upgrades in areas where they face competition. Providers generally offer faster speeds when competing. Next generation wireless broadband networks—for instance, Long Term Evolution Systems (LTE)—could offer speeds between 4 and 12 Mbps which can compete with mid-tier fixed broadband speeds and rates. The competition policy for Portland must include incentives to ensure that multiple wireless providers serve the entire City, and the metropolitan region.

Goal 2 Action Recommendations

By 2013

- Work with non-profits and NGOs to increase access to broadband tools for underserved communities.
- Identify funding and revise rules for local grants to allow support for training and access to broadband services.
- Convene a planning committee with the provider industry to identify and leverage incentives for broadband service expansion including complete neighborhood coverage for wireless. This could include access to public sector assets (rooftops, conduit, fiber etc) and tax reductions, etc.
- Advocate at local, state and federal levels for robust competition in broadband markets.
- Study ways to lower the cost of infrastructure deployment including working with industry to pool or share core infrastructure builds (towers, conduit, spectrum, etc.) to move the model toward competition with collaboration.
- Conduct a study to demonstrate the impact of broadband availability on property values.
- Promote a subsidy or grant program for low income or distressed communities to allow them to obtain commercial service at affordable rates, to pull latent demand for service into the marketplace.

By 2017

- Partner with non-profit community groups to provide technology grants to communities.
- Establish a fund for Broadband Equity. Develop a stable funding stream for access subsidies through a strategy such as a 1% universal service fee.
- Begin distributing City workforce from office buildings to neighborhoods, where they are connected digitally to City Hall.
- Provide free WIFI at all public buildings in each neighborhood.
- Negotiate a service agreement for public safety levels of reliability, capacity and coverage with a provider.
- Identify and commit to policy and financial incentives such as franchise fee credits, shared trenching, City-provided conduit, grant programs, or other means to reach accessibility goals and objectives.
- Develop a fiber to the dwelling standard for multi-family new construction.
- Aggregate public sector demand among several institutions and entities (higher education, government, transit, K-12) to incentivize development of service providers in underserved areas.
- Work with PPS to achieve online student portfolios/academic planners, 1:1 Netbooks for remote access to PPS tools/services and online credit recovery/general credit options for High School students.

By 2020

- Work with the County, Higher Education and Portland's public schools to build telework centers and resources within community centers, K-12 schools or community college campuses that align with "healthy connected neighborhoods."
- Become a "city without walls" where all city services, meetings and records are available to all residents and constituents on interactive digital platforms so that it isn't necessary to travel to a city office to conduct business, provide testimony or participate in City business.
- Conduct all City public meetings, hearings, etc. via interactive video so that residents can participate without travel.

Goal 3

GOAL 3	KEY STRATEGIES
Develop highly technology-skilled and employable residents, students, small businesses and workforce.	• **Create Broadband Centers of Excellence:** Create innovative alliances, partnerships and incentives to develop advanced services and applications locally. • **Promote Technical Literacy and Skills:** Leverage existing and support new investment in lifelong technology education and training. • **Modernize and Adopt** Telecommuting and remote work strategies and policies

Several key emerging and evolving technologies are driving digital adoption and the Internet economy in the near and long term - These include expanded video use in all of its forms; in-home services accessed remotely; evolution and rapid growth of applications for portable mobile devices; and collaborative, real-time, high capacity applications. **Emerging technologies will positively impact several key network attributes** – This includes ease of use; highly scalable bandwidth; centralized data storage and network reliability and redundancy. The combination of evolving attributes will make network tools central to social interaction, employment, medicine and treatment options, transportation, and household management. While the network will free us from many unproductive and wasteful activities, it will also cause the obsolescence of a majority of policies and practices developed to support hierarchies of management of systems, people and institutions. These must be replaced with adaptive policies and systems, which empower innovation and flexibly support change.

CENTERS OF EXCELLENCE

Portland cannot wait for innovations to trickle down to second-tier cities if it wishes to have the advantages of innovation. Oregon is a nationally recognized center for the open-source software movement, and software start-ups and mobile and cloud-based computing. Portland needs to leverage the skills of the tech-savvy professionals it has "in residence" to develop a digital services economy. A key to this strategy is the development of technology "Centers of Excellence" within Portland institutions which will establish the area's leadership in new economy innovations – in software, management, standards, buildings, telecommuting and education. Also key is investment in research and development in science and technology, which require very high bandwidth connectivity.

The first key strategy will demonstrate Portland's ability to innovate and accelerate technology developments to accomplish desirable social outcomes. This strategy focuses on ways to propel innovation into Portland's structures, institutions and educational and social fabric.

TECHNOLOGY LITERACY AND LIFELONG LEARNING

Broadband and Internet access are essential for student achievement and workforce development. The current workforce development system is fragmented and relies heavily on bricks-and-mortar facilities to deliver services. This physical infrastructure makes it difficult to adjust to changes in demand, resulting in inconsistent supply, quality and information distribution.

- ✓ Delivering services online through a scalable platform can expand the reach of One-Stops to everyone who has access to the Internet. Additionally, adopting content and service standards would ensure every participant receives consistent high-quality service.
- ✓ Broadband-enabled solutions address time, information and technology barriers faced by disadvantaged Americans seeking jobs and training.
- ✓ Research shows that unemployed workers who receive re-employment services land a job and exit unemployment insurance approximately one week sooner than those who do not receive such services.

Computer and Internet access alone do not produce greater student achievement. Access needs to be combined with appropriate online learning content, systems and teacher training and support. Some school districts are finding that online systems can help decrease high dropout rates. In addition to dropout prevention, online systems provide flexibility to students who cannot be in school for health, child-care, work or other reasons.

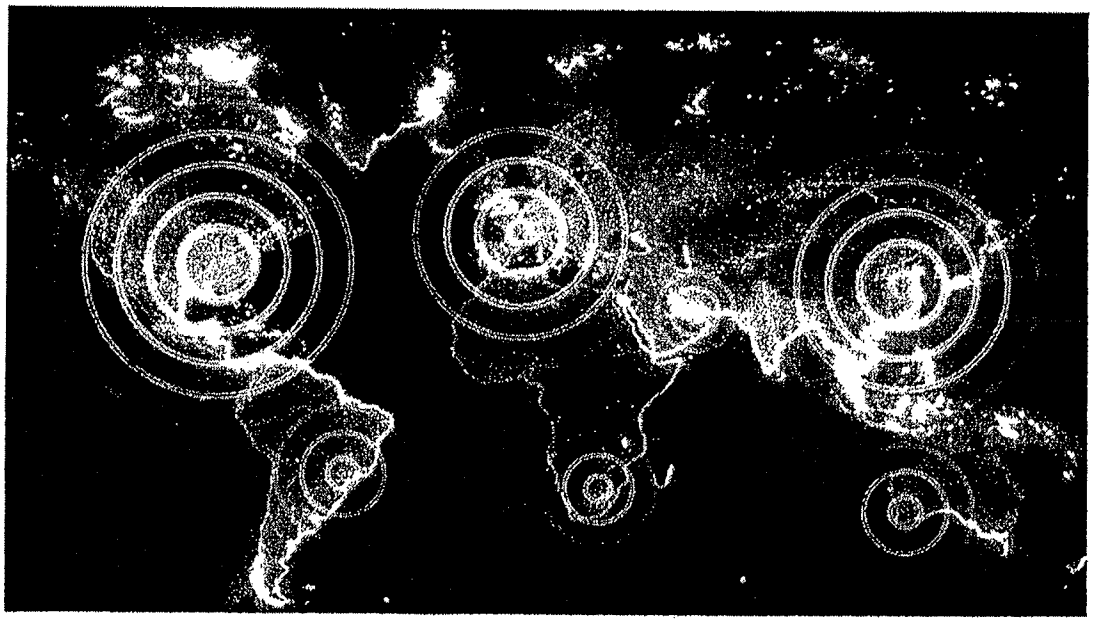
However, the Network has changed the way workers and students need to be educated and mentored. Sitting in a classroom, learning from dusty textbooks, and taking standardized tests will not support the economic future of students and workers. They must be trained in a new way, by institutions built on a foundation of global collaborative instruction and research, and flexible, on-demand instruction, tutoring and mentoring. Portland must work with every educational provider in the region to impress modernization and flexibility into their structures, student services and governance models.

The second key strategy establishes regional partnerships aimed at making sure that Portlanders are well trained and well educated at the earliest possible age to thrive in a digital economy. We need to focus on literacy, content and mentoring, not just technology to create a population that is ready for the new economy.

TELEWORK

Telework and telecommuting can reduce congestion, pollution and energy consumption. If we eliminate the need to travel to work, for civic engagement and for meeting basic communication needs we can also reduce carbon emissions and congestion. The knowledge "class" of workers and employers will not be focused on geographical proximity to the "office" or direct line-of-sight control over workers. The future of professional work is that it will be done "anywhere" and will not require a fixed location. The corollary reality is that Portland must attract workers and employers by having the Network they need and the lifestyle and environmental attributes they desire in order to locate here.

The third key strategy modernizes our approach to work in order to foster and encourage remote work and telework, rather than to marginalize and "test" it. This strategy focuses on management issues as well as network issues to promote remote work styles and opportunities.



Goal 3 Action Recommendations

By 2013

- Work with PDC, Higher Education, the State and other potential partners to incentivize research and development partnerships in software, applications and digital services.
- Establish a clearinghouse for digital information access and resources.
- Develop telework resources, including training, technical assistance and technology subsidies for small businesses and large employers.
- Work with Higher Education to create HR resources and advisors for employers who wish to promote telework.
- Provide tax incentives to employers who embrace telework solutions using broadband, decreasing commuting.

By 2017

- Support K-12 and ongoing digital literacy programs in libraries, schools and other institutions.
- Develop small business training for owners and employees in the use of digital tools.
- With the medical community, establish a pilot project for aging-in-place that features affordable high-capacity Broadband for patient/physician connectivity and information exchange.
- Assist local educational institutions and school districts to modernize technology and teacher training in on-line instruction.

By 2020

- Partner with Industry and Education to establish "Centers of Excellence" which promote innovation in Digital Communities and undertake research and development in advanced applications and economic and social change.
- Partner with state and local workforce development providers to create learning centers for small businesses and job seekers.
- Work with Portland's education institutions to extend and enhance distance learning platforms.

Goal 4

GOAL 4	KEY STRATEGIES
Promote and plan for the use and wide-spread adoption of broadband technologies in government, energy conservation, transportation, health, education and public safety.	• **Energize a Dynamic City Technology Culture:** by fostering a change in the culture of City bureaus so that the use of technology and civic engagement is facilitated, embraced and cultivated. • **Adopt Information Technology Standards:** to improve the efficiency and effectiveness of the buildings, streets, parks and health services in the City. • **Adopt Regional Public Safety Standards for Wireless Networks:** that incorporate Public Safety's needs for reliability and ubiquitous coverage, interoperability and priority access.

Broadband can facilitate a vast change in government and government's impact on urban planning. Once we understand that broadband is the lifeblood of advanced systems of all types, it is clear that broadband is essential in the design, monitoring, and control of our entire infrastructure – including communications, water and sewer, roads, buildings, energy systems, manufacturing systems and payroll and inventory systems. Like some private companies, government can make its services available 24 hours a day, seven days a week, 365 days a year across departments and across different levels of government. Moreover, communications technologies are the arbiters of transparency and inclusion. Recent social unrest across the globe has illuminated just how important it is for citizens to trust the transparency and equity of government. Elected officials and executive management must realize that there is no longer a delay between action and reaction in policy, politics and service. The network interjects a powerful new force in public policy and politics, and we don't yet employ it to gain its advantages. The longer the City waits to understand and employ technology, the further behind it will fall.

ENERGIZING OUR TECHNOLOGY CULTURE

Portland's City Bureaus and Offices are not prepared to embrace innovation and rapid technology change for a variety of reasons, including the cost to change, current policies, current management styles and structures and internal operating rules. However, the City will continue falling behind the technology curve if it doesn't identify these constraints and remove them from City culture and practices.

One of the most important ways the City can improve is in its use of networking technology for civic engagement. Currently, the City's use of web-enabled technologies is inefficient and ineffective, and could be improved. The City does not have an integrated web-enabled service delivery platform for citizens, and it does not conduct public business or provide public information effectively over the web.

The City also operates several data centers and many servers to maintain computer and network systems for its Bureaus. New technologies will replace these systems with more efficient generations of information and communications technology. A study by Booz Allen Hamilton estimates that an agency that migrates its infrastructure to a public or private cloud **can achieve savings of 50-67%**[16]. Social media technologies provide the government

16 http://www.boozallen.com/media/file/Economics-of-Cloud-Computing.pdf

another platform to spur innovation and collaboration. The private sector has come to recognize the efficiency gains and other benefits of social media within the workplace. Today, **out of the 36% of Americans involved in a civic or political group, more than half of them (56%) use digital tools to communicate** with other group members. Government must take advantage of these trends to encourage citizens to communicate with government officials more often and in richer ways. City managers and officials must encourage, not discourage the migration to digital platforms.

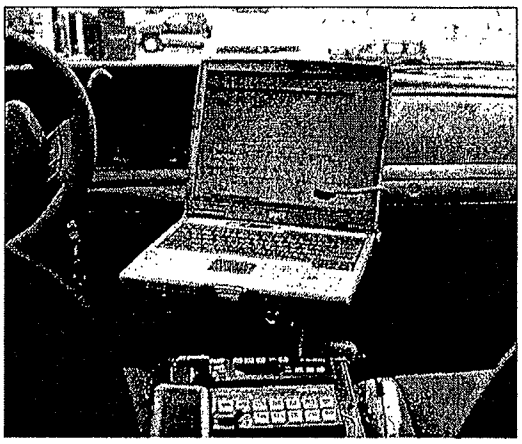
The first key strategy addresses the application of broadband tools to improve City operations and services, especially to improve public access to government services and public safety services. This strategy also addresses productivity improvements and cost reductions through the adoption of advanced broadband applications in City government.

ADOPT INFORMATION TECHNOLOGY STANDARDS

The infrastructure Bureaus of the City, including Environmental Services, Transportation, Planning, Facilities and the Portland Development Commission –should be working toward understanding and adopting information technology standards to underpin the development of the City's infrastructure. Knowing with certainty that broadband infrastructure will be necessary in every structure and system built in the City is a clear mandate that standards and practices for integrating this technology in an efficient way into the urban fabric is essential.

The second strategy addresses the requirement for standards setting and cooperation and collaboration between the City, developers and manufacturers to ensure that new technology platforms which underpin our urban structure are efficient and ubiquitous.

ADOPT REGIONAL PUBLIC SAFETY STANDARDS FOR WIRELESS NETWORKS



The core function of City government is public safety. The City is responsible for firefighting, search and rescue, law enforcement, policing, 911 services and emergency planning. These functions represent nearly three quarters of the expenditures of the general fund. Yet our police and firefighters have less sophisticated wireless technology than most schoolchildren carry in their backpacks. The tools for first responders are dated, but even more distressing is their network access. Police and fire wireless networks and the 911 network, currently only carry voice calls, and very limited textual data. They cannot text or access the web from handheld devices. Callers to 911 cannot provide videos or text to call-takers. Though the City has access to a large amount of licensable wireless spectrum for broadband, it does not have the means to finance or plan a broadband network for public safety. Moreover, the public safety community as a whole has not provided standards or operational requirements for using wireless broadband. There is an immediate need for the City and its regional partners to develop wireless standards for interoperability, capacity and coverage requirements, and work with the carrier and equipment industries to develop next-generation wireless services that meet or exceed these requirements.

Sensors that can monitor chemical spills, water levels, heart and lung function, location and other essential data are available, but the wireless network to transmit the information from the sensors to response officials don't exist. The Portland Fire Bureau reports that it has sensors in its equipment today, but they can't be used because there is no network to support them. Video cameras around the City, whether located at traffic lights or in apartment building corridors could provide essential situational awareness during accidents, emergencies, fires or crimes in progress, but their signal is not available in real-time to incident command. These systems can be improved through standards, procedures, partnerships and investment.

The third key strategy addresses the need for public safety broadband services to improve response time, lower costs and save lives.

Goal 4 Action Recommendations

By 2013

- Lead a "culture change" within City government to promote full utilization of digital tools, especially to provide public access to civic engagement and city services.
- Begin a standards process with the public safety community on a regional level to develop public safety standards for commercial wireless use, so that public safety could become an anchor tenant on a 4-G wireless infrastructure.
- Create City policies, practices and funding mechanisms to foster greater adoption and utilization of digital tools.
- Put wireless broadband accessible to the public in all public buildings.
- Investigate any health hazards, e-waste issues associated with broadband deployments and issue credible study results to inform the public and decision-makers.
- Improve use of social media to engage citizen involvement in local public safety efforts.

By 2017

- With the transit community, develop smart applications to assist in traffic management, traffic safety, commuter connections and fuel conservation.
- Emphasize the adoption of digital tools in City government through modernized equipment, software, data storage techniques and workforce education. Adopt best practices from emerging technology-rich business models and social media platforms.
- Seek funding or redirect existing funds to modernize the City's technology and software to support broadband utilization and workforce mobility, especially for public safety.
- Encourage video within buildings for safety, using smoke detector model. Incentivize in partnership with home insurance industry.
- Support wide adoption of "wired household or Smart Home" standards. Incentivize builders and homeowners through expedited review or financing through an energy conservation trust model.
- Develop strategic spectrum plan for spectrum licenses available to the City in the 700 MHz, 4.9 GHz bands that will serve public safety and promote Citywide broadband goals.
- Investigate and adopt "smart building" codes.
- Implement a fully-functional, Web 2.0 enabled "311" service online.
- Place all government information in standardized, usable, searchable, accessible formats on-line.

By 2020

- Increase municipal telework-force and telework hours over time so that only mandatory commuting happens.
- Address and change city culture (personnel and management policies, workforce technology, incentives and rules) to reward higher levels of telework in Bureaus. Calculate and monitor direct and indirect savings and other benefits (such as reduced carbon emissions, longer "hours of operation", family and quality of life and other benefits) from telework.
- Adopt cloud computing platforms where prudent and feasible to replace data centers, equip public buildings with energy sensors to reduce energy use.
- Implement next-generation 911, including text and video call-taking.

Goal 5

GOAL 5	KEY STRATEGIES
Create future-oriented broadband policy, modernize government organizations and institutionalize digital inclusion values throughout the region.	• **Establish a Regional Task Force on Digital Inclusion Policy:** Portland must innovate both by establishing partnerships with industry, education, and other governmental bodies, and by reforming our government institutions and policies to root out silos of control and resistance to change. • **Advocate for legislation, regulation and adoption of open network platforms and open data standards.**

The conclusion of the Aspen report notes, "Government and public policy can play a tremendously helpful role in guiding the forces that are emerging. But historically, government and public policy have tended to be more reactive and short-term oriented, not pro-active and visionary...New sorts of government leadership are needed to address social inequality, education and training, and improvements in governments services...There is a keen imperative, in short, for serious institutional innovation."

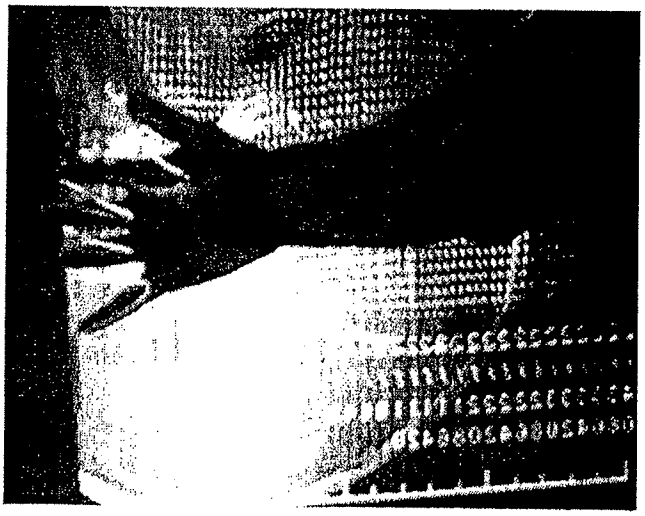
The imperative for leadership and institutional innovation is central to the goals and strategies included in the Portland Broadband Plan.

The strategies proposed in this plan are based on expectations for radical changes in society, local and national government and economic opportunity. The pace of change is assumed to be rapid – much faster than our current government models, practices and structures can respond to. This plan is also visionary – attempting to forecast our social and political needs into the future on a landscape that we imagine is coming quickly. Though there are many short-term actions suggested in this plan, the preparation for longer-term change must also begin now.

The pervasive reality of the networked society breaks down traditional barriers and roles, and reassigns new ones. So the City must adapt with collaboration and advocacy. We need regional partners with a similar and harmonious vision of the future to work with us to accomplish the goals in this plan.

These two key strategies address the need for Portland to advocate as well as innovate. Public policies must be changed within the institutions around us (higher education, state and federal government, private industry) to allow the other goals of this plan to be realized.

Advocacy for changes in policy must produce evolution in everything from standards for open access and open data, copyright reforms and affordability of access to public records and public meeting laws. Leadership in changing government institutions across government levels to promote education and equity are essential. Also essential is the institutionalization of the value that broadband is critical infrastructure and that public access to it is a social goal.



Several participants in the Portland broadband planning workshops supported the idea of a publically funded, open access infrastructure platform over which private entities could compete to provide service in an equitable and affordable manner to every household in Portland.

Goal 5 Action Recommendations

By 2016

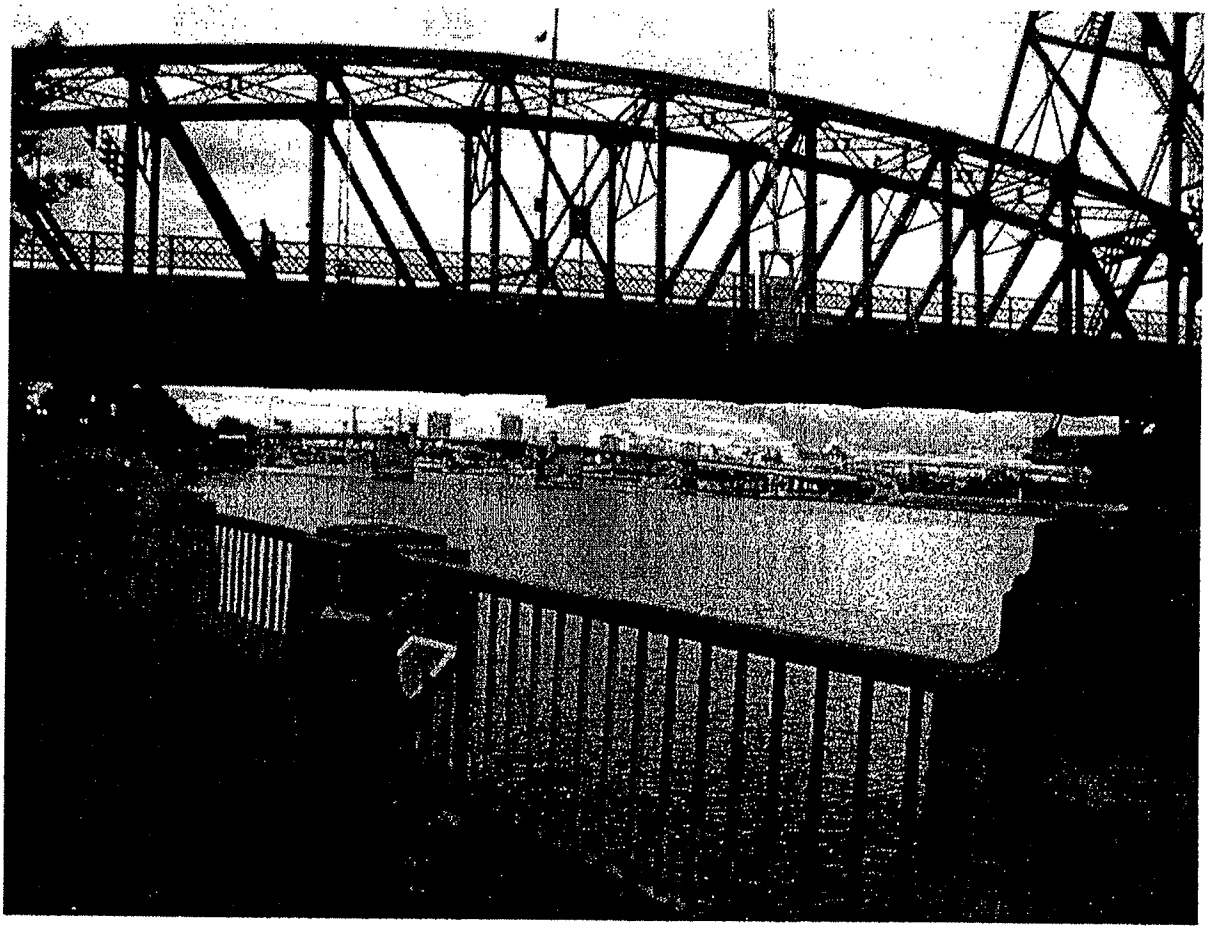
- Establish a task force on digital policy that includes representatives from local, regional and state government.
- Review and update the City's comprehensive approach to wireless facilities in the City including a database and mapping.
- Compile an action agenda for policy review of internal City policy that must evolve.
- Create a public/private working group on digital equity issues.
- Advocate for open access platforms.

By 2017

- Introduce legislation at the State level to create digital equity standards statewide.
- Advocate at the Federal level for broadband standards in publicly-funded infrastructure.

By 2020

- Re-structure local government institutions for the digital age.

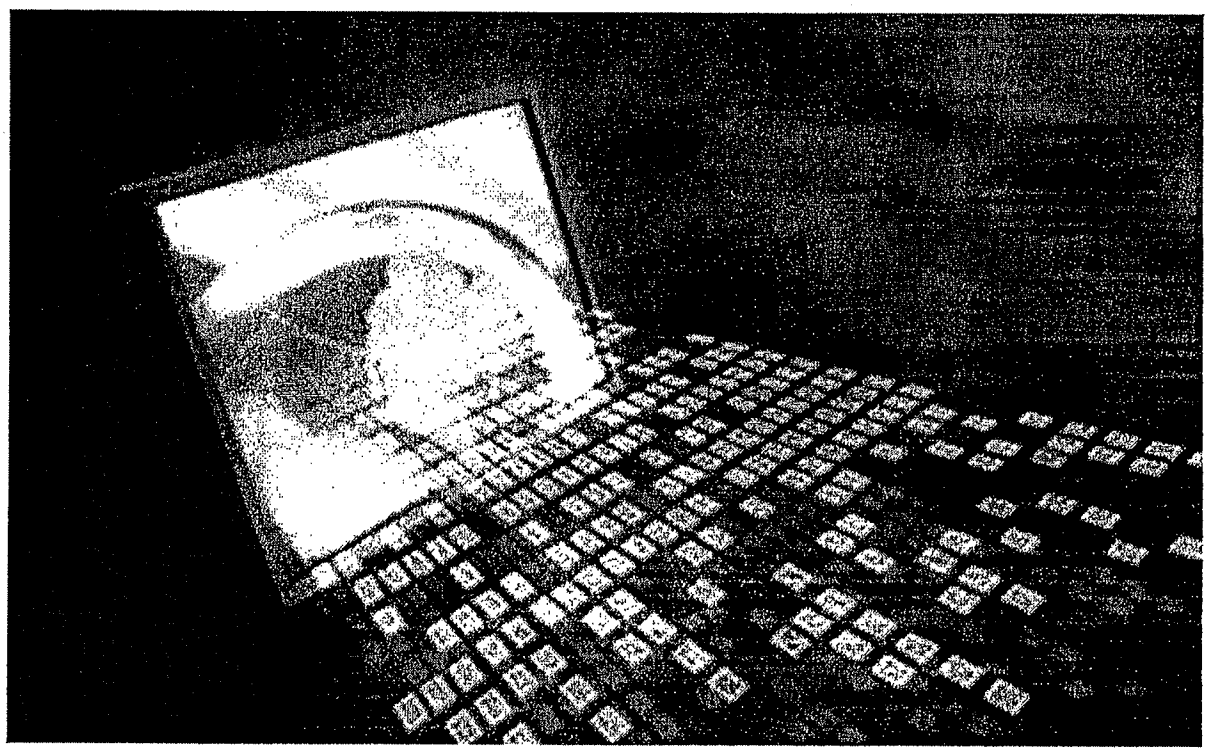


Conclusion and Next Steps

The Portland Broadband Strategic Plan represents the vision of Portland's City Council, its Bureau Directors and executives, and most importantly the needs and desires of Portland's diverse communities for quality, inclusion and equity. Once the strategic plan is adopted, a work plan for 2012-2013 will be developed through the City's budget process. It is this first work plan which will launch the activities that stem from the goals and key strategies.

Success Metrics

As the City begins the implementation process, key measures of success will be developed for the plan. This Plan will inform other plans in development including the Portland Plan and the Climate Action Plan. This Broadband Plan lays the foundation for understanding, embracing and adapting to the digital economy.



Attachment 1: Workgroup Participants

CONNECTING TO OUR FUTURE: PORTLAND'S BROADBAND STRATEGIC PLAN ROUNDTABLE PARTICIPANTS

ECONOMIC DEVELOPMENT/BUSINESS VITALITY

NAME	ORGANIZATION
Skip Newberry	Mayor
Gerald Baugh	Portland Development Commission
Sheldon Renan	Renan & Associates
Vince Porter	Governor's Film Office
Rich Bader	Easystreet OnLine Services
Wilf Pinfold	Intel Corporation
Matt Nees	Oregon Software Association
Andy Frazier	Frazier Hunnicutt Financial
Bernie Foster	The Skanner Newsgroup
Naomi Pierce	North Portland Multimedia TrainingCenter

EDUCATION AND HEALTH

NAME	ORGANIZATION
Kali Ladd	Mayor Adams
Sherry Swackhamer	Multnomah County
Don Westlight	Network Engineering, OHSU
Nick Jwayad	Portland Public Schools
Sharon Blanton	Portland State University
Eileen Argentina	Parks
Christine Blouke	Parkrose School District
Miles Ellenby	OHSU
David Olson	City of Portland
Leslie Riester	PCC/Tech Solution Svcs

DIGITAL INCLUSION/CIVIC ENGAGEMENT

NAME	AFFILIATION
Tim Crail	Commissioner Fritz
Cece Hughley	Portland Community Media
Doretta Schrock	NPNS
Abdiasis Mohamed	IRCO
Kayse Jama	CIO
Julie Omelchuck	MHCRC
Rick Nixon	BTS
Dylan Amo	Citizen
Brian Hoop	ONI
Sonia Schmanski	Commissioner Fish
Russell Senior	Personal Telco

CONNECTING TO OUR FUTURE: PORTLAND'S BROADBAND STRATEGIC PLAN ROUNDTABLE PARTICIPANTS

PLANNING/TRANSPORTATION/SUSTAINABILITY

NAME	ORGANIZATION
Brendan Finn	Commissioner Saltzman
Don Stastny	StastnyBrun Architects, Inc
Chris Smith	Portland Planning and Sustainability Comm
Gary Odenthal	Planning & Sustainability
Peter Koonce	PBOT
Alex Bejarano	PBOT
Mike Burnett	Hot Sky Consulting
Kate Miller	Kate Miller Studios
Michael Jung	Silver Spring Networks
Scott Robinson	Metro
Tim McHugh	TriMet

PUBLIC SAFETY AND EMERGENCY RESPONSE

NAME	ORGANIZATION
Aaron Johnson	Commissioner Leonard
Mark Greinke	BTS
Karl Larson	PSSRP
John Klum	Portland Fire & Rescue
Mark Elwood	Portland Police
Lisa Turley	BOEC
Carmen Merlo	POEM

Attachment 2: Broadband Strategic Plan Project Timeline

Phase I

1. Resolution at Council - September 22, 2010
2. Kick-Off Event - January 28, 2011
3. Roundtables – February & March 2011
   - Economic Development/Job Creation
   - Planning, Sustainability & Transportation
   - Public Safety
   - Education & Health
   - Digital Inclusion

Phase II

1. 1. Targeted Engagement with Under-represented Groups (Urban League, CIO, IRCO, NAYA) - July – August 2011
2. Industry Forum – June 3, 2011
3. Presentations of draft BSP – June 2011
   - PDXTECH4GOOD - May
   - Bureau Director Briefing – June 2
   - Planning & Sustainability Commission – June 14
   - Open Source Bridge June 23
   - Lunch 2.0 June 29
   - Small Business Advisory Committee (SBAC) July 13
   - Portland Business Alliance September 8
   - Eco-District Working Group

Phase III

1. Council Work Session – July 26, 2011 @ 9:30 am
2. Council Adoption – September 14, 2011 @ 2:00 pm

*Roundtable Participants & interested citizens updated throughout via web and email

Attachment 3: History of Broadband Policy in Portland

- Open Access to the Internet (1998-2000)
- IRNE (City's Wide Area Fiber Network) (construction c. 1999)
- Portland issues 1st RFI for community broadband provider (1999)
- Franchising/partnership discussions with broadband companies (2000-2002)
- IRNE - INET interconnection (low cost broadband to schools/libraries) (c. 2002 and continuing)
- Portland Community Fiber Network Feasibility Studies (Council Work Sessions 2005; Business plan 2007)
- Metro-Fi (2006-2008)
- Response to Google RFI (2010)
- BTOP Grant application (2010)
- Broadband Strategic Plan initiative (2010-2011)

Attachment 4: State of Broadband in Portland Today

Why does Speed Matter?

Broadband speeds in most networks in the US have been steadily increasing. In ten years' time, the Country has migrated from very slow dial-up connections to very fast Internet connections. In fact, high speed Internet connections are considered a necessity in most businesses and households in the US and abroad today. But limitations exist in the networks we have today that prevent efficient downloads and uploads of content. As the Network develops richer applications that include more real-time video "conferencing", video education, and other forms of rich content, the network we have today will simply be too slow to function. The traffic on the network is growing by 34% per year, threatening the ability of the network infrastructure to handle demand. On the consumer side, those without robust competition and fast reliable networks will be left out of the information economy and its opportunities.

Residential Broadband

Most households in Portland have a choice between two dominant providers of broadband service to the household – Comcast and CenturyLink. Comcast offers a cable DOCSIS-based technology which offers a choice of speed and pricing. Their least expensive offering provides 1.5 Mbps downstream and 384 kbps upstream for about $40/month. Their fastest offering in Portland is nearly 10 times faster: 105 Mbps/10 Mbps for $105 - $200/month. CenturyLink offers DSL-based technology which offers a choice of speed and pricing. One offering provides 12 Mbps downstream and 5 Mbps upstream for $37 per month.

One option not available to Portlanders, but offered in surrounding cities is Frontier's FIOS (Fiber-to-the-home) service which leaves Portland at a competitive and technological disadvantage. The highest speed offerings of these companies are compared in the table below. Verizon's FIOS "ultimate" is significantly faster than Comcast's highest bandwidth offering, and CenturyLink has nothing to compare to the speed of FIOS today.

PROVIDER	HIGHEST SPEED DOWN	PRICE (FROM WEB)	UPLINK SPEED
Comcast	105 Mpbs	$200/mo	10 Mbps
CenturyLink	40 Mpbs	$100/mo	5 Mbps
Frontier FIOS	150 Mpbs	$200/ mo	35 Mbps

For more mid-range services, there are more providers and closer competition, including Clearwire, which uses WiMAX wireless technology to provide service.

PROVIDER	MID-RANGE	PRICE (FROM WEB)	UPLINK SPEED
Comcast	15 Mbps	$30/mo	3 Mbps
CenturyLink	12 Mbps	$37/mo	5 Mbps
Clearwire	15 Mbps	$ 40/mo	1 Mbps
Verizon FIOS (Portland suburbs only)	15 Mbps	$50/mo	5 Mbps

Mobile Wireless

All major wireless companies and several smaller companies offer service in Portland. Facilities-based wireless providers include AT&T, Verizon, Sprint, T-Mobile, Clear, Cricket, Newpath and Next G. This industry has recently adopted a new broadband technology standard called "Long Term Evolution" or LTE. LTE has not been rolled out in Portland as yet (the standard was only adopted in 2009, and the first roll-outs were in 2010) but it is expected to be available in Portland in 2012. LTE is also known as the 4G (or fourth generation) standard for wireless. There are several 3G (third generation) "standards" including WiMAX, HSPDA, and others which provide high speeds, but LTE is a giant step forward for wireless networks, providing an option equivalent to wired services, but with total national and international mobility (if you don't mind roaming charges). The development of mobile broadband is perhaps the greatest driver for consumer demand for more and more bandwidth. Companies offering 3G, 3G+ or 4G services in Portland include Sprint/T-Mobile, AT&T, Verizon Wireless (2012). These services are delivering 10-12 Mbps download speeds today, and are expected to approach 50 Mbps within 24 months. Rate packages vary from $30-$80 per month depending on upload speeds. If mobile wireless LTE networks can really reliably deliver 50 Mbps wirelessly at these rates, they will pose a very real competitive challenge to cable, DSL and FIOS, hopefully causing both price and service competition.

Business Services

There are more options for business level services in Portland, than for residential service. Facilities-based wireline providers include AT&T Inc, Comcast, Sprint Nextel Corp., CenturyLink (Qwest), XO Communications, tw telecom, Integra, Level 3, Abovenet, McLeodUSA, Verizon, Tata, WCI, and 360 Networks. Businesses in Portland can purchase gigabit Ethernet services from a variety of companies, wireless Internet services and lit or dark fiber, depending on their location. There is a wide range of pricing options from $20 - $200 per month for DSL and Cable-type services. Ethernet transport can be significantly more expensive but provides 100 times the speed. Some business entities have reported difficulty in accessing fiber-based service providers in Portland, because fiber is not laid in every area of the City. While downtown businesses are more likely to have fiber available in their buildings, businesses outside of the City core are unlikely to find fiber available. These businesses may be able to purchase service from several wireless high-speed companies including Silver Star Telecom, Freewire Broadband, Portland Internetworks, and others.

The Pittock Internet Hotel and Competition

More competition is developing in both the business and residential markets as start-ups pursue using a combination of facilities-based fiber and DSL as well as wireless technologies like WiMAX, WiFi and point to point microwave. Tom Bechtell, Property Manager of the Pittock Internet Hotel in Portland says many companies have co-location facilities in the Pittock, allowing them to take advantage of the growing market for Internet services for small and medium size businesses as well as home-based businesses. He expects the market to "explode" as IP video services drive demand for more and more bandwidth to the consumer in both residential and business settings. The Pittock Internet Hotel, located in downtown Portland, is a meet point for all major fiber facilities in the nation. Local services who also locate hubs there can take advantage of on-site connections to very big Internet pipes and fiber connections around the world. This provides both small and large companies with the opportunity to access huge connections at very low costs. Companies like Stephouse Networks, Freewire, and others are then able to provide Internet to their customers at lower rates. Their distribution networks are often wireless technologies rather than cable or telephone wires. As these technologies are licensed for more and more broadband services, Bechtell expects rapid growth in provider options to continue. Today, Freewire offers up to Gigabit Ethernet services on its network for business subscribers. As television migrates to all digital, all IP platforms, the demand for high bandwidth connections will expand. Regional networks are forming, according to Bechtell, which take advantage of new IP video technology and fast internet over both wire and wireless delivery mechanisms. The video explosion is not limited to typical broadcast content. Bechtell points out a project between the National Science Foundation and the University of Washington which is placing wireless nodes, cameras and sensors in the ocean, and tying them back to the Pittock. The raw data collected for research will be distributed via Internet 2 to research centers across the globe. Eventually, consumers will have access to the data to learn about the ocean in real time as well.

Intel and Google TV are working on technology to provide Internet service directly to televisions, while reducing power requirements in data centers. They want to set up an experimental area in Portland, according to Bechtell. Freewire and Fibersphere are among other companies setting up alternative services to Comcast. These are hubbed at the Pittock. There is a push, according to Bechtell, to get "local guys" to provide services in the niche areas of the market.

CSI Digital, for instance, has installed big satellite dishes on the roof of the Pittock, which receive hundreds of television programming channels. These are resold to ISPs to offer over the Internet to compete with Netflix, Comcast, Roku, Amazon and others.

The IRNE Network

The Integrated Regional Network Enterprise (IRNE) is a fiber network operated by the City, serving hundreds of public buildings in Multnomah County, including offices, police precincts, fire stations, K-12 schools, universities and hospitals. IRNE is able to reach many of the public sector institutions through an interconnection with Comcast's Institutional Network (I-Net) and the emergency communications network. The IRNE provides high-speed data transport (up to 10 Gbps connections) and very low rates to public institutions throughout the County. The IRNE was constructed using fiber and conduit obtained by the City during franchise negotiations with telecommunications providers, as well as fiber constructed by the City, TriMet and ODOT for SCADA and intelligent transportation systems. The IRNE provides all voice and data for the City of Portland. The IRNE is exclusively non-commercial at this time.

Attachment 5: Industry Roundtable on the City of Portland's draft Broadband Strategic Plan

On June 3, 2011, the City of Portland sponsored a telecommunications industry roundtable to discuss the City's draft Broadband Strategic Plan. Several of the City's telecommunications providers attended, including CenturyLink, Comcast, TW Telecom, LS Networks and Integra Telecom. They were joined by EasyStreet OnLine Services and the Northwest Internet Exchange (NWAX). The purpose of the roundtable was to update the City on Broadband Services offered by these carriers, as well as their future plans, and to discuss ways that Industry could participate in advancing the goals of the plan through implementation partnerships and strategies.

Presentation Highlights:

The roundtable event began with an opportunity for each industry participant to briefly outline their current services within the City and any future plans for services. Rich Bader of EasyStreet began by describing their migration from providing Internet access services to the development of their green data center, and a focus on server hosting and cloud computing for business customers.

Chris Denzin of CenturyLink discussed consumer space services currently available, which include DSL services from 1.5 Mbps to 40 Mbps downstream and 1.5 Mbps to 20 Mbps upstream. Denzin described the CenturyLink network in Portland as a fiber-to-the-node architecture, which the company plans to modernize with a minimum investment over the next five years of $40M statewide. Speeds are planned to increase to 100 Mbps (downstream) and 40 Mbps (upstream). They are planning to introduce an IPTV service called Prism in several cities in the US. If Portland is chosen, there will be additional infrastructure investment. CenturyLink has introduced a "lifeline" service of lower speed broadband for $9.95/mo. which includes the ability to purchase a discounted computer. Business services include 40/20 Mbps DSL, Ethernet up to 10 Mbps and Ethernet Private Line service up to 10 Gbps. They also offer their Q-Wave DWDM Sonet over Fiber service up to 40 Gbps.

Theresa Davis of Comcast described their high speed DOCSIS network which currently provides up to 100 Mbps business service and 105 Mbps downstream to residential users at its highest tier of service. Since 2007, Ms. Davis reports that Comcast has invested $449 M in the region, $60M of that in Portland. She reports that Comcast reaches 100% of residences with its fiber to the node network, and 90% of Portland Businesses. Comcast provides 2000 local jobs. She notes that there are 250 I-Net sites in Portland. Comcast considers Portland a "pioneer market" and good test market where the company launches new services, such as its recent launch of Infinity high speed broadband services. In Fall, 2011, Comcast will launch its "Internet Essentials" service offering students who qualify for free lunches a basic broadband package which will include a low cost computer, and some training.

Jon Nicholson of TW Telecom described TW's business services (it is not a residential provider). TW is the largest competitive access provider in the Country. They operate in 75 markets, serving 14,000 buildings with 27,000 miles of fiber plant. Nicholson notes that TW spends 25% of total revenue on capital investment. They provide wide area and metro Ethernet services, and are moving into voice over IP service, and "up the stack" to managed services and managed applications. Customers have several options for business services, including Ethernet up to 10 Gbps, which is available in increments of 1 Gbps. Their network is engineered to expand infrastructure once it reaches 60% of capacity subscribed, so that the network avoids any congestion.

Integra Telecom, which began in Oregon invested $38M in network enhancements to its network in 2011. Steve Anderson reports that Integra is focused on small, medium and large business offerings, and does not provide residential service. Offerings include DSL up to 100 Mbps (soon) and Metro Ethernet up to 10 Gbps. They are considering moving into cloud services or cloud access services. They also provide wholesale services to other carriers.

Michael Weideman discussed LS Networks, which is a local company with a 600% increase in revenue of the last five years. LS Networks does not provide services within Portland because, Mr. Weideman stated, the fees and taxes in Portland are three times higher than in other areas of the State. Also, Mr. Weideman noted that unlike in Eugene, OR, the franchise fees in Portland do not get reinvested in telecommunications infrastructure, and

gaining access to right-of-way (such as TriMet right-of-way) is difficult. LS is owned by rural electrical cooperatives. It provides services from 10 Mbps to "10's of Gigabits for network interconnection services to rural telecom's throughout the State.

Don Westlight, representing the Northwest Regional Internet Exchange (NWAX) which provides a peering point for telecoms and internet providers at the Pittock Internet Hotel in downtown Portland, said that the City's Broadband Plan is essential to promote economic development in the region. NWAX allows members to trade traffic within the State, without charge. There are 31 networks plugged in so far. The exchange allows local internet traffic to stay local, thereby increasing throughput and reducing transit cost for providers of internet services. To illuminate the value of the exchange, Don highlighted the Oregon Health Network (OHN), which has 200 clinics, hospitals and medical treatment sites connected through the exchange. The OHN provides secure high speed private internet services, using EasyStreet Online's network operations center, allowing data traffic to remain in-state.

Discussion Topics

Following the brief presentations by each company on their services and planned services, the group convened a moderated discussion of topics raised in the Portland Broadband Strategic Plan. Nancy Jesuale, of NetCity (consultant to the project) moderated this discussion.

Status of Competition in Portland

In light of the information presented in the presentations by each company, Nancy Jesuale asked participants whether they felt that Portland had sufficient broadband competition, and whether there were "holes" in broadband accessibility for Portlanders. Jon Nicholson responded that he feels that among cities of similar size, Portland is one of the "most wired" in the Country. Theresa Davis agreed, calling Portland "a highly competitive market." She mentioned the National Telecommunications and Information Agency (NTIA) broadband mapping project. In preparation for the roundtable, Theresa looked at NTIA's broadband mapping in the Portland area. She noted that the purple color on the map shows fiber infrastructure and that "there was a lot of purple in Portland." She agreed with Jon that the Portland market does not "lack" in competition. Chris Denzin spoke about his belief that competitors rely on a strategy of "success-based investment" meaning that they invest where demand is evident to support a reasonable return on investment. He stated that "simply throwing money out there to build fiber and hope people show up is not a strategy. Adoption, utilization, attraction of new businesses and business districts are what we actually need". He noted that Mary Beth Henry had shown a slide earlier which stated that 20 percent of those living in Portland choose not to have broadband access, so to simply build fiber to every single home within Portland may not be a "best use of capital dollars for CenturyLink or any of us". He feels that the Plan's goal to develop a cluster strategy in key areas for economic development is the right direction to developing tenants and attracting citizens to the areas to serve. He believes this goal will build demand for broadband services and "when that demand materializes we will build into that. But to build into a demand that is not currently present today doesn't make a lot of sense."

Wireless as a substitute for wireline Broadband

Nancy Jesuale asked industry participations to weigh in on whether they think that the next generation of wireless technology for mobile broadband (4G) is going to provide another consumer competitive option for broadband to DSL and cable. Participants agreed that the demand for mobile, wireless internet connectivity and high speed broadband over wireless in growing at a very fast rate. Nancy Jesuale asked whether wireless is a way to get accessibility and competition into areas where it hasn't been before. Participants noted that accessibility to mobile data is really going to be critical to market growth in both residential and business settings. They note," for people that are embedded at desk all day long-- they want their gigabit connection, but how much did you put up with on your cell phone for the fact that it was mobile?"

Beyond the consumer demand for mobility the deployment of a wireless technology was seen by some as a way to lower cost to reach consumers where accessibility is an issue. "Feeding a number of cell sites rather than every premise that you pass is clearly more cost effective."

While clearly smart devices are proving to the market that consumers want to be "untethered", participants brought up the disadvantages of relying on wireless access for broadband. Specifically they noted the scarcity and cost of radio spectrum to support wireless services.

"If you fast forward 20 years to the projected growth of smart devices of every description there is no escaping the need for fiber." One participant felt "there is a place for public partnerships and things like that to do some base deployment in areas that wouldn't get a fiber backbone any other way and then turn the competition loose on riding on that platform to deliver services." Even though wireless is essential, participants felt that networks are going to need fiber to feed it. Fiber and wireless are complimentary, not competitive.

With respect to using a wireless delivery into areas that are difficult to justify fiber builds to households and businesses, participants mentioned the possibility of "some kind of public private partnerships either between the city and multiple companies or multiple public agencies and a company to forge a strategy into those targeted areas" that isn't necessarily based on any particular technology, but the best technology for that situation.

Partnerships

Rich Bader framed the question in terms of finding a balance between competing goals; for the City the goal is affordable access to every citizen, but to the companies the goal is return on investment. He restated the question of public private partnerships this way; "Are there things that we can structurally do within a public private partnership that help move us faster towards the public goals without disrupting the financial metrics of the private sector?" Are there structural things that we can do that are basically win-wins for both sides? Nancy Jesuale then asked whether others would agree that they would like to come to the table and jointly figure out solutions with the city when we have, for instance identified an accessibility hole or an affordability hole or a business access hole in broadband service?

There was general consensus that the Industry would like to tackle problems of broadband availability and affordability in partnership with the City.

Chris Denzin of CenturyLink cited specifically the recommendation in the draft plan to identify and implement a dig once policy. He related an example where the company was required to relocate aerial plant to underground conduit. He noted that "cost is what drives us and if something costs more it means we get less for what we paid for it." He suggested that a notification process coordinated by the City to notify all franchise holders when a street was going to be opened so that they could coordinate a low cost installation of infrastructure for all interested parties. Theresa Davis of Comcast agreed, and took the concept further, suggesting that the City could help to coordinate a uniform notification procedure that could be implemented across the region, or even across the State. There was concern that such a policy be fair. For instance Chris worried that if his company was bearing the cost of opening the trench, "and my competitor regardless of who it is can come through and for a $1.50 a foot to throw in conduit behind me and I'm bearing the majority of that cost, then that is not equal treatment." Jon Nicholson suggested a revision to the City's per foot permitting costs which apply no matter how many feet of infrastructure are being permitted and vault permit fees which are the same no matter what size vault is installed.

Incentives

This brought the conversation to a discussion of incentives. The Broadband Plan suggests that the City find ways to incentivize companies to take actions that will result in more affordable and ubiquitous broadband services throughout the City. Participants suggested that the city consider changes to franchise fees, right-of-way fees, and permitting fees and practices "as a way to promote growth." There was a comment that the City's franchise fees are disparate and inequitable. Mary Beth Henry asked participants if they were saying that "you'd like us to work with you to review whether there are some different strategies we should employ in setting franchise fees?" Jon Nicolson responded, "We'd absolutely love that. The other thing that we'd love for the city to do is to help us work with the building community because we would really like to have fair and equitable access to buildings as well."

Building Entry Standards or Best Practices

Nancy Jesuale asked, "What do you think about a standards process for city buildings, at least new development?"

At least one participant did not like the idea of standards for building entrance access. "I've dealt with over 200 buildings in the last two years and I think there are best practices that you can help drive, good habits, awareness of routes; but none of us are architects by trade. Several architecture firms that build buildings do come to us and they work with us. We need to point out what is the easiest means of access from the street for us--that helps in the planning; but you can't force them to fit just one mold. So you have to enforce best practices within that group. One practice wouldn't work because in truth four different providers – competitors--could be on four different sides of the street, so does that mean the architect has to build four different means of access so that each provider has equally fair entrance costs? What would be really nice – and what industry has asked for across the country for years is just equal treatment. Equal access into the buildings -- that's really key."

The group discussed whether building owners deny access to some carriers. It was confirmed by several participants that these situations do happen. There was a suggestion that perhaps the City could assist. Mary Beth Henry suggested that perhaps "the city and some of our partners should approach the development community and the building owners in Portland and talk about this issue and raise awareness."

Participants agreed that there could be a working group including carriers and property owners to encourage better practices. There has been some collaboration with the Portland Development Commission (PDC) in the last year on property renovations in the area, and this was seen as a "good first step" to try and drive more broadband deployment, bring in new businesses, economic opportunities for the community and grow small-medium businesses as well."

Rich Bader summarized; "So if were to put a cap on this piece of the discussion, from my point of view, I think that the way to accelerate accessibility of fiber and broadband services is to lower the cost of deployment for those services. I think we all agree lowering costs is a good thing. And then we have identified a couple of different mechanisms for lowering those costs: One is a dig once or some type of shared conduit or infrastructure strategy so that the overall cost of deploying broadband goes down--then there's the cost of getting in the building, whether it's standards, best practices, addressing the business relationships between the carriers and property owners all of that also provides barriers and then that last couple of feet of not only getting it in the building, but getting it to the tenant that they're looking for – addressing all of those costs will be should be a central part of the business aspect of delivering broadband in the Broadband Plan."

Ms Jesuale commented, "No matter whether it's for a business or a consumer the City has to have "some skin in the game" to help create incentives for broadband deployment. And things were brought up like permitting fees and franchise fees. Are there other incentives besides these?

Rich Bader remarked that "that's an interesting place where the financial dynamics that I described earlier about how the city wants deployment for free and the private sector is trying to make money...those roles now become reversed because the city is now dependent upon the franchise fees that all of you guys pay. And one of the ways to lower the cost to the private sector would be to take the franchise fees to zero. Just as in the extreme our services could be available for zero... I'm just painting the extremes to show the tension, so...lowering franchise fees, making it easier, making that relationship more frictionless..." There's a revenue stream that the city has as a result of this activity that they will want to balance--how much should franchise fees be before they impede the deployment of broadband in the city?

Mary Beth Henry noted that "I have yet to meet a person who says please, please let me pay fees and taxes--but what I have heard over and over again is if you're going to have a system of fees, please treat each provider equitably. That we can get behind 100%. But we could not defund Police, Fire and Parks– sorry, but providers depend on those services as much as the rest of us and it's your franchise fees/taxes that pay for them. Yet, I think we can partner with you on leveling the playing field and we would be happy to do that."

Social Equity

Nancy Jesuale then asked participants to talk about whether there were partnering opportunities beyond the lifeline

services introduced to consumers this year by Comcast and Century link to work with schools, the elderly and other populations to increase adoption of broadband services.

Chris Denzin remarked, "We've already established that every citizen of Portland can get high speed internet today, but do they want to use their resources personally, financially to go ahead and do so? And the answer has been proven with their wallets – the answer is no. Education on why it's important to get established online and what benefits it brings to their lives is essential and it needs to begin in the school system. There is no direct public broadband adoption assistance program and maybe it's time to think about creating some programs. You can't just build it and hope they use it – you have to teach people how to use it and how it benefits them."

Ms. Davis added, "From a Comcast perspective, yes we have our $9.95 program, but we've spent a lot of time and a lot of our community investment dollars in bridging the digital divide. We are starting a program this year with One Economy called Digital Connectors and we're developing a relationship with a non-profit where we're going to have kids learn how to be "digital connectors" for their community. Low income kids volunteer service hours where they get a laptop and a flip cam and learn how to use it. At the end they get a certificate from Cisco and they're certified in IT. It's a really great program where we're partnering to make sure that low income kids can get on the Internet and this way when they grow-up they will see a need for the Internet."

Nancy Jesuale then asked what things the City might do that would discourage the Industry from working with the City to accomplish the Plan goals? One participant remarked "competition we all agree is good, but competition between public and private is not good."

Participants felt that the best way to move forward is a collaborative model; "to succeed in Portland so that we can go out and tell other cities that this is how you do broadband strategic planning -- set your goals, work with industry, work with educators, work with public safety and get it done. But don't set up the dichotomy of "if I get what I want, you lose."

Steve Anderson summed up. "While we don't want a municipal competitor, we do want to work with the City to encourage investment from each one of us, who are all customers of each other."

Participants:

City of Portland

Brendan Finn, Chief of Staff to Councilmember Dan Saltzman

David Olson, Bureau Director, Office of Cable and Franchise Management

Mary Beth Henry, Deputy Director, Office of Cable and Franchise Management

Nancy Jesuale, NetCity Inc., project consultant

Industry

Steve Anderson, Integra Telecommunications

Stuart Taubman, Integra Telecommunications

Theresa Davis, Comcast

Chris Denzin, CenturyLink

Jon Nicholson, TW Telecom

Don Westlight, NWAX

Michael Weideman, LS Networks

Rich Bader, EasyStreet OnLine Services

Attachment 6: World Class Broadband: Experiences from Other Communities

Communities worldwide have demonstrated creative, innovative practices to develop world class broadband infrastructure. This range of successful initiatives can inform the City as to strategies to contemplate. Some are incremental and modest in scope, and can be immediately undertaken should the City decide to do so. Others are much more ambitious and broad—and thus may not be feasible at the current time—but they remain important reference points as the City contemplates its broadband future. The following is a brief survey of some of those strategies.

Align government policies to catalyze pro-broadband, market-led approach. In Hong Kong, the Office of Telecommunications Authority (OFTA) developed pro-competition, pro-consumer broadband policy objectives designed to catalyze investment by the private sector in providing the widest range of high speed telecommunications services as economically as possible to the broadest range of the population. These policies were successful in inducing a major investment by the Hong Kong Broadband Network (HKBN) which, after an initial period of construction, began in 2010 to offer gigabit-per-second fiber-to-the home broadband services to Hong Kong residents for around $25 (USD) month. HKBN was encouraged by government incentives in the early 2000s to take a long range view (7 years+) of payback requirements and a mass market, commoditized approach to broadband emphasizing the fastest possible broadband speeds to the greatest percentage of the population at very low cost. HKBN reached profitability in 2011, is now listed 3rd in the world in FTTP penetration, has outpaced the incumbent Hong Kong telecommunications companies in market penetration and deployment (HKBN is nearly 80% built out at this writing), and is well on the way to exceeding HKBN's own goal of becoming Hong Kong's dominant broadband provider by 2016, all with a unique mass market approach that emphasizes high speed deployment at the lowest possible cost, encouraged by an uncapped rate-of-return and government policies designed to encourage a market-led approach, lower the cost of deployment, and make certain everyone is served (e.g. OFTA sponsors a broadband subsidy program for low income Hong Kong families with children in school).

Aggressively court the private sector to invest in broadband locally. This strategy has been successful where the private sector has undertaken extremely ambitious investments. Fort Wayne, Indiana is one community that successfully courted private sector investment. Under the leadership of Mayor Graham Richard, Fort Wayne undertook an extremely ambitious campaign to lure Verizon to build fiber to the premises (FIOS) to Fort Wayne. This was as aggressive an economic development effort as has ever been launched by an American community, and entailed significant cost and effort on the part of the city. Part of what helped Fort Wayne is that it reached out to Verizon when Verizon was first planning its FIOS deployments and had not yet narrowed the range of communities where it would build.

Implement a "dig once" policy that cost-effectively enables gradual deployment of infrastructure. In this model, a community implements a policy mandating installation of conduit (or fiber) any time a trench or road is open in the public rights-of-way, thus enabling build-up of a critical mass of infrastructure at relatively low incremental cost. Ideally, the conduit and fiber are specified in advance and, of course, they must be impeccably mapped and recorded. Such a policy is most effective where there exists extensive planning and coordination among the various departments responsible for infrastructure and construction (public works, transportation, IT, permitting authorities, and utilities). It also helps to coordinate the construction timelines of various departments so as to facilitate cost-effective placement of conduit and fiber. This strategy enables deployment of infrastructure for backhaul and middle-mile fiber that can be leased to the private sector and stimulate offering of services. It can also enable placement of conduit directly to wireless facilities sites, thus facilitating not only deployment of next-generation wireless services but also reducing the cost for new competitors to enter the market. . This strategy recognizes that certain sections of our city are rich with fiber infrastructure such as in the Central Business District. If moved to the work plan stage, the "dig once" strategy will be planned for the sections of Portland that are currently deficient in fiber infrastructure.

A pioneer of this strategy, Mesa, Arizona, placed conduit opportunistically whenever trenches were open until it eventually completed a downtown ring. The city leases space in the conduit to the private sector, which only has to blow or push fiber through the existing conduit and thus saves significant construction costs. Among the many benefits to the city are the revenues, the reduced barriers to entry for the private sector, and the reduced damage to the roads and other public assets.

Another key pioneer in this area, the City of Santa Monica, built fiber wherever feasible and then connected local businesses over the fiber to competing providers. Santa Monica operates a 10 Gigabit per second network that connects the business community to 160 Internet Service Providers (ISPs) in Los Angeles data centers, thus enabling them to select among cost-effective competitors. Santa Monica built this fiber by extending its network during any city project, including roadwork, water and sewer main installations, and traffic signal system installation.

Build fiber to potential wireless tower sites. In this model, the community builds fiber to public sites that are promising for the siting of wireless facilities. The combination of fiber and high-value sites amounts to a desirable package for wireless providers, and thus both the fiber and the site could realize revenues in the form of lease payments from wireless service providers. The community-based non-profit, One Community, in northwest Ohio has very effectively partnered with wireless providers, and realized significant revenue by building fiber to logical tower locations—and has made this a centerpiece of not only the revenue flow of their network, but also their efforts to attract wireless providers to provide service to residents and businesses within their footprint.

Deploy a modest, scalable FTTH pilot as a platform for innovation and research. In this model, the community builds a small, inexpensive pilot area that can scale in size over time. This approach was pioneered by Case Western Reserve University in Cleveland, in partnership with local communities and non-profits (such as healthcare institutions and social service groups). The project has deployed one block of FTTH technology and provides free symmetrical gigabit service to all residences on the block. That single block has become an important test-bed for application providers to test and experiment and innovate in areas including energy/environment, health care, and education. As a result, this single block pilot is at the center of a number of initiatives headed by the Office of Science and Technology in the White House. For the cost of building out one block, the community has a platform for innovation, a platform for a variety of entities to test their applications, and a platform for research by local academic institutions.

Incrementally develop publicly-owned fiber using a variety of approaches. In this model, the community gradually, using a variety of mechanisms, builds a network that serves institutional needs and is publicly owned and controlled--such that there is no limitation on the services it can provide or the service providers it can support. This strategy enables the benefits of an I-Net such as IRNE, without the limitations imposed as a result of the cable franchise agreement. Over time, using the strategies suggested above, the District of Columbia has developed much of its own infrastructure to serve its own needs. As a result it has not only secured its network (i.e., no risk of losing the network to the private sector fiber owner), but has also dedicated capacity within the network to enable private sector competitors to enter markets at much lower cost—essentially lowering the barriers to entry.

Develop a public/private FTTH partnership. In this model, the community finds non-traditional partners to build and own fiber. For example, the City of Amsterdam wanted to see open access FTTH emerge, and had as its top priorities not only open access, but that it would reach all residents—not just those that were commercially desirable. The city agreed to make a significant investment that attracted investment from local real estate owners and banks to build open access fiber. The city has been able over time to reduce its ownership percentage of the underlying fiber because the policy requirements of open access and universal deployment had been met. In this way, the city was able to meet its public policy goals by partially, rather than fully, investing in a network.

Build a public FTTH network with a risk-sharing element. In this model, the community initially funds the network and effectively sells it to local operators over time—thus reducing operator risk and increasing incentives to participate. The government of New Zealand is the prime example of this model. Crown Fibre Holdings, the government's designated entity, has selected local partners—both public utilities and private sector companies—that will be funded by the government to build open access FTTH throughout the country. Eventually the network will reach one million homes and businesses. The business model requires open access, and also requires that as providers activate portions of the network and bring customers onto the network (i.e., as they begin realizing revenues), they will reimburse the government in part for the capital costs. Ideally the network will be very successful nationally and the government will be reimbursed in large part for many of the capital costs. An open access FTTH network throughout the country would not have been conceivable if the government had not taken the capital risk. The business model enables local providers to build and operate the network in a competitive environment, while sharing the financial risk with the government; that risk would likely have precluded those providers from building the network absent the government investment. Thus, even if the government is not fully reimbursed, it has still met its public policy goals.

Attachment 7: National Broadband Plan Summary

This link provides access to a "digest" of the National Broadband Plan prepared by the City's consultants, NetCity Inc. and IBI Group as a briefing book for workshop participants.

http://www.portlandonline.com/cable/index.cfm?c=54038&a=334313

To access the full National Broadband Plan published by the Federal Communications Commission in 2010, click on this link:

http://www.broadband.gov/plan/

SUBSTITUTE

RESOLUTION No. 36816

Authorize the Office of Cable Communications and Franchise Management, in cooperation with the Portland Development Commission and the Bureau of Technology Services, to develop a citywide Broadband Strategic Plan and report back to Council by June 30, 2011. (Resolution)

WHEREAS, high-speed, accessible and affordable broadband is essential infrastructure for job creation, education, health care, the enhancement of safe and connected communities, civic engagement, government transparency and responsiveness, reduced carbon emissions, and emergency preparedness; and

WHEREAS, a strategic approach to Broadband will complement the City's Economic Development Strategy, which, among other things, focuses on strengthening four traded-sector industries, including clean technology, active-wear, advanced manufacturing and software, as well as Portland's diverse neighborhood business districts; and

WHEREAS, establishing the City's broadband objectives and initiatives will inform the Portland Plan and create tools to achieve the City's goals for prosperity, health, and equity; and

WHEREAS, the Federal Communications Commission (FCC) has completed a national plan "for use of broadband infrastructure and services in advancing consumer welfare, civic participation, public safety and homeland security, community development, health care delivery, energy independence and efficiency, education, worker training, private sector investment, entrepreneurial activity, job creation and economic growth, and other national purposes." (National Broadband Plan, FCC, 2010); and local and State governments are involved in efforts to achieve the recommendations of the "National Broadband Plan"; and

WHEREAS, the State of Oregon has established The Oregon Broadband Advisory Council (OBAC) to encourage coordination between existing organizations and sectors that can leverage broadband to their advantage, and the City is represented on this Council; and

WHEREAS, there are critical strategic fiscal, policy, and planning benefits to the City which will arise through coordinating and leveraging on-going and planned efforts related to improving broadband access for citizens and businesses throughout the City; and

WHEREAS, the City should develop broadband communications infrastructure and connectivity strategies to promote economic development by emphasizing business vitality and job creation, enhance government services, promote sustainability, transportation, health care and regulatory policies; and improve accessibility and responsiveness of government to citizens through connectivity; and

WHEREAS, the City currently has multiple programs and projects proposed or underway in different bureaus and portfolios that involve broadband initiatives and investments that should be coordinated in the most effective manner; and

WHEREAS, a completed long term strategic plan for accomplishing the City's Broadband objectives can guide efforts and investments made throughout the City, both on behalf of City bureaus and with our Local, State, Federal and private sector partners; and

WHEREAS, The Office of Cable Communications and Franchise Management has a long history of facilitating coordinated policy and regulatory leadership on the Council's behalf in the area of Broadband and advanced telecommunications services in the City and the Bureau of Technology Services is a recognized leader in delivering broadband and public safety communications services to City Bureaus and Offices as well as our regional government partners;

NOW, THEREFORE, BE IT RESOLVED, the Office of Cable Communications and Franchise Management is hereby authorized and directed to develop and manage the preparation of a draft City of Portland Broadband Strategic Plan that shall be presented in initial form to the Mayor and Council for review no later than June 30, 2011. The Office of Cable Communications and Franchise Management shall work with other Bureaus and Offices of the City including but not limited to the Portland Development Commission, the Bureau of Technology Services, the Fire Bureau, the Police Bureau, the Public Safety Systems Revitalization Program, the Office of Planning and Sustainability, and Mayor and Council Offices to ensure that a comprehensive, informed and inclusive broadband planning effort is undertaken that emphasizes equitable provision of services, business vitality and job creation, and continues on an ongoing basis.

Adopted by the Council: SEP 22 2010

Commissioner Amanda Fritz

Prepared by: Mary Beth Henry & David C. Olson
Date Prepared: September 15, 2010

LaVonne Griffin-Valade
Auditor of the City of Portland
By

Deputy

S-1271

Suk

Resolution ~~ORDINANCE~~ NO. Agenda No. SUBSTITUTE 36816

Title

Authorize the Office of Cable Communications and Franchise Management, in cooperation with the Portland Development Commission and the Bureau of Technology Services, to develop a citywide Broadband Strategic Plan and report back to Council by June 30, 2011. (Resolution)

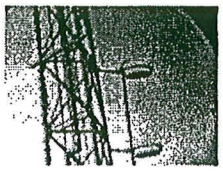
INTRODUCED BY Commissioner/Auditor: **Fritz**	CLERK USE: DATE FILED SEP 21 2010
COMMISSIONER APPROVAL	LaVonne Griffin-Valade Auditor of the City of Portland
Mayor—Finance and Administration - Adams	
Position 1/Utilities - Fritz For Dan	By: _____ Deputy
Position 2/Works - Fish	
Position 3/Affairs - Saltzman	
Position 4/Safety - Leonard	ACTION TAKEN:
BUREAU APPROVAL	
Bureau: OCCFM Bureau Head: David Olson	
Prepared by: Mary Beth Henry Date Prepared: 9/15/2010	
Financial Impact Statement Completed ☒ Amends Budget ☐ Not Required ☐	
Portland Policy Document If "Yes" requires City Policyparagraph stated in document. Yes ☐ No ☒	
Council Meeting Date **September 22, 2010**	
City Attorney Approval Benjamin Walters	

AGENDA
TIME CERTAIN ☒ **Start time: 9:30am** **Total amount of time needed: 35 minutes** (for presentation, testimony anddiscussion)
CONSENT ☐
REGULAR ☐ **Total amount of time needed:** ____ (for presentation, testimony and discussion)

FOUR-FIFTHS AGENDA	COMMISSIONERS VOTED AS FOLLOWS:	YEAS	NAYS
1. Fritz	1. Fritz	✓	
2. Fish	2. Fish	✓	
3. Saltzman	3. Saltzman	—	—
4. Leonard	4. Leonard	✓	
Adams	Adams	—	—

- **Home**
- **Present**
- **Past & Future**
- **Services**
- **Broadcast Services**
- **Personnel**
- **References**
- **Technical Papers**
- **dTR/H&D Joint Venture**
- **Downloads**

Present



Hatfield & Dawson Consulting Engineers

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email: hatdaw (at) hatdaw (dot) com

Hatfield & Dawson is a Washington State consulting engineering firm with a specialized practice in telecommunications and electromagnetic engineering. The firm has been in operation in its present form since 1973 and is the successor to the firm of James B. Hatfield (Sr.), established in 1945.

The principals and associates of the firm have experience in nearly all aspects of telecommunications and electromagnetic engineering. The firm performs telecommunications policy analysis, operational and economic planning, conceptual and specific system design, government agency and license application engineering, preparation of specifications, construction supervision, propagation analysis, measurements, testing and operational review of

- AM, FM, and TV allocation engineering and FCC application processing
- Two-way and wireless communications systems
- Transmission and antenna systems for AM and FM broadcasting
- Microwave communication and data links
- Television systems for broadcast and closed circuit
- Specialized electromagnetic engineering and analysis
- Electromagnetic compatibility of multiple use transmission sites
- Non-ionizing radiation hazard analysis
- Field strength measurement
- Propagation studies and analysis

Hatfield & Dawson has a long history of innovative telecommunications engineering ranging from regulatory planning for government licensing agencies to hands-on system and facility design and implementation. Because the firm specializes in telecommunications engineering work, its analysis and planning activities benefit from specific experience with the implementation and operation of the communications systems under study. We have performed extensive regulatory analysis

and communications systems planning for numerous clients. These clients include: cities; counties; states; and agencies of the United States and foreign governments; broadcasting companies; telecommunications common carriers; industrial communications users; educational institutions; and cable and satellite television system operators.

Hatfield & Dawson has a staff of eleven, including eight engineers and three support staff. Seven of the eight engineers are Registered Professional Engineers. The principal engineers of the firm are members of the Association of Federal Communications Consulting Engineers (AFCCE) and the Institute of Electrical and Electronic Engineers (IEEE). Members of the firm serve on the main and subcommittees of the Standards Coordinating Committee 28 of the International Committee on Electromagnetic Safety (ICES) of the IEEE. The firm maintains a fully equipped laboratory and shop, and owns a large variety of specialized test and measurement equipment, as well as an extensive library.

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Past & Future

Hatfield & Dawson is a Washington LLC (Limited Liability Company) and is wholly owned by its principal engineers. The firm was established in its present form in 1973, and is the successor to James B. Hatfield Sr., Consulting Engineer, firm est. 1945.

In order to provide accurate assessments of the alternatives available to any client in the complex and rapidly changing environment in which all wireless communications systems operate, it is necessary for all personnel in our firm to remain abreast of both technical and regulatory changes that affect that environment. In many cases, we are required to perform an analysis of changes in technology and of regulatory actions by the FCC in a specific area along with an assessment of how those changes will affect the client's wireless communication systems and environment over time periods that may extend into the next decade.

We have produced long-term strategic plans for a number of different government and private entities in which we have analyzed viable technology options available to the client, including an assessment of their potential costs, advantages and disadvantages, and recommendations on the appropriateness of those technologies given the scope of the client's communications needs identified in the project.

In some cases we have addressed very specific technical and regulatory constraints imposed by the location of wireless systems (e.g. constraints imposed on wireless systems by treaty in areas in close proximity to international borders).

As part of these long-term strategic plans, we have made recommendations regarding the continued use of existing systems, potential design criteria for new systems, and on policies or procedures that should be implemented by the client to ensure correct system operation and effective spectrum resource management in the future.

The members of our firm maintain awareness of both technological and regulatory changes affecting the realm of wireless communications by constantly reviewing applicable journals and magazines in the field, by working frequently with

equipment vendors, by staying abreast of FCC news releases, rulemaking proposals, and other FCC releases, and by participating in industry forums and conferences--including IEEE committees. (One of the principals of the firm, James B. Hatfield, P.E., serves on the IEEE SCC Committee and its five subcommittees, which sets standards for non-ionizing radiation hazards.) We maintain subscriptions to a large number of technical journals and to the FCC daily releases in all of the areas in which we do work. We also maintain a large and very complete technical and legal reference library.

- **Personnel**
- **Benjamin F. Dawson, III, PE**
- **Thomas M. Eckels, PE**
- **James B. Hatfield, PE**
- **Stephen S. Lockwood, PE**
- **Thomas S. Gorton, PE**
- **Paul W. Leonard, PE**
- **Erik C. Swanson, PE**
- **Michael H. Mehigan, EIT**
- **Bob Allen, CFI**
- **Richard J. McAlister**
- **Theresa Boothby**

David J. Pinion, PE

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Active Registration:
Professional Electrical Engineer, WA, OR, CA, HI

Education: BS Electrical Engineering, University of Maryland
Masters in Engineering, Johns Hopkins University

Member:
IEEE Communications Society

Mr. Pinion is a partner and senior engineer of Hatfield & Dawson. He has over 24 years of extensive experience in all aspects of telecommunications engineering, radio frequency (RF) engineering, and electromagnetics. Projects he has overseen or participated in include design, government agency application and approval, specifications, construction supervision, testing, measurements and operation review of communications and radio systems projects for broadcast, closed circuit video and data, industrial and government land mobile and microwave systems, LF navigation and communications, VHF and UHF video, voice and data systems, and industrial uses. He has worked on over 100 projects worldwide for private broadcasting companies, telecommunications common carriers, industrial communications users, educational institutions, cities, counties, states, cable television systems, and the United States and foreign governments.

Mr. Pinion specializes in antenna design, electromagnetic modeling, and RF propagation analysis. He is recognized as a pioneer in the development of the most widely used PC-based electromagnetics modeling software, NEC2. In 1989 he successfully ported a bug-free version of NEC2 from mainframe to PC environment. Since then he has developed many more PC-based programs for commercial and in-house use. Those programs are used in the design and testing of critical land-mobile systems for public safety, medical emergency, and airport applications, as well as intersystem electromagnetic compatibility at multiple use communications sites.

Representative Projects

- Analysis and preparation of reports concerning the operation and performance of telecommunications facilities and industrial radio frequency devices.
- Measurement and field inspection of facilities for propagation and verification of computer and manual prediction methods.
- Field inspection of radio communications facilities for compatibility between radio transmission systems.

- Analysis, development of amelioration, and field testing relative to radio frequency interference.
- Inspection of radio transmission facilities, recommendation of capital budgets, and evaluation of quality and performance of radio and television systems.
- Development of software for propagation prediction, antenna calculation, non-ionizing radiation prediction, and use of digitized terrain and land cover characteristics.
- Preparation of facility applications for FCC approval, and for land-use approval by local government agencies.

Thomas S. Gorton, PE

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- **Personnel**
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- **Michael H. Mehigan, EIT**
- **Bob Allen, CFI**
- **Richard J. McAlister**
- **Theresa Boothby**

Active Registration:
Professional Electrical Engineer, WA, OR

Education: BS Electrical Engineering, Seattle University

Member:
IEEE

Mr. Gorton has over 20 years experience with all types of communications systems. This experience includes public safety, transit, complex cellular infrastructure, and broadcast facilities. He has performed analyses of antenna and electromagnetic propagation problems and calculations of non-ionizing radiation density at multiple use communications sites for compliance with federal and local standards for environmental impact. He has designed medium wave, VHF, UHF, and microwave propagation and antenna systems. His experience encompasses the design, installation supervision, and testing of complex cellular infrastructures throughout Washington State, including cellular base stations. He has been responsible for planning, installation, and project management for a major metropolitan broadcast station, including all significant RF activities.

Representative Projects

- Propagation measurements for King County Wastewater Treatment Division.
- Propagation studies and data analysis for radio systems for Sound Transit.
- Rebuild of control system for MW broadcast station facility, KZOK.
- Supervisor of project to mitigate interference problems between AT&T and Nextel at commonly used or contiguous sites.
- Design and installation supervision of microcell and in-building distributed antenna system.
- Design and FCC application for numerous AM and FM broadcast stations, land mobile facilities.
- Facility siting and land use analysis and litigation support, including Qwest Cougar Mt. Project.