Introduction

This Engineering Statement supports an application for a new experimental license by the City of Seattle for experimental operation of a mobile data system on TV Channel 65 (776-782 MHz) from transmitter sites in the vicinity of downtown Seattle, Washington.

The proposed experimental operation is designed to test the performance of a multi-site mobile data system in the 700 MHz band using prototype equipment adapted from similar equipment already commercially available and in use in the 1.9 GHz band. The objective of the testing program is to determine the feasibility of implementing a mobile data system using the 700 MHz band in the central core of downtown Seattle, Washington, and to characterize the propagation and other operational characteristics of such a 700 MHz system in the dense urban environment and difficult terrain encountered in the Seattle area

Data sheets for the 1.9 GHz versions of the base station and mobile equipment that will be used for the testing are attached to this Engineering Statement as part of Appendix 1. The only difference between the units shown in the data sheets and the units used in the testing will be the operating frequency range. A data sheet for the transmitting antenna proposed for all of the sites is also contained in Appendix 1

Simultaneous operation is proposed from five separate transmitter sites as shown in the map in Figure 1 below. Mobile units will operate within an 8 kilometer radius of the five transmitter sites throughout the downtown Seattle area. This Engineering Statement supports the application for all five proposed transmitter sites.

Allocation Circumstances

The closest licensed co-channel television facility on Channel 65 is television translator K65AU, licensed to Stemilt, WA, which is 149 kilometers from the proposed transmitter site.

The only "UHF Taboo" protection requirement that needs to be evaluated in relation to this application is the aural carrier image "taboo", which applies to Channel 51, 14 channels below the proposed operation on Channel 65. The protection requirement for facilities operating on a channel 14 channels below the proposed channel is based on an Undesired-to-Desired signal ratio of 23 dB at the protected station's Grade B Contour, based on §74.705(d)(5) of the Commission's Rules.

The closest licensed television facility operating on Channel 51 is KWOG-TV, licensed to Bellevue, Washington. KWOG operates with a maximum lobe ERP of 3400 kilowatts at an antenna height of 952 meters AMSL from the American Tower site on West Tiger Mountain east of Seattle.

Interference Considerations

Figure 1, shown as Appendix 2, shows the five transmitter sites and the mobile unit operating area proposed in this application for a new Experimental License. Figure 1 also shows the predicted field strength produced by the KWOG-TV licensed facilities,

based on an assumed receiving antenna height of 9.1 meters (30 feet) AGL and using the Okumura-Hata propagation model, composite digitized terrain data which includes 10 meter and 30 meter data, and USGS LULC (Land Use Land Cover) data to provide clutter loss predictions based on the structures and land cover for each grid square shown in Figure 1. The Okumura-Hata model was run in the "Open" area mode to avoid duplication of the clutter loss calculations incorporated into the predictions through the use of the LULC data.

The lowest predicted field strength from KWOG in the area shown in Figure 1, 78 dBµV/m, occurs in the grid immediately south of the grid that contains the site labeled "Adaptix Office". Assuming a receiving antenna system net gain of -16 dBd, which is the antenna gain for an "indoor antenna contour" assumed in the Commission's UHF television planning factors for contour shown in the Staff Report on Comparability for UHF Television[1], the received signal power at a television receiver in this grid would be:

Received Signal Power (dBm) = Field Strength (dBµV/m) - 20 log (f) – 75.1 + G_n

Where: f = frequency in MHz
G_n = net gain of receiving antenna system

For a field strength of 78 dBµV/m, the resulting received signal power at an indoor antenna would be -69.9 dBm, ignoring the effects of any building losses. The indoor antenna assumption is valid for the urban neighborhoods in and around downtown Seattle, in which the proposed mobile data base stations will be located. Cable penetration is very high in these neighborhoods and there is little use of outdoor antennas in these areas.

At this desired signal power level, the median U/D (Undesired-to-Desired) signal ratio at the threshold of "just perceptible" interference is 31 dB, based on the test measurements for a desired signal received power level of -65 dBm shown in the table for Test No. 13 in the FCC Internal Technical Note "A Study of UHF Television Receiver Immunities", published in March 1989[2]

The threshold for "just perceptible" interference for an indoor receiver operating at the received signal power shown above would be (-69.9 + 31) = -39.9 dBm

This received signal power is based on the peak of sync of the visual carrier for both the desired and undesired signals. The interference mechanism which underlies the aural image UHF taboo has to do with mixing in the receiver front end between the receiver local oscillator and the aural carrier signal of a television signal 14 channels above the desired channel. The received signal power of the interfering aural carrier, which is the critical component for the generation of aural carrier image interference, is 6.99 dB lower than this, or (-39.9- 6.99) = -46.9 dBm, assuming that the aural carrier operates at 20% of the visual carrier power.

Therefore, at the threshold of interference for a receiver with an indoor antenna to a 78 dBµV/m NTSC signal on Channel 51 from another NTSC signal on Channel 65, the interfering signal aural carrier power would be -46.9 dBm.

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[1] *Comparability for UHF Television, A Preliminary Analysis*, UHF Comparability Task Force, Office of Plans and Policy, Federal Communications Commission, Washington, D.C. 20554, September 1979; Table B-3, p. 185.

[2] A Study of UHF Television Receiver Interference Immunities, FCC OET Internal Technical Note, William H. Inglis, March 1989, Test #13.

Base Station Interference Analysis

The base station sites shown in this application will operate with a transmitter output power of 4 Watts (36.02 dBm), an antenna transmission line loss of 3.0 dB and a Sinclair SC481-L omnidirectional antenna with an antenna gain of 10.5 dBd. This results in a proposed ERP of 22.5 Watts (43.52 dBm) at each of the five (5) sites.

Because the proposed mobile data system will use OFDM modulation over an occupied bandwidth of 5 MHz, any analysis of the potential for interference must take into account the difference in spectral power distribution between an analog NTSC television signal (which provides the basis for the U/D ratio shown above) and an OFDM signal, which has a uniform power distribution across its entire occupied bandwidth rather than having discrete visual and aural carrier signals.

The actual interfering signal power seen at a victim television receiver will be lower than would be indicated by a straightforward received power calculation based on the total ERP shown above because the OFDM signal has less signal power within the portion of the channel usually occupied by the aural carrier than an NTSC signal has, given the same ERP. For an NTSC signal the ERP is based on the peak of sync for the visual carrier, while for an OFDM signal it is based on the total average power distributed across the entire bandwidth occupied by the signal.

Figure 2 below shows a spectrum analyzer graph of the OFDM signal produced by the equipment proposed in this application:

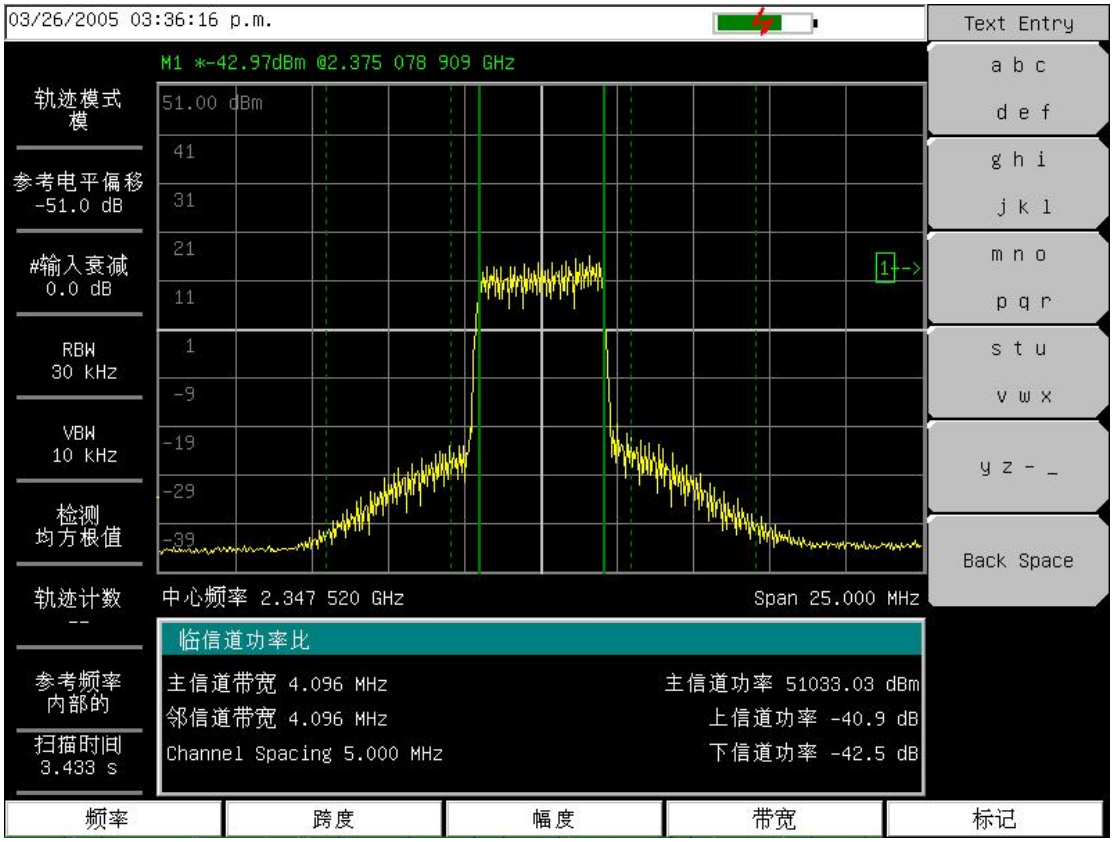


Figure 2 – Spectrum Analyzer Graph of Proposed OFDM Signal

The ratio between the signal power within the bandwidth normally occupied by the aural carrier (50 kHz) and the total signal power within the entire occupied bandwidth of the OFDM signal is:

50 KHz Bandwidth (Hz)/Total OFDM Occupied Bandwidth (Hz) = 50000/5000000
= 0.01

This ratio can be expressed in dB as follows:

10 log (0.01) = 50 kHz bandwidth signal power ratio (dB)
= -20.0 dB

This adjustment provided by this ratio produces the appropriate modification of the predicted OFDM interfering signal power level at the worst case victim receiver:

Interfering OFDM Signal Power Adjustment Factor = -20.0 dB

Based on the analysis shown above, an undesired OFDM signal power level at or below -46.9 dBm within the 50 kHz normally occupied by the aural carrier on Channel 65

would preclude interference to television receivers operating on channel 51 in the operating area proposed for the City of Seattle mobile data system on Channel 65.

Assuming that the nearest indoor receiving antenna is at least 100 feet from the proposed base station site, the OFDM signal level within the Channel 65 aural carrier bandwidth at a the victim receiver can be calculated as follows:

Base Station ERP (dBm – Dipole Reference)	43.5
Free Space Path Loss (100 feet @ 779 MHz) [dB]	-55.7
TV Receiver Antenna Net Gain (dB)	-16.0
Interfering OFDM Signal Power Adjustment Factor (dB)	-20.0
Interfering Received Signal Power Within Aural Carrier Bandwidth (dBm)	-48.2

This interfering signal level within the aural carrier bandwidth is below the interference threshold shown above. The analysis shown above is a worst case analysis, because in actual practice, both the desired television signal and the undesired OFDM signal will be attenuated by building losses at any indoor antenna.

Mobile Interference Analysis

The mobile units shown in this application will operate with a transmitter output power of 0.2 Watts (23.01 dBm), with a net antenna system gain of 0 dBd. This results in a proposed mobile unit ERP of 0.2 Watts (23.01 dBm).

Assuming that the nearest indoor receiving antenna is at least 50 feet from a mobile unit on the street, the OFDM signal level within the Channel 65 aural carrier bandwidth at a the victim receiver can be calculated as follows:

Base Station ERP (dBm – Dipole Reference)	23.0
Free Space Path Loss (50 feet @ 779 MHz) [dB]	-49.7
TV Receiver Antenna Net Gain (dB)	-16.0
Interfering OFDM Signal Power Adjustment Factor (dB)	-20.0
Interfering Received Signal Power Within Aural Carrier Bandwidth (dBm)	-62.7

This interfering signal level within the aural carrier bandwidth is below the interference threshold shown above. The analysis shown above is a worst case analysis, because in actual practice, both the desired television signal and the undesired OFDM signal will be attenuated by building losses at any indoor antenna.

APPENDIX 1
Data Sheets for Proposed Base Station and Mobile Units
Base Station Antenna Data Sheet

NewHorizon™ Base Station 2.0

ADAPTIX® NewHorizon WiMAX- and WiBro-compatible Software Defined Radio technologies enable feature-rich services deployment for the increasing flexibility and mobility demands of enterprise and residential broadband subscribers. ADAPTIX technology provides highly granular control over all radio system domains, including frequency, time, modulation, power, space, and coding. The result is a deployment and user experience agile enough for the rapidly changing broadband landscape, and connectivity powerful and intelligent enough to support flexible and profitable high value broadband IP services anywhere, anytime.

Base Station 2.0 Features

Use scenarios
Supports portable and fixed devices.

IP Based Applications
QoS managed VoIP, streaming media, video, Internet browsing, e-mail, FTP, and VPN supported.

Network Management
SNMP manageable
Local and remote access monitoring
Web-based element management system
Plug and play subscriber provisioning
Over-the-network Base Station software upgrades
Over-the-air CPE software upgrades

Adaptive Interference Optimization
User terminals sense the local radio frequency environment to determine the best available connection to support its traffic using:

- Dynamic frequency selection
- Dynamic sub channel allocation
- Dynamic power control
- Dynamic time slot allocation

Base Station 2.0 Technical Specifications

Configuration
Single sector base station with antenna diversity

Operating Frequencies
Available Configurations: 1.8Ghz, 1.9Ghz, 2.3Ghz.
Future Configurations from 700Mhz – 6Ghz

Radio System Characteristics
Bandwidth: 5MHz, 10MHz, and 20MHz
Duplexing: Time Division (TDD)
Symmetry: network operator selectable
Power output: 4W, 8W, 16W per sector

Physical Interfaces
RF: 2 N-connectors
GPS for network synchronization: BNC
Data: RJ-45

Adaptive Modulation
Downlink: 64 QAM, 16 QAM, QPSK
CPE uplink: 16 QAM, QPSK

Data Rates per Sector per 5MHz Channel
Total raw throughput: up to 23.5Mbps
Downlink data throughput: up to 10Mbps at 64QAM
CPE uplink data throughput: up to 6Mbps at 16QAM (5Mhz channel, TDD DL : UL 1:1)

Range
Line of sight: 15km
Near line of sight: 10km
Non line of sight: 1.5km to 6km

Antenna Options
Beam patterns: 60°, 90°, 120°, 360°

Environmental, Temperature, and Humidity
-0°C to +50°C, 5% to 98%

Power
Input voltage: 48VDC, consumption: 200W/sector

Physical
3U: 44.5cm x 53.5cm x 130cm, 20Kg

605 5th Avenue South, Suite 800, Seattle, WA 98104 USA +1 214.254.3650 Toll Free (In USA) 1 800.736.0594 www.adaptix.com
Specifications subject to change without notice. Prod Spec: Base Station 2.0 03/05

NewHorizon™ User Terminal 1.5.1

Offer subscribers a high-value broadband experience like they've never experienced before. ADAPTIX NewHorizon™ pre- WiMAX and WiBro compatible Software Defined Radio (SDR) platform enables feature-rich deployments for the evolving demands of enterprise and residential subscribers. The ADAPTIX OFDMA/TDD operating system provides highly granular control over all radio system domains. As a result, network deployments evolve and scale with the needs of your network and your business. The NewHorizon User Terminal offers plug-and-play functionality to get subscribers up and running on your network quickly, enabling access enhanced broadband IP services that build network loyalty and reduce churn.

NewHorizon User Terminal 1.5.1 Features

Use Scenarios
Portable and fixed non-line-of-sight operation.

IP-Based Applications
QoS managed VoIP, streaming media, video, Internet browsing, e-mail, FTP, and VPN supported.

Adaptive Interference and SINR Optimization
The NewHorizon User Terminal senses the local radio frequency environment to determine the best available connection to support its traffic using:

- Dynamic sub channel allocation
- Dynamic power control
- Dynamic time slot allocation

User Terminal Technical Specifications

Configuration
Externally powered, self-registering user terminal

Operating Frequencies
Available Configurations: 1.8Ghz, 1.9Ghz, 2.3Ghz.
Future Configurations from 700Mhz – 6Ghz

Radio Frequency Characteristics
Bandwidth: 5MHz
Duplexing: Time Division (TDD)
Symmetry: service provider selectable
Power output: 0.2W (higher power available)

Physical Interfaces

RF:	SMC connector
Data:	RJ-45, USB

Adaptive Modulation

Downlink:	64QAM, 16QAM, QPSK
Uplink:	16QAM, QPSK

Data Rates per Terminal per 5MHz Channel

Received data rate:	2.5Mbps at 64QAM
Transmit data rate:	1.6Mbps at 16QAM

Antenna Options
Switchable dipole
High gain directional

Environmental, Temperature, and Humidity
-0°C to +50°C, 5% to 98%

Power
Input voltage: 6VDC, consumption: 7W

Physical
10cm x 14cm x 3.5cm, 0.5Kg

ADAPTIX®, Inc. 605 5th Avenue South, Suite 800, Seattle, WA 98104 USA Toll Free (In USA) 1 800.736.0594 www.adaptix.com
Specifications subject to change without notice. Prod Spec: UT0405

SC481-L

Collinear omni antenna, 10.5 dBd gain, low PIM, 694-960 MHz

- 10.5dBd gain, high null fill and 1.4:1 VSWR, providing excellent coverage
- -153dBc passive intermod performance reduces unwanted harmonic frequencies
- Designed to operate in extreme environmental conditions

Electrical Specifications

Frequency range	MHz	694 to 960
Gain	dBd (dBi)	10.5 (12.6)
Passive intermod. (2x20W, 3rd ord.)	dBc	-153
Pattern		omnidirectional
Input VSWR (max)		1.4:1
Polarization		vertical
Vertical beamwidth	degrees	5
Electrical tilt	degrees	0,2,4,6,8
Average power input (max)	W	500
Lightning protection		DC ground

Mechanical Specifications

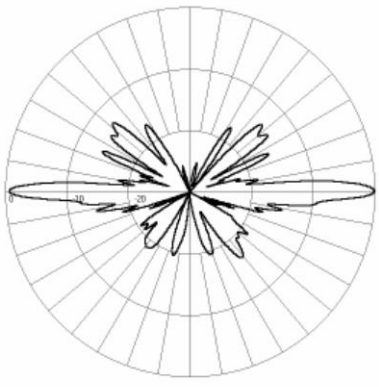
Length	in (mm)	194 (4928)
Depth	in (mm)	2.5 (64)
Width	in (mm)	2.5 (64)
Connector		7/16 DIN (female)
Weight	lbs (kg)	29 (13.2)
Mounting hardware		#130 clamp

Environmental Specifications

Rated wind velocity (no ice)	mph (km/h)	130 (209)
Rated wind velocity (1/2" radial ice)	mph (km/h)	100 (161)
Lateral thrust (100mph)	lbs (N)	78 (346.9)
Temperature range	°F (°C)	-40 to +140 (-40 to +60)

Ordering Information

Specify required operating frequency when ordering.

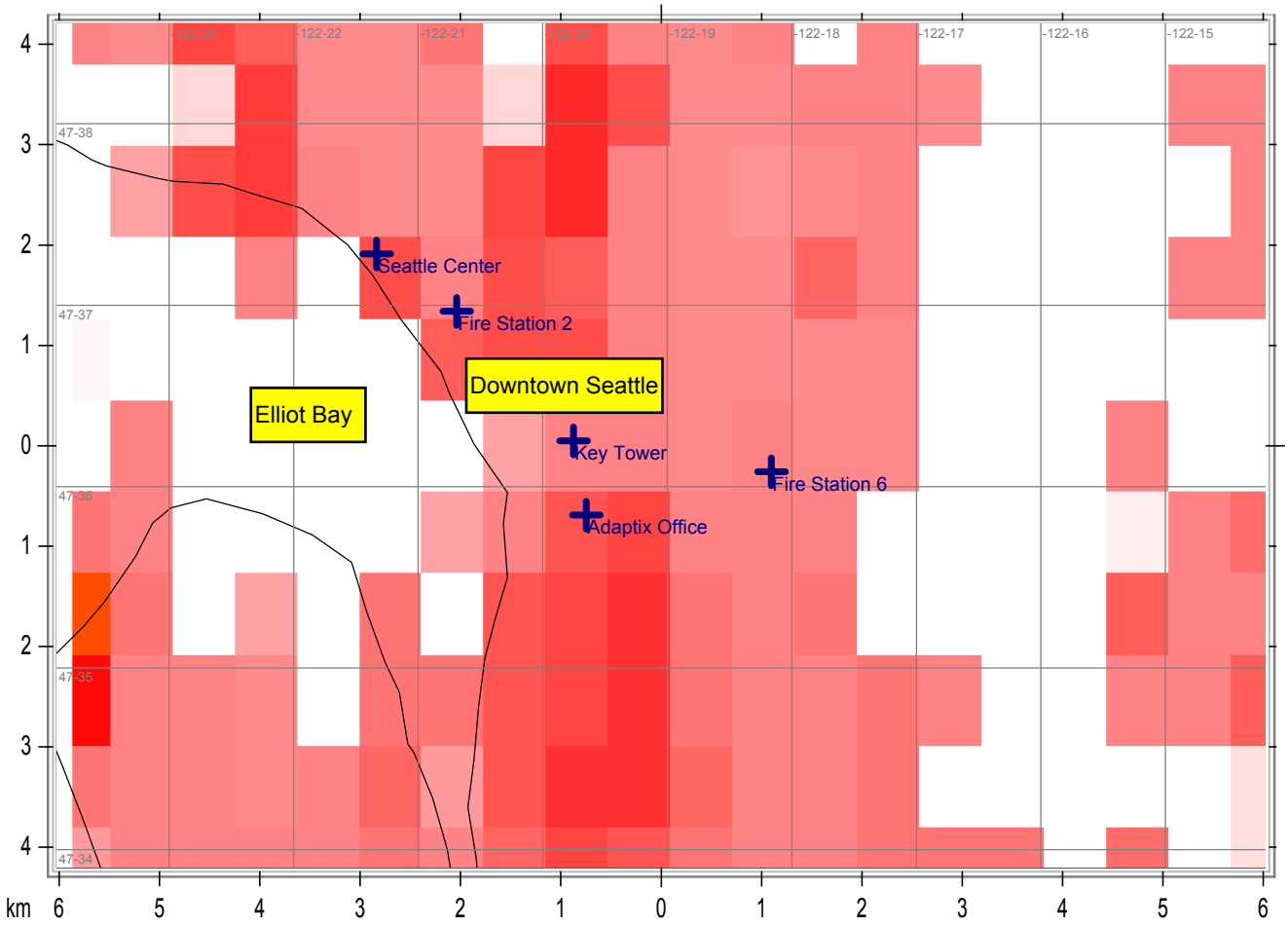


Elevation

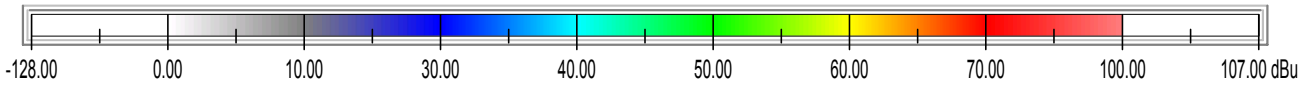
Region	United States, South & Central America	Europe, Middle East and Africa	Canada and rest of the world
Telephone	USA: 1 800 288 2763 International: +1 716 874 3682	International: +44 (0) 1223 42 03 03	Canada: 1 800 263 3238 International: +1 905 727 0165
E-mail	salesusa@sinctech.com	salesuk@sinctech.com	salescan@sinctech.com

APPENDIX 2
Figure 1 – Map Showing Proposed Transmitter Sites and KWOG Signal Power

KWOG-TV Field Strength Levels in Vicinity of Proposed Mobile Data System Transmitter Sites



Hatfield & Dawson Consulting Engineers



State Borders Lat/Lon Grid

Map Scale: 1:73330 1 cm = 0.73 km V|H Size: 8.41 x 12.04 km