SECTION 2

COVERAGE METHODOLOGY

PROJECT 25 SYSTEM UPGRADE 13 MAY 2015

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COVERAGE METHODOLOGY

2.1 COVERAGE OVERVIEW

Coverage Design

Motorola Solutions, Inc. (Motorola) has proposed a three-site linear simulcast system for the City of Fort Lauderdale (City). The site-specific data used in our design is shown in Table 2-1 through Table 2-4.

Table 2-1: RF site coordinates and tower/building heights

Site Name	Latitude	Longitude	Structure Type	Structure Height (feet)
PD	26° 07' 17.00" N	80° 09' 33.00" W	Tower	350
Utilities	26° 10' 35.00" N	80° 09' 24.00" W	Tower	200
Playa Del Sol	26° 10' 17.30" N	80° 05' 54.1.00" W	Building	280

Table 2-2: RF site transmission line and antenna data transmit parameters

Site Name	GTR 8000 Power (dBm)	Jumper and Splitter Loss (dB)	Combiner Loss (dB)	Main Line Loss (dB)	Antenna Gain TX/RX (dB)	Antenna Height TX/RX (feet)	TX Antenna Type	Antenna Azimuth (deg)	Effective Radiated Power (dBm)
PD East	50	-3.3	3.5	2.1	15	275	BCR-80015-3-25	90	53.6
PD West	50	-3.3	3.5	2.1	15	275	BCR-80015-5	270	56.1
Utilities East	50	-3.3	3.5	1.9	17	170	BCR-80017-3-25	90	58.3
Utilities West	50	-3.3	3.5	1.9	-12.3	170	BCR-80013-3-25	270	53.2
Playa Del Sol	50	-0.3	3.5	.8	13	280	BCR-80013-25	270	58.4

Table 2-3: RF site transmission line and antenna data receive parameters

Site Name	Jumper and Splitter Loss (dB)	Main Line Loss (dB)	Antenna Gain TX/RX (dB)	Antenna Height TX/RX (feet)	RX Antenna Type	Antenna Azimuth (deg)	Effective Receive Sensitivity (dBm)
PD	2	3.7	10	290	SC488-HF1SNF	0	-124.7
Utilities	2	2.4	10	170	SC488-HF1SNF	0	-124.5
Playa Del Sol	2	1.2	13	280	BCR-80013-25	270	-121.5

Table 2-4: Portable parameters – PSM with ¼-wave antenna

Parameter	Value
Model	XTS portable
RF Power	3 W
Configuration	Public Safety Microphone (PSM)
TX ERP	22.1 dBm
Effective Faded Receiver Sensitivity	-97.1 dBm
Antenna Type	¼-wave antenna
Tx Antenna Height	4.9 feet
Tx Antenna Placement	shoulder
Rx Antenna Height	4.9 feet
Rx Antenna Placement	Shoulder

Motorola's coverage guarantee is based on Map 30C in Section 2.3.4. The following details the configurations used for this coverage guarantee.

Three-site P25 FDMA linear simulcast system (round trip):
Portable using PSM with ¼-wave antenna inside 20 dB building for a service area reliability of 97%.

Table 2-5 lists coverage maps included in this proposal.

Table 2-5: Coverage maps provided

Map #	FDMA or TDMA	Talk-In/ Talk-Out/ Round Trip	Reliability (%)	Sub-Configuration	Coverage Type	DAQ	Mod
29CW	FDMA	ROUND TRIP (3 SITES)	97	Portable using PSM with ¼-wave antenna; shows coverage beyond service area.	20 dB building	3.0	LSM
30C	FDMA	ROUND TRIP	97	Portable using PSM with ¼-wave antenna; coverage bounded by service area.	20 dB building	3.0	LSM

2.2 COVERAGE PREDICTION METHOD

2.2.1 Hydra Overview

Hydra℠ is an innovative software tool developed by Motorola to accurately predict coverage, model traffic (voice and data), analyze interference, plan channel re-use, and perform other design tasks for our diverse portfolio of radio networks. This description concentrates on Hydra coverage planning aspects. Our solution presents typical Hydra coverage analysis for the City.

2.2.2 Hydra Development

Motorola's Hydra coverage prediction tool was developed to provide accurate coverage simulations by applying proven models to detailed system and environmental data across large geographical areas.

To create an accurate picture of the predicted radio coverage, many elements must be considered. Some of these elements, called system factors, are related to the system design parameters. System factors affecting coverage performance include frequency, distance, transmitter power, receiver sensitivity, antenna height, and antenna gain. Other factors, called environmental factors, vary according to the path taken by the radio signal and the environment surrounding the receiver. Environmental factors include terrain variations, obstructions, vegetation, buildings, ambient noise, and interference.

All coverage prediction methods try to account for both types of factors and incorporate them into a computational model. In general, the currently accepted models, such as Okumura, Longley-Rice, and TIA provide excellent portrayals of radio coverage when used within their respective ranges of applicability.

In the past, this level of analysis was adequate for the type of basic systems that were available. However, today's complex technologies, such as digital voice radios, packet data systems, or simulcast, require a much more in-depth analysis of the expected coverage performance to create a cost-effective design. This makes it necessary to select the appropriate coverage model, provide accurate representation of the environmental factors throughout the service area, and apply the coverage analysis method to every location within the service area.

Recognizing these facts, Motorola has developed Hydra, a multi-purpose network design tool that includes a coverage analysis program. Taking advantage of the knowledge gained from Motorola's many years of practical experience and coverage testing, Hydra provides a superior means for analyzing system coverage. This program, unique to Motorola, employs a technique of computing coverage on every tile in a service area rather than along a finite number of radials. Hydra computes "layers" of these tiles, with each layer containing the values of propagation model losses, coverage simulation results, or datasets. Layers can be displayed separately or in any combination as maps of the service area.

2.2.3 Hydra Detailed Description

Inputs and Outputs

Inputs to Hydra simulations include system architecture, equipment characteristics, service area boundaries, areas of various building losses, subscriber unit distribution density for traffic analysis, etc.

Hydra coverage map outputs are created and displayed using ESRI's shapefiles, an industry-standard GIS file format. Shapefiles from many sources (GIS vendors, the Internet, your own GIS department, etc.) can be loaded, displayed, and used in Hydra to enhance mapping, and to define service area polygons. Hydra coverage analyses can be limited to specified service area polygons (e.g., a county, a city, or a dispatch territory), so coverage reliability can be analyzed exclusively within the boundaries of your operating area.

In addition to showing coverage reliability, Hydra maps can display terrain, land cover, roads and boundaries, signal strength and field strength, interference predictions, etc.

Hydra provides closed-loop integration between predicting coverage and verifying coverage using Motorola's Voyager^{SM} coverage acceptance testing tool. Field survey measurements—signal strength, Bit Error Rate (BER), and Message Success for data—can be loaded into Hydra for analysis, display, and printing.

Tile Method

Hydra uniformly divides the entire geographical area to be analyzed into small, distinct areas called tiles. The resolution (size) of the tiles can be as fine as one arc-second (approximately 100 feet at U.S. latitudes). At each tile, Hydra models propagation from each site in the system.

The tile method is of particular importance in the calculation of simulcast coverage and interference analysis. Radial methods determine performance only at the locations where radials from all sites cross, leaving many areas where coverage performance is not calculated. With the tile method, the information from every site and all datasets is available in every tile; this provides the most accurate results for multi-site analyses (simulcast, voting, interference, best server, etc.).

Datasets

For propagation prediction, Hydra uses two types of geophysical datasets:

1. Hypsographic (terrain elevations) to determine shadow loss and elevation.
2. Morphological (land use) for environmental clutter loss.

With the proper datasets, Hydra produces accurate results. Because propagation prediction accuracy is directly dependent on the quality of the digitized datasets, Motorola uses high-quality datasets for its analyses. These datasets generally originate from official government agencies such as the U.S. Geological Survey in the United States, and equivalent governmental organizations worldwide. When datasets are not available from these sources, Motorola can work with commercial GIS vendors to produce Hydra-compatible datasets.

Even the best datasets contain a certain amount of errors, caused by a number of factors that are difficult to completely overcome due to the massive amount of data involved. Some examples follow:

- Source information – Older hypsographic and morphologic datasets were derived from existing map information, so any errors in the existing maps were carried over to the datasets. Newer datasets such as the U.S. National Land Cover Dataset (NLCD) are derived from satellite imagery, and are affected by digitization error.
- Dataset development process – Potential error sources include limitations in the digitizing algorithms, computer hardware problems, and judgment calls by the dataset developer.
- Dataset currency – Since the physical world is constantly changing, datasets can never be completely up-to-date. Over time, forests and shrub land are turned into farmland, hills are leveled, roads are built, communities are developed, and large buildings are constructed. Natural phenomena such as earthquakes, volcanoes, fires, storms, etc., change both the topography and environmental factors.

Hydra, like all terrain-based propagation tools, provides coverage predictions that are only as accurate as the available datasets permit. In the U.S., Motorola uses high-quality terrain and land cover data derived from USGS 30-meter DEM and NLCD sources.

Other datasets, which Hydra can use, include the following:

- Planimetric (mapping) – Roads, water features, political boundaries, feature names, etc.
- U.S. radio site locations – Coordinates of existing radio sites, including FCC wireless licenses, FCC antenna site registry, and some commercial site providers.
- U.S. frequencies – Potentially available channels in geographic areas, per FCC wireless licenses.

Propagation Model

For each tile, Hydra predicts signal strength using an improved algorithm based on the industry-accepted Okumura model.[1]

Coverage Reliability

Hydra coverage maps indicate the probability (usually referred to as reliability) of the radio system providing a minimum acceptable criterion, such as a voice Delivered Audio Quality (DAQ) or a data Message Success Rate (MSR). Since system coverage can never be 100% reliable, there will always be particular times and locations where the signal strength or Bit Error Rate (BER) does not meet that needed to reach the performance criterion. These locations of unsatisfactory performance are often predictable in a coverage study. However, there are also areas of unsatisfactory coverage that cannot be predicted due to unknown circumstances such as unusual structures, tree density, ambient noise, atmospheric conditions, dataset errors, and interference from co-channel or adjacent channel units operating outside their normal service area. *Because these conditions exist and signals fade due to these environmental and terrain factors, coverage must be described statistically in terms of a percentage of locations that exhibit the minimum acceptable criterion.*

Hydra predicts Area reliability, defined as the probability of achieving a specified performance criterion within a geographical area of interest. The area of interest is either the Covered Area (the painted area on a Hydra coverage map), or the entire Service Area.

[1] Okumura, Yoshihisa *et al*, "Field Strength and Its Variability in VHF and UHF Land-Mobile Radio Service", *Review of the Electrical Communication Laboratory*, 16(9-10), Sept-Oct 1968, pp 825-873.

To provide radio systems with acceptably few communications failures throughout the Covered Area, Motorola designs coverage at high Area reliabilities. The performance criterion is usually DAQ for voice or MSR for data. It is also important to note that locations outside of a Hydra map coverage area may still provide useable communications, even though such locations do not achieve the minimum acceptable performance.

2.2.4 Hydra Capabilities

Hydra provides detailed performance simulation of the following Motorola wireless network architectures:

- Voice coverage and traffic (Analog FM, ASTRO®, SECURENET™, etc.).
- ASTRO 25 Integrated Voice & Data (IV&D) coverage and traffic.
- Dimetra® coverage and voice traffic.
- High Performance Data (HPD).
- Long Term Evolution (LTE) data coverage.

If co-channel and/or adjacent-channel sites are known to exist, Hydra can model both Interfered and non-Interfered coverage.

Hydra frequency re-use planning analysis takes into account both co-channel and adjacent channel frequencies.

Voice Systems

Hydra coverage models use proven Okumura-based prediction methods and Monte Carlo simulation techniques to provide coverage reliability maps. Voice coverage models (Voice, Dimetra, and ASTRO 25) provide system-wide coverage maps, as well as subsystem maps (when applicable; e.g., for simulcast cells and receiver voting), and individual site maps.

Simulcast Coverage Performance

For a simulcast system, merely providing coverage maps of individual sites (separately or on the same map) does not accurately represent the total system performance, which depends upon differential delays and aggregate signal levels. Therefore, Motorola has developed the Hydra simulcast model that uses the delay spread methodology to simulate aggregate signal strength and audio phase angle (delay) throughout the entire predicted coverage area. All locations within the predicted coverage area are analyzed for the combined effect of signal strengths and differential delays from the simulcast transmitters in the system. Hydra simulcast coverage maps will show any areas predicted to have coverage problems caused by out-of-phase signals and/or inadequate signal strengths. Hydra allows modeling with varied transmitter launch delays to predict optimized simulcast coverage within the area being evaluated.

Data Systems (ASTRO 25 IV&D, HPD, and LTE)

Wireless data network performance is highly dependent on RF coverage reliability, network protocol, and network traffic load. Hydra accurately predicts the coverage and traffic performance of Motorola data systems by modeling the automatic protocol retry mechanisms of data protocols. Hydra integrates RF coverage prediction, network protocol modeling, and traffic engineering into a single simulation, and utilizes Monte Carlo simulations as well as discrete event simulation techniques to provide a tool that accurately predicts wireless network system performance.

Hydra uses the Okumura model for terrain-based propagation prediction, and adds the modeling of the protocol behavior (try-based coverage) via a detailed protocol simulation. Hydra models the relevant layers of the OSI protocol stack, from the physical layer of the air interface to the application layer of the host and subscriber entities.

Using this modeling approach, Hydra can account for all the elements that impede network performance, from packet loss on the wireless link due to co-channel interference, to packet latencies in the fixed end equipment introduced by protocol behavior. Hydra's modeling architecture allows true end-to-end system modeling.

Data Coverage

Hydra's data coverage model, through multiple iterations, displays the area that meets the MSR performance criterion requested by the user. The system-wide maps show the composite coverage from multiple sites, at the specified area reliability criterion and for the specified number of protocol tries.

Data Traffic

Hydra integrates coverage prediction into the traffic simulation, so the terrain and subscriber distribution effects on packet collisions and interference are modeled in the simulation. Traffic simulation results provide performance statistics for the RF station, radio channel, controller, and application(s). Hydra allows predicting the performance of the actual network topology as designed by the engineer.

2.2.5 Summary

Hydra is continually updated for the latest technologies by Motorola's Resource Development Engineering team, to create the most accurate and up-to-date coverage and traffic prediction tool. It is used extensively in the design and testing phases of Motorola's radio networks. Hydra provides accurate, easy-to-read maps of the predicted coverage for your radio system.

2.3 COVERAGE ACCEPTANCE TEST PLAN

2.3.1 Overview

This Coverage Acceptance Test Plan (CATP) is designed to verify that the voice radio system implemented by Motorola meets or exceeds the required coverage reliability within the City service area. The CATP defines the coverage testing method and procedure, the coverage acceptance criterion, the test documentation, and the responsibilities of both Motorola and the City.

Coverage acceptance testing is based upon a coverage prediction that accurately represents the implemented infrastructure and parameters consistent with the contract agreements. If the implemented system varies from the design parameters, a revised coverage map will be prepared. New test maps will reflect the measured losses and gains associated with the implemented infrastructure and subscribers. These will be used to define the test configuration and potential areas from which test locations may be included in the evaluation process.

The defined service area as outlined in this CATP is the City of Fort Lauderdale service area.

To verify that the radio service area reliability is met as presented, the City's service area will be divided into approximately 560 equally-sized test tiles for Coverage Map 30C (Figure 2-1).

Per customer's request, Motorola has defined the in-building loss factor to be 20 dB. Coverage Map 30C was used to create the CATP Grid Test Map to evaluate 97% area reliability for portable using PSM with ¼-wave antenna inside 20 dB building with DAQ 3.0 (Figure 2-1).

Table 2-6 details the service area reliabilities for the configuration being tested. The service area reliability is the percentage of test tiles that will pass within the service area with a specified CPC or DAQ. Motorola will perform CATP for the XTS portable using PSM with ¼-wave antenna inside 20 dB building.

Table 2-6: Predicted system coverage

Equipment Configuration	% Service Area Reliability for the City of Fort Lauderdale
XTS portable using PSM with ¼-wave antenna in 20 dB building	≥97% City's Service Area for DAQ 3.0

2.3.2 CATP Definitions

Several definitions are needed to accurately describe the coverage test method.

2.3.2.1 Coverage Area

The coverage area is the geographical region in which communications will be provided that meets or exceeds the specified CPC at the specified reliability for the specified equipment configurations. For portable using PSM with ¼-wave antennas inside 20 dB building with DAQ 3.0, the test grid map in Figure 2-1 will be used to evaluate coverage performance for 97% area reliability for both objective signal strength test and subjective audio test.

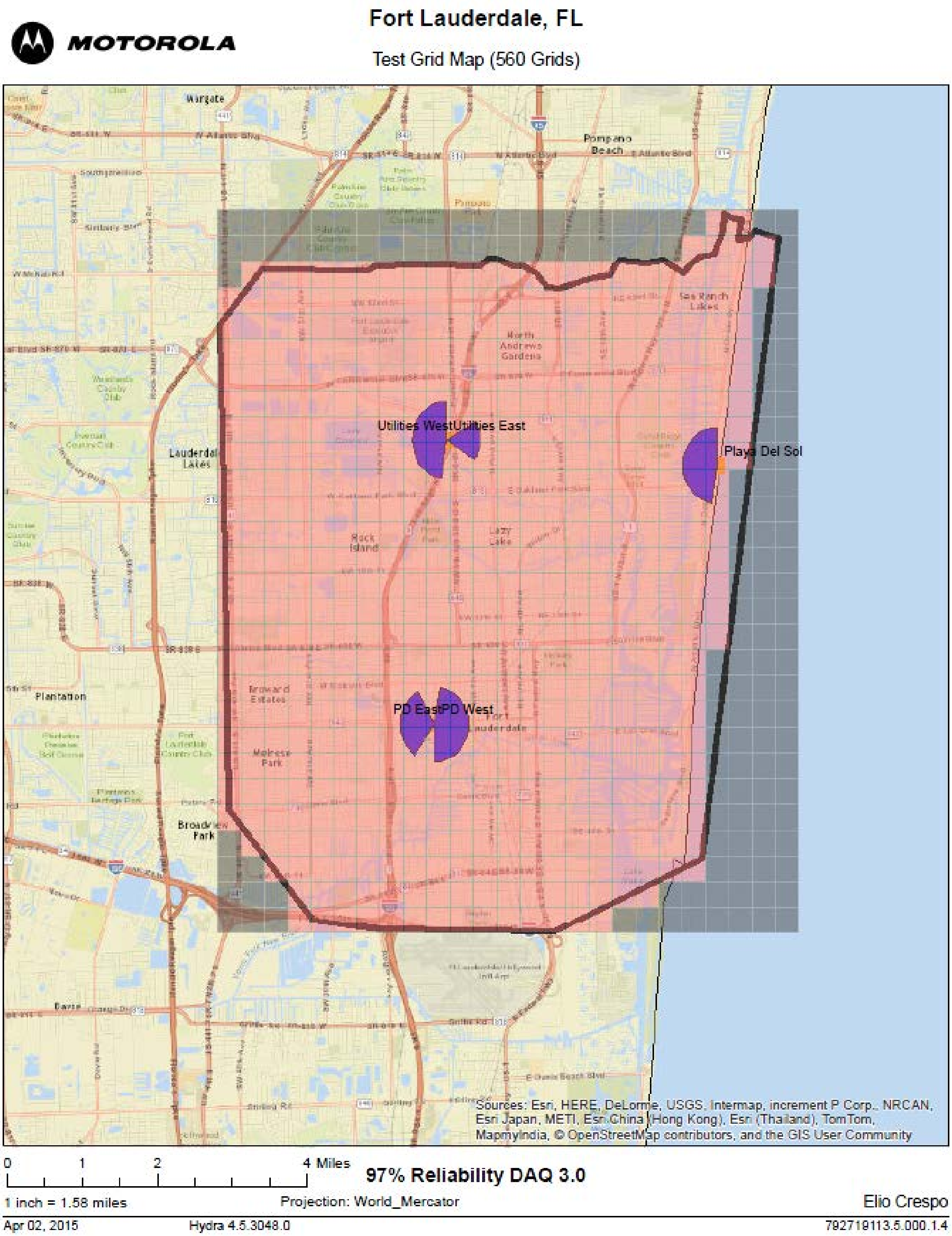

Figure 2-1: Portable testing inside 20 dB building for 97% area reliability

2.3.2.2 Reliability

Reliability is the percentage of locations within the coverage area that meet or exceed the specified CPC. Coverage Map 30C indicates the area within which this system is predicted to provide at least 97% reliability for portable using PSM with ¼-wave antenna inside 20 dB buildings with a DAQ 3.0.

2.3.2.3 Channel Performance Criterion

CPC is the specified minimum design performance level in a faded channel. For this CATP, the CPC is DAQ 3.0 for portables inside 20 dB building. The DAQ definitions are provided in Table 2-7.

Table 2-7: DAQ definitions

DAQ	Faded Subjective Performance Description
1	Unusable, speech present but unreadable.
2	Understandable with considerable effort. Frequent repetition due to noise/distortion.
3	Speech understandable with slight effort. Occasional repetition required due to noise/distortion.
3.4	Speech understandable with repetition only rarely required. Some noise/distortion.
4	Speech easily understood. Occasional noise/distortion.
4.5	Speech easily understood. Infrequent noise/distortion.
5	Speech easily understood.

2.3.2.4 Service Area Reliability

The service area reliability is the percentage of test tiles that will pass within the service area with a specified CPC or DAQ. The service area reliability is noted in the header of Table 2-6 and meets the requirements of the proposed coverage.

The defined service area is outlined in this CATP as per the City of Fort Lauderdale. The outline of this service area is depicted on each coverage map. Motorola has indicated the CPC Service Area Reliability of this area in Table 2-6 of this document for the losses detailed in this proposal. Although the coverage maps do not guarantee coverage within a specific location, they do indicate the ability of the system to overcome the expected losses of these buildings.

2.3.2.5 Equipment Configurations

There is one configuration for the field unit equipment or subscriber upon which coverage acceptance is based. Motorola's coverage map for this system indicates the coverage area for a three-watt portable with PSM using ¼-wave antenna.

The proposed P25, three-site linear simulcast design supports this configuration.

In-Building Coverage

Motorola's coverage maps for portable in-building equipment configurations are predictions of coverage inside 20 dB loss buildings. Since building loss varies significantly depending on the construction of buildings, Motorola's coverage maps do not predict coverage within any specific building, but rather, the in-building coverage maps indicate the area within which this system is predicted to provide the percentage reliability of meeting or exceeding the CPC of DAQ 3.0.

2.3.3 CATP Method

The method used to test coverage is statistical sampling of the predicted coverage area to verify that the CPC is met or exceeded at the required reliability for the defined equipment configuration. It is impossible to verify every point within a coverage area, because there are infinite points; therefore, coverage reliability will be verified by sampling a statistically significant number of randomly selected locations, quasi-uniformly distributed throughout the predicted coverage area.

This CATP provides an objective, quantitative method of measurement using Motorola's Voyager software in conjunction with an XTS portable radio for location reference, signal strength measurements, and recording.

The CATP also provides a subjective audio quality test by using actual equipment configured as it will be used in the system.

If a coverage test, or a portion thereof, is suspected by Motorola to have failed due to external interference, those tiles suspected of being affected by an interferer may be retested. If the tiles (or test points) retested are confirmed to have failed due to interference, those tiles (or test points), including test points that have marginally passed, will be excluded from all acceptance calculations and Motorola will work with the City to identify potential solutions to the interference issues.

If a coverage test, or a portion thereof, is suspected by Motorola to have failed due to the system malfunctioning and being in need of repair, those tiles (or test points), including test points that have marginally passed, suspected of being affected by this may be retested. The coverage testing will be stopped until the repairs are made. After the repairs are made, Motorola will retest only the tiles (or test points) that failed due to the system malfunctioning and being in need of repair.

Determine the Required Number of Test Tiles in the Coverage Area

The predicted coverage area shown on Motorola's coverage maps and service area will be divided into a tile pattern to produce at least the number of uniformly sized test locations (or tiles) required by the Estimate of Proportions formula {TSB-88B, sub clause 8.2.1, equation 64}. The minimum number of test tiles required varies for different systems, from a hundred to many thousands, depending on the size of the service area, desired confidence in results, type of coverage test, and the predicted versus required reliability. Motorola's Hydra coverage modeling tool calculates the required test tiles as described.

Constraints on Test Tile Sizes

The minimum tile size is 100 by 100 wavelengths; however, the minimum practical test tile size is typically about 400 by 400 meters (about 0.25 by 0.25 miles). The minimum practical tile size for any system is determined by the distance traveled at the speed of the test vehicle while sampling, GPS error margin, and availability of road access within very small test tiles. A related consideration is the time, resources, and cost involved in testing very large numbers of very small tiles. The maximum test tile size is 2 by 2 km (1.25 by 1.25 miles). In some wide-area systems, this constraint on maximum tile size may dictate a greater number of test tiles than the minimum number required by the Estimate of Proportions formula. This CATP will be performed for test tile size of approximately 0.25 by 0.25 miles.

Accessibility to Test Tiles

Prior to testing (if possible) or during the test, Motorola and the City will determine whether any test tiles are inaccessible for the coverage test (due to lack of roads, restricted land, etc.). Motorola expects to test all test tiles within the service area and expects the City to provide access to all test tiles that require other than a standard four-wheel drive vehicle. If the City cannot provide access, inaccessible tiles with predicted coverage will be counted as a pass for the acceptance test calculation.

Randomly Select a Test Location within Each Tile

Using Voyager, the actual test location within each test tile will be randomly selected by the test vehicle crossing into the tile at an arbitrary point, with an arbitrary speed and direction. This will be the queue for the objective sampling test to begin.

Perform Subjective Voice Quality Test in Each Tile

A subjective voice quality test will be performed in each tile to determine if the inbound and outbound voice quality passes or fails the CPC for DAQ 3.0 as defined in Table 2-7. The results of the subjective voice quality test will determine the final pass/fail criterion for the Coverage Acceptance Test Procedure (CATP).

After all accessible tiles in the coverage area have been tested; the coverage area reliability (percentage) will be determined by dividing the number of tiles that pass by the total number of tiles tested for subjective voice quality result. The total number of tiles is defined as the summation of the tiles tested in the City of Fort Lauderdale service area. The coverage test acceptance criterion for each equipment configuration is that the tested coverage area reliability must be equal to or greater than the required reliability as shown in Table 2-6.

Perform Objective Signal Strength Test Measurements in Each Tile

In each test tile, a series of 200 or more sequential SSI measurements (sub-samples) will be made. This test location measurement, containing a number of sub-samples, constitutes the test sample for this location. The test sample will establish the local mean and median SSI within the test tile. With this measurement, the required target SSI can be extrapolated for each configuration and loss required. The distance over which the sub-samples are measured will be 40 wavelengths. A mean or median of multiple SSI sub-samples is used rather than a single measurement to ensure that the measurement is not biased by taking a single sample that might be at a peak or null point on the radio wave.

The results of the objective signal strength test will be for informational purposes only.

Objective Signal Strength Test Pass/Fail Target Value

For each test tile, the pass/fail criterion for the objective target signal strength test that indicates the specified DAQ 3.0 shown in Table 2-8. To simulate losses of buildings, the loss is simply extrapolated from the measured faded SSI. The target faded SSI is the actual signal level as measured by the test radio at the input connector.

Table 2-8: Net target signal strength indication – portable using PSM

Objective Test	Portable Faded Sensitivity (dBm) DAQ 3.0	Portable Faded Target SSI (dBm) DAQ 3.0	Adjustments for Mobile Antenna Loss/Gain, Portable Antenna & Building Loss (dB)
Large building (20 dB)	-109.9	-81.4	-28.5 (-12.7[2]-20.0+4.2[3])

[2] The -12.7 dB is the antenna loss figure for the ¼-wave antenna on a XTS portable public speaker microphone and standard battery.
[3] The +4.2 dB is the mobile antenna and transmission line that a portable does not have and thus must be added back to get the signal at the input to the test radio.

2.3.4 Responsibilities and Preparation

This information will help set the expectations of the City and Motorola regarding requirements for equipment, personnel, and time during the coverage test.

The City will provide the following for the duration of the coverage test:

- Two test teams are required. Team #1 will be a field team and Team #2 will be a dispatch team.
  - Team #1 will consist of at least one City representatives and one Motorola representative.
  - Team #2 will consist of at least one City representative and one Motorola representative.
- One vehicles for the duration of the test.

Motorola will provide the following for the duration of the coverage test:

- One Motorola representative to operate one Voyager kit.
- Setup subjective voice quality test per Figure 2-2.
- Setup objective signal strength test using voyager kit per Figure 2-2.
- One calibrated Motorola Voyager coverage testing package.
- Two test radios for each field team member (will use calibrated subscribers).

Coverage acceptance testing will be performed within the borders of the City's service area. Motorola has determined the minimum number of test tiles required, as described in Section 2.3.1 of this CATP. Motorola and the City will plan the route for the test vehicles through the coverage test area, to ensure that at least the minimum required number of tiles is tested. If possible, any tiles not accessible to the test vehicles will be identified while planning the route.

Motorola will calibrate the test radios (standard XTS portables) used with the Voyager coverage-testing package. This can be done at an independent testing lab or facility using their calibrated signal generating equipment. Depending on the system, either Motorola or the City may provide the test radios.

Motorola will conduct this test only once. If any portion of the test is determined to be unreliable because of proven equipment malfunctions or failures, Motorola will repeat the portion of the test affected by the equipment malfunction or failure, including test points that have marginally passed. The City will have the option to accept the coverage at any time prior to completion of the coverage test.

Before starting the test, the City and Motorola will agree upon the time frame for Motorola's submission of a report containing the coverage test results.

2.3.5 CATP Procedures

Subjective Voice Quality Testing

A subjective voice quality test will be performed for coverage acceptance testing to verify talk-out and talk-in for the required DAQ 3.0 performance. The Subjective Voice Quality Testing will be performed in parallel of the Objective Signal Strength Test.

The procedure for the subjective DAQ coverage test will be as follows:

- To perform a statistically valid subjective DAQ test, a large group of people is required to ensure high confidence in the results. However, obtaining a large group of people for a subjective listening test is usually impractical; therefore, a smaller group must be used for the test which makes it very important that the personnel participating in the subjective test be familiar with the sound of radio conversations.
- The test participants will be divided into two teams: the Field Team and the Dispatch Team.
- Each team will have a representative from the City and a representative from Motorola.
- The field team will have members that operate a portable unit configured per Figure 2-2.
- As the field test team(s) drive through the coverage area, test locations within each tile will be selected randomly by Voyager that will be conducting the objective SSI testing. The voice subjective test may begin after the sampling is complete. This is to prevent any degradation to the receiver sampling the SSI.
- The field team will initiate a call and identify the test location by the current x-y tile number. A test count "1, 2, 3, 4, 5" will be provided to Dispatch Team. The dispatch test team will then log the test location and determine if the voice test passes or fails per the DAQ criteria as defined in Table 2-8 and makes note of the result. The dispatch team will then respond with a test count "Test 1, 2, 3, 4, 5" back to the field team who, in turn, will make similar determination and recording of the result.

The tile pass/fail evaluations will be used to determine the coverage area reliability of the defined coverage areas in Table 2-8.

- If any test point should fail, the test team will move three feet and perform another test in the same manner.
- A test point result is considered a "pass" only if both the inbound and outbound tests are each a "pass".
- Motorola reserves the right to review any test tiles that fail the subjective DAQ tests.

Objective Signal Strength Testing Measurements

The Motorola Voyager coverage test setup consists of the following:

- A calibrated digital voice test radio, connected to an antenna installed in a representative location on the test vehicle. The test radio will monitor sequential transmissions within each grid from the fixed network radio site(s).
- A laptop computer with Voyager software and a mapping database, which includes highways and local streets, political boundaries, rivers, and railroads.
- A Global Positioning System (GPS) receiver, which will provide the computer with the location and speed of the test vehicle.

Objective BER and SSI Testing and Subjective Voice Quality Testing

Both the subjective and objective testing as described will be performed at the same time but will be evaluated independently of each other. A failed tile for the objective test does not constitute a failure for the subjective testing. The reason for this is that the points are taken at different times (thus at different locations). The modeling does not predict the probability of one location against the other but predicts area reliability of all test points for each test. Final pass/fail analysis is based on the subjective voice test and the BER and Objective SSI Testing results are for information only.

2.3.6 CATP Documentation and Coverage Acceptance

During the coverage acceptance test, Voyager generates computer files that include the mean and median SSI for each test tile. It also generates a raw file that has the multiple samples for each test point taken. A copy of this raw data will be provided to the City at any time.

Motorola will process this data to determine whether the coverage test was passed for the equipment configurations and to produce a map that graphically displays the statistical coverage test results along with the analyzed numbers of the passes and failures.

Motorola will submit to the City a report detailing the coverage test results. This report will include a document, which is to be signed by both the City and Motorola, indicating the test was performed in accordance with this CATP and the results of the test indicate the acceptance or non-acceptance of the coverage portion of the system. The City will have the option to accept the coverage at any time prior to completion of the coverage test or documentation process.

2.4 COVERAGE MAPS

The coverage maps referenced in Section 2.1 are provided at the end of this section.

2.5 CATP CONFIGURATION DRAWING

The CATP configuration drawing is provided below (Figure 2-2).

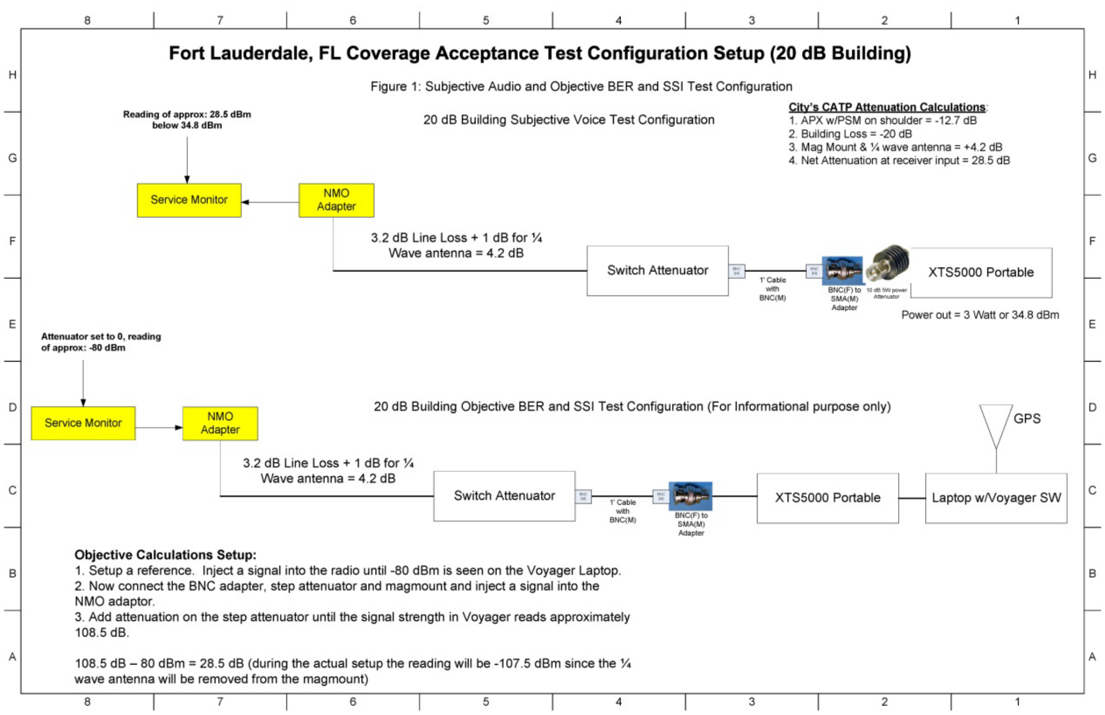

Figure 2-2: Subjective audio test configuration