

System Integration – Statement of Work

1.14 FREQUENCY PLANNING (MOD. #2 REV.)

Motorola will provide initial system design work, which will include professional services to develop a Frequency Plan for all of the STARS wireless networks identified in this Contract. This includes the Land Mobile Radio (LMR) Integrated Voice and Data (IV&D) Network and the microwave network. The frequency-planning effort for the LMR network includes the identification of additional channels from the existing pools for any given transmitter site, as well as specialized subscriber components such as 700/800 MHz Vehicular Repeater System; 700/800 MHz, VHF, and microwave transportable sites; subscriber communications outside the infrastructure (tactical channels); and tunnels.

The LMR frequency planning process will consist of six (6) iterative steps leading up to the Frequency Plan. Motorola will provide, if required, additional Tuning as the system is implemented due to unpredictable events that may occur. "Tuning" means changing the field-settable adjustments to the frequency-specific components on installed Radio Frequency (RF) equipment inside equipment shelters. Motorola field technicians may make these adjustments by physically changing turn-screw settings to field-tunable transmitter combiners, receiver multicouplers, or filtering devices. Motorola may also make these adjustments by changing software parameters using field-service programming tools for equipment such as the Quantar repeaters.

Throughout the process, Motorola will reevaluate its design assumptions including, where new or additional use of Radio Frequency multiplexing equipment (such as transmitter combiners, receiver multicouplers and filtering devices) may allow use of frequencies that would not be available for use under previous assumptions. A cost-versus-benefit analysis will be completed by Motorola and provided to the Commonwealth for review. The implementation of these additional frequencies will be based upon the technical and cost/benefit analyses and will be mutually agreed to by both STARS and Motorola and incorporated into a Change Order. Should the need for additional frequencies occur, the responsibility of each party follows:

- Under the Spectrum Agreement between the parties, Motorola agreed to deliver certain channel pair frequencies for the STARS project. If it is determined that any of channel pair frequencies defined in the Spectrum Agreement cannot be used, Motorola will pay for the costs associated with new or substitute Radio Frequency multiplexing equipment required by the additional frequencies.
- If the Commonwealth is unable to clear spectrum that it licensed prior to this Contract, which requires Motorola to secure additional frequencies, the Commonwealth will pay for the costs associated with securing additional frequencies and the costs associated with



new or substitute Radio Frequency multiplexing equipment required by the additional frequencies.

- Spectrum available from the Commonwealth for Motorola's consideration is listed in Attachment #1, which is attached hereto and incorporated herein. Motorola and the Commonwealth will mutually determine an individual frequency's availability through its migration planning on a per site basis.
- If Motorola's Frequency Plan design improperly assigns spectrum to a Site, Motorola will redesign the Frequency Plan to properly assign frequencies and pay for the costs associated with the redesign and any new or substitute Radio Frequency multiplexing equipment required by the redesign. Assignment of frequencies will include selection of frequencies, which meet the values provided in Coverage Summary Reports of the Contract Appendix 15.

The goal of frequency planning is to populate all sites with the necessary number of optimal channels, as defined in this Contract and in the parties Spectrum Contract, as early as possible in the process. However, until all sites are populated with all their frequencies, then the frequency search and acquisition process will remain as an ongoing task in all six steps.

The following are the steps required to achieve the statewide Frequency Plan:

- First Draft for STARS Division 1
- Second Draft for STARS Division 1
- Third Draft for STARS Division 1
- First Draft for STARS Divisions 2-7
- Second Draft for STARS Divisions 2-7
- Third Draft for STARS Divisions 2-7
- Frequency Plan for STARS Divisions 1-7

As frequency planning is an iterative process, it requires three cycles of draft plans before the Frequency Plan is ready for submission. As such, the term "Draft," is defined as Frequency Plan documentation containing the "then current" analysis and assignment of frequencies to the respective equipment categories. First and Second Draft documentation may include some frequency assignments as "To Be Determined" (TBD) or "Future Channel Not Yet Assigned," depending on the pool of qualified frequencies available at that time to populate the Frequency Plan. To facilitate communicating the current pool of qualified frequencies, Motorola will provide STARS an updated pool of current qualified frequencies each time a substantial number of frequencies are added or deleted from the pool to ensure all parties are aware of ongoing changes throughout the iterative process. The Commonwealth of Virginia will review the result of Motorola's frequency searches to help determine when the Commonwealth agencies' frequencies may be assigned and placed into service on STARS. This also includes determining which locality frequencies may be pursued for use on STARS. After the Third Draft Division 1 Plan, any changes beyond those that are mutually agreed to by both STARS and Motorola will be at Motorola's expense.



First Draft for STARS Division 1

A frequency reuse study will be performed by Motorola for the entire Commonwealth to determine the required number of channel reuse sets. A revised pool of frequencies will be developed from existing frequencies currently licensed by the Commonwealth of Virginia and identified by STARS for use in this project, along with available frequencies identified by Motorola from FCC Part 90 searches and additional frequencies purchased by the Commonwealth. These frequencies will be evaluated as to their use and reuse capabilities serving the STARS Division 1 LMR sites. The frequencies from the available pool will be grouped as channel pairs and assigned to sites referencing the reuse pattern as needed. Motorola will perform frequency searches and associated paper-study predictions to determine the best frequency-reuse strategy and allocate which specific frequency pairs are to be used at designated tower, vehicle, and transportable sites. Motorola will seek additional spectrum (all bands being used) as available/required and prepare the necessary documentation to license the radio frequencies. Interference-prediction studies are then performed on the allocated channels at each site to determine if the new frequency pairings will operate properly at each site. The studies will qualify all frequencies whether new, future, or existing at each site. If issues are identified, then the frequency pairings will be reallocated and reexamined for interference.

Additional interference considerations include, but are not limited to, the following:

- Environmental noise and terrain influences
- Co-channel frequencies (including LMR licensees and coordinated applicants, in any radio service, within 70 miles of Virginia land areas or navigable waterways, as well as any plan-proposed use)
- Adjacent-channel frequencies (including LMR licensees and coordinated applicants, in any radio service, within 35 miles of Virginia land areas or navigable waterways, as well as any plan-proposed use)
- Transmitter noise and receiver desensitization (desense)
- Intermodulation
- Electromagnetic Compatibility
 - Spurious, image responses
 - Harmonic relationships

Spectrum utilized at each site for locality and agency interfaces, legacy radio systems, and other co-located transmitters such as commercial wireless services will be considered in the interference prediction studies.

The output of the above analysis will comprise part of a First Draft Frequency Plan. As stated earlier in this section, this draft may not show all frequencies allocated at all sites. Motorola will provide a feasible First Draft Frequency Plan, based upon the system design as detailed in this Contract, with enough technical analysis including the current pool of qualified frequencies



considered in the plan to allow a detailed review by the Commonwealth. The plan will also be in accordance with the Spectrum Contract with Motorola. The Commonwealth will provide comments to Motorola on the First Draft Frequency Plan.

Second Draft for STARS Division 1

If all sites serving Division 1 are not populated fully with channel assignments, Motorola will conduct additional frequency searches in both the public safety and commercial bands. Allocated frequency pairings requiring frequency coordination will be identified.

Each available tower site will be monitored with appropriate equipment, including spectrum analyzers to establish an in-field baseline measurement of fixed and mobile transmit or receive frequencies for each of the following items:

- Peak and Average Environmental noise floor within each potential range of frequencies (i.e. evaluate each band or sub-band)
- Co-channel interference
- Adjacent channel interference
- Transmitter noise (which would cause receiver desense)
- Intermodulation interference

The information gathered from these in-field RF baseline measurements is the spectrum fingerprint and will be documented and utilized to determine the usability of frequency combinations at the sites. All data will be provided in raw and analyzed form, with date, time, and level information for recorded/measured interference. This will determine whether substitutions or other adjustments are needed in order to revise the First Draft Frequency Plan. The output will be the Second Draft Division 1 Frequency Plan, including frequency coordination requirements, Maximum Permissible Exposure (MPE) data for Motorola-provided STARS equipment, and any other technical details or parameters required to complete any necessary FCC license applications or license modifications and ensure compliance with FCC regulations.

Motorola will prepare the necessary documentation to license the radio frequencies assigned in this plan. Should new frequencies be assigned to repeater channels at a given site, Motorola will perform and provide additional interference-prediction studies to account for the newly allocated channels at each affected site. This will determine whether the new frequency pairings will operate properly at each site. The studies will qualify all frequencies whether new, future, or existing at each site. If issues are identified, then the frequency pairings will be reallocated and reexamined for interference. Motorola will provide a feasible revised Second Draft Frequency Plan, consistent with the system design as detailed in this Contract, with enough technical analysis including the current pool of qualified frequencies considered in the plan to allow a detailed review by the Commonwealth. Motorola will also provide revisions of its coverage and Grades of Service performance guarantees for the Commonwealth's concurrence and provide justification for each change. The Commonwealth will provide comments to Motorola on the Second Draft Frequency Plan.



For those Commonwealth agencies and localities encumbering state frequencies, the Commonwealth has agreed to migrate these users to STARS' frequencies and release those agencies' frequencies to STARS, based upon a schedule to be mutually agreed upon by the parties. If the Commonwealth does not migrate these agencies or users according to this schedule, Motorola is not responsible for its inability to meet Grades of Service requirements due to the inability to use a state agency's frequencies. The Commonwealth will not withhold or delay its approval of Acceptance Testing, Coverage Acceptance Testing, Division Acceptance, Final System Acceptance, nor any payments due Motorola according to the terms of the Contract, based solely upon any problems associated, either directly or indirectly, with the migration delay. Affected test procedures will be modified prior to their commencement to reflect any needed changes due to migration issues. Once the frequency migration is complete, Motorola will meet the Grades of Service as required by this Contract.

Third Draft for STARS Division 1

The Third Draft Division 1 Frequency Plan is based upon the actual radio frequency authorizations received. To prevent interference complaints by incumbent locality/agency license holders when STARS activates the Commonwealth-licensed frequencies, Motorola will develop and submit to STARS a prioritized list of incumbents to be contacted by the Commonwealth. The Commonwealth agrees to contact the identified incumbents based upon the prioritized list provided by Motorola. The Commonwealth will provide Motorola with progress reports on the status of its discussions with incumbents at the parties' frequency planning meetings. STARS will be responsible for conducting all discussions with incumbents already operating on licenses, which may experience interference from those call signs the Commonwealth licensed unilaterally for use on STARS. In a separate, parallel activity, Motorola will develop and submit to STARS a prioritized list of localities/agencies identified by Motorola to join STARS by transferring assignment of their FCC licenses to the Commonwealth for use on STARS. The Commonwealth will be responsible for conducting all negotiations with these localities/agencies for FCC license transfers to STARS. This effort will only be used to enhance the existing feasible Frequency Plan and to mitigate potential interference. The Commonwealth will then contact the localities/agencies and determine which will be joining STARS. Motorola will provide an impact analysis to include adding a locality/agency to STARS and to include those bringing spectrum, those voiding interference spectrum, or those wishing to join the system without spectrum. Based upon the Commonwealth's determination of which new users will be joining STARS, Motorola will verify if the original guaranteed Grades of Service are maintained or Motorola may draft revisions for the Commonwealth's concurrence and provide justification for each recommended change. Motorola will provide to the Commonwealth for review the Third Draft Division 1 channel plan, supporting documentation, and field measurements. Division 1 Frequency Plan will be the channels implemented in the Richmond area in December 2005 for the IV&D, Microwave, and Transportable Site networks. Motorola will prepare the necessary documentation, including Special Temporary Authorizations, to license any additional radio frequencies assigned as a result of this plan. With this Third Draft Division 1 Frequency Plan, Motorola will provide a status report regarding the progress toward the Division 2-7 plan. This status will include a First Draft Division 2-7 Frequency Plan.



First Draft for STARS Divisions 2-7

A frequency reuse study will be performed by Motorola for the entire Commonwealth to determine the required number of channel reuse sets. A revised and updated pool of frequencies will be developed from existing frequencies currently licensed by the Commonwealth of Virginia and identified by STARS for use in this project. This pool of frequencies will include available frequencies identified from FCC searches (public safety and commercial) and additional frequencies purchased by the Commonwealth. These frequencies will be re-evaluated as to their use and reuse capabilities at the STARS Divisions 2-7 LMR sites. The frequencies from the available pool will be grouped as channel pairs and assigned to sites referencing the reuse pattern as needed.

Motorola will perform frequency searches and associated paper-study predictions to determine the best frequency-reuse strategy and allocate which specific frequency pairs are to be used at designated tower, vehicle, and transportable sites. Motorola will seek additional spectrum (all bands being used) as available/required and prepare the necessary documentation to license the radio frequencies. Motorola will perform and provide interference-prediction studies to account for the channels allocated at each affected site. This will help to determine whether the new frequency pairings will operate properly at each site. The studies will qualify all frequencies whether new, future, or existing at each site. If issues are determined, then the frequency pairings will be reallocated and reexamined for interference consistent with the process used for Division 1.

Additional interference considerations include, but are not limited to, the following:

- Environmental noise and terrain influences
- Co-channel frequencies (including LMR licensees and coordinated applicants, in any radio service, within 70 miles of Virginia land areas or navigable waterways, as well as any plan-proposed use)
- Adjacent-channel frequencies (including LMR licensees and coordinated applicants, in any radio service, within 35 miles of Virginia land areas or navigable waterways, as well as any plan-proposed use)
- Transmitter noise and receiver desensitization (desense)
- Intermodulation
- Electromagnetic Compatibility
 - Spurious, image responses
 - Harmonic relationships

Spectrum utilized at each site for locality and agency interfaces, legacy radio systems, and other co-located transmitters such as commercial wireless services will be considered in the interference predication studies.

The output of the above analysis will comprise part of a First Draft Frequency Plan for Divisions 2-7. As stated earlier in this section, this draft may not show all frequencies allocated at all sites.



Motorola will provide a feasible First Draft Frequency Plan, based upon the system design, as detailed in this Contract, to include sufficient technical analysis, including the current pool of qualified frequencies considered in the plan, to allow for a detailed review by the Commonwealth. The plan will also be in accordance with the Spectrum Contract with Motorola. The Commonwealth will provide comments to Motorola on the First Draft Frequency Plan.

Second Draft for STARS Divisions 2-7

If all sites in Divisions 2-7 are not fully populated with channel assignments, Motorola will conduct additional frequency searches. Allocated frequency pairings requiring frequency coordination will be identified in this plan.

Each available tower site will be monitored with appropriate equipment, including spectrum analyzers, to establish an in-field baseline measurement of fixed and mobile transmit or receive frequencies for each of the following items:

- Peak and Average Environmental noise floor within each potential range of frequencies (i.e., evaluate each band or sub-band)
- Co-channel interference
- Adjacent channel interference
- Transmitter noise (which would cause receiver desense)
- Intermodulation interference

The information gathered from these in-field RF baseline measurements is the spectrum fingerprint and will be documented and utilized to determine the usability of frequency combinations at the sites. All data will be provided in raw and analyzed form, with date, time, and level information for recorded/measured interference. This will determine whether substitutions or other adjustments are needed to revise the First Draft Frequency Plan. The output will be the Second Draft Division 2-7 Frequency Plan, including frequency coordination requirements, National Radio Astronomy Observatory (NRAO) limitations, maximum permissible exposure (MPE) data for Motorola-provided STARS equipment, and any other technical details or parameters required to complete any necessary FCC license applications or license modifications and ensure compliance with FCC regulations.

Motorola will prepare the necessary documentation to license the radio frequencies assigned in this plan. Should new frequencies be assigned to repeater channels at a given site, Motorola will perform and provide additional interference-prediction studies to account for the newly allocated channels at each affected site. This will help to determine whether the new frequency pairings will operate properly at each site. The studies will qualify all frequencies whether new, future, or existing at each site. If issues are determined, then the frequency pairings will be reallocated and reexamined for interference. Motorola will provide a feasible revised draft Frequency Plan, consistent with the system design as detailed in this Contract, to include sufficient technical analysis, including the current pool of qualified frequencies considered in the plan, to allow a detailed review by the Commonwealth. Motorola will confirm that Performance Guarantee Design Assumptions have been met, as detailed in Section 4 of the Contract. This will be



confirmed by combiner/multicoupler manufacturer detail design information. Motorola will also provide revisions of its coverage and Grades of Service performance guarantees for the Commonwealth's concurrence and provide justification for each change.

To prevent interference complaints by incumbent locality/agency license holders when STARS activates the Commonwealth-licensed frequencies, Motorola will develop and submit to STARS a prioritized list of incumbents to be contacted by the Commonwealth. The Commonwealth agrees to contact the identified incumbents based upon the prioritized list provided by Motorola. The Commonwealth will provide Motorola with progress reports on the status of its discussions with incumbents at the parties' frequency planning meetings. STARS will be responsible for conducting all discussions with incumbents already operating on licenses, which may experience interference from those call signs the Commonwealth licensed unilaterally for use on STARS. In a separate, parallel activity, Motorola will develop and submit to STARS a prioritized list of localities/agencies identified by Motorola to join STARS by transferring assignment of their FCC licenses to the Commonwealth for use on STARS. The Commonwealth will be responsible for conducting all negotiations with these localities/agencies for FCC license transfers to STARS. This effort will only be used to enhance the existing feasible Frequency Plan and to mitigate potential interference. Motorola will consider both under-utilized spectrum and co- and adjacent-licenses. The Commonwealth will then contact the localities/agencies and determine which ones will be partnering/joining STARS. Motorola will provide an impact analysis to include adding a locality/agency to STARS and to include those bringing spectrum, those voiding interference spectrum, or those wishing to join the system without spectrum. Based upon the Commonwealth's determination of which new users will be joining STARS, Motorola will verify if the original guaranteed Grades of Service are maintained or may draft revisions for the Commonwealth's concurrence and provide justification for each recommended change.

The Commonwealth will provide comments to Motorola on the Second Draft Frequency Plan.

Third Draft for STARS Divisions 2-7

The Third Draft Divisions 2-7 Frequency Plan will be based upon the actual radio frequency authorizations received. Motorola will verify if the originally contracted coverage and guaranteed Grades of Service are maintained or Motorola may draft revisions for the Commonwealth's concurrence and provide justification for each recommended change. Motorola will provide to the Commonwealth, for review, the Third Draft Division 2-7 channel plan, supporting documentation, the results of the interference considerations including IV&D performance changes (ERP and receiver sensitivity) as a result of using selected frequencies, multiplexing equipment, and field measurements. Motorola will prepare the necessary documentation, including Special Temporary Authorizations, to license any additional radio frequencies assigned as a result of this plan. Motorola will pay for any adjustments required to installed equipment if it must rearrange frequencies after Division 1 Implementation.

Frequency Plan for STARS Divisions 1-7

Upon completion of the six-step frequency planning process described in this section, Motorola will submit the final Frequency Plan for STARS Divisions 1-7, including supporting documentation and field measurements, to the Commonwealth to document the completed, statewide plan.

Acknowledging that even this “final” Frequency Plan may require minor adjustments to account for the ever-changing VHF spectrum activity, Motorola will work closely with the Commonwealth to document such adjustments to the final plan. Motorola will pay for any adjustments required to installed IV&D site equipment if it must rearrange any Part 80 or Part 22 frequencies after Division 1 Implementation.

Any reprogramming necessary in Division 1 to implement the final plan shall be mutually agreed by the Commonwealth and Motorola, in addition to the other reprogramming provided elsewhere in this Contract.

If, due to unintentional errors or omissions in the Frequency Plan, interference is encountered by or caused by the implementation of STARS in accordance with the plan, Motorola will revise and implement the Frequency Plan to meet STARS contractual performance guarantees and agreements and mitigate impacts to adversely affected parties to the greatest extent possible. Motorola and the Commonwealth will collaborate closely to inform the other party of the latest frequency-licensing updates.