THIS FIRST AMENDMENT TO SYSTEM PURCHASE AGREEMENT (hereinafter "Amendment") is made and entered into as of the Effective Date by and between the City of Farmers Branch, Texas (hereinafter referred to as "Buyer") and Harris Corporation through its RF Communications Division (hereinafter referred to as "Seller") (Buyer and Seller are sometimes referred to herein together as the "Parties" and individually as a "Party").

RECITALS

WHEREAS, the Parties previously entered into that certain *System Purchase Agreement* ("Agreement"), dated June 27, 2013, setting forth the Parties agreement regarding the purchase and installation of the System; and

WHEREAS, the MQC desires to modify the design of the System to provide for the consolidation of the certain emergency communication dispatching; and

WHEREAS, the Parties desire to enter into this Amendment for the purpose of modifying the Agreement and its applicable exhibits to reflect the modifications to the System necessary to implement the consolidated dispatching configuration desired by the MQC.

NOW, THEREFORE, for and in consideration of the mutual promises of the Parties and other good and valuable consideration, the receipt of which is hereby acknowledged, Buyer and Seller agree as follows:

A. The words and phrases used in this Amendment, including but limited to the capitalized words and phrases used herein, shall have the same meanings and definitions as set forth in the Agreement.

B. The Agreement shall be amended as follows:

1. Section 6. PRICE is amended to read as follows:

> Section 6. PRICE.
>
> The Total Agreement Price to be paid by Buyer to Seller is TWELVE MILLION SIX HUNDRED TWENTY EIGHT THOUSAND SIX HUNDRED FORTY TWO US DOLLARS AND 93 CENTS ($12,628,642.93) consisting of the following breakdown:

Infrastructure Hardware and Services Price	$ 3,367,230.00
Terminal Hardware Price	$ 5,541,558.00
Dispatch Console Price	$ 1,727,573.75
Software FX price	$ 320,000.00
Maintenance Price	$ 1,578,746.00
Change Order 1*	$ 78,750.00
Change Order 2*	$ 14,785.00

> **invoiced individually, and not invoiced per Section 9 PAYMENTS*

2. Exhibit A – Statement of Work, Revision 1 to the Agreement, which is hereby attached to this Amendment as Attachment A, replaces Exhibit A – Statement of Work in its entirety.

3. Exhibit A – Statement of Work, Attachment 1 – System Description, Revision 1 to the Agreement, which is hereby attached to this Amendment as Attachment B, replaces Exhibit A – Statement of Work, Attachment 1 – System Description in its entirety.

4. Exhibit A – Statement of Work, Attachment 2 – Block Diagrams, Revision 1 to the Agreement, which is hereby attached to this Amendment as Attachment C, replaces Exhibit A – Statement of Work, Attachment 2 – Block Diagrams in its entirety.

5. Exhibit A – Statement of Work, Attachment 8 – Project Schedule, Revision 1 to the Agreement, which is hereby attached to this Amendment as Attachment D, replaces Exhibit A – Statement of Work, Attachment 8 – Project Schedule in its entirety.

6. Exhibit A – Statement of Work, Attachment 11 – Pricing, Revision 1 to the Agreement, which is hereby attached to this Amendment as Attachment E, replaces Exhibit A – Statement of Work, Attachment 11 – Pricing in its entirety.

C. The terms and conditions of the original Agreement, except as amended by this Amendment, shall remain in full force and effect.

D. This Amendment may be executed in any number of counterparts, each of which when executed and delivered is an original, but all of which together shall constitute one instrument with the same effect as if the Parties had signed the same counterpart and signature page. In making proof of this instrument, facsimile signatures shall be deemed originals, and it shall not be necessary to produce or account for more than one such counterpart which is executed by the Party against whom enforcement of such instrument is sought. In addition, any signature page and related notary acknowledgments may be detached from any counterpart of this instrument without impairing the legal effect of any signatures thereon, and such signature page and related notary acknowledgments may be attached to another counterpart of this instrument having attached to it one or more additional signature pages and related notary acknowledgments.

E. This Amendment shall be effective on the date it is signed by the authorized representatives of all of the Parties ("the Effective Date").

[Signature Page Follows]

IN WITNESS WHEREOF, Buyer and Seller, through their duly authorized representatives, have executed this Amendment.

SIGNED AND AGREED this ____ day of March, 2014.

BUYER

City of Farmers Branch, Texas

By:_____
Gary D. Greer, City Manager

Attest:

_____
Angela Kelly, City Secretary

Approved as to Form:

_____
City Attorney

SIGNED AND AGREED this 20th day of March, 2014.

SELLER

HARRIS CORPORATION
RF COMMUNICATIONS DIVISION

By:_____
Christopher W. Chaffee

Title: Contracts Manager

Attachments:
A. Exhibit A – Statement of Work, Revision 1
B. Exhibit A – Statement of Work, Attachment 1 – System Description, Revision 1
C. Exhibit A – Statement of Work, Attachment 2 – Block Diagrams, Revision 1
D. Exhibit A – Statement of Work, Attachment 8 – Project Schedule, Revision 1
E. Exhibit A – Statement of Work, Attachment 11 – Pricing, Revision 1

A. Exhibit A – Statement of Work, Revision 1

Exhibit A: Statement of Work (SOW)

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General

This SOW describes the general project responsibilities of both parties to perform which are not specifically associated with any one site location. It summarizes the site facilities, defines the specific site development and equipment installation activities to be performed, and defines the responsibilities of all parties for the implementation of the MQC's project for each site or location.

Standards and Codes

Harris' site development pricing is based on the International Building Code (IBC). IBC is a model building code developed by the International Code Council (ICC) that has been adopted throughout most of the United States, as well as by each participating member agency of the MQC.

Grounding and Lightning Protection

Harris' grounding system design goal for every site is a measurable five ohms or less resistance between any connected point on the ground bus and earth ground. All grounding system improvements provided within this scope of work are based on soil conditions local to the RF site are typical, conducive to good grounding systems and the RF site geography can receive a standard grounding system.

Harris will measure the site grounding system resistance using a "clamp-on" ground resistance test. For each new external grounding system it installs, Harris will develop and provide to the MQC a design that meets the Harris procedure - "Site Grounding and Lightning Protection" AE/LZT 123 4618/1, as well as any applicable references in R56 that may be more stringent.

Fixed Equipment Installation

Harris will install all fixed equipment contained in the following detailed description of work as approved out of the Customer Design Review. Installation will be scheduled in conjunction with the delivery of equipment after staging and the completion of site development work required at each site. All equipment will be installed in a neat and professional manner, employing a standard of workmanship consistent with Harris' installation standards and in compliance with applicable National Electrical Code (NEC), EIA, Federal Aviation Administration (FAA), and FCC standards and regulations. Figures 1 and 2 list the major systems to be installed as part of this SOW:

Figure 1. Major Systems To Be Installed

Site Name	Site Purpose
Spectrum Center	10-channel P25 RF Site Microwave Hop to Josey Ln WT Microwave Hop to FB1 (Justice Ctr WT) WT Microwave Hot Standby Spur to Addison EOC
Josey Lane Water Tank	10-channel P25 RF Site Microwave Hop to Consolidated Dispatch Microwave Hot Standby Spur to Carrollton City Hall Microwave Hop to Spectrum Center
Hebron Water Tank	10-channel P25 RF Site IP Simulcast Control Point Network Switching Center Microwave Hop to Consolidated Dispatch Microwave Hop to Wagon Wheel WT
Wagon Wheel WT	10-channel P25 RF Site Microwave Hop to Hebron WT

Site Name	Site Purpose
	Microwave Hop to Hutton Water Tank
FB2 (Davis Street WT)	10-channel P25 RF Site Microwave Hop to Hutton Water Tank Microwave Hop to FB1 (Justice Center WT) IP Simulcast Control Point Network Switching Center
Carrolton Dispatch (Back-up)	Interoperability Radios P25 & Microwave System Mgt Terminals Microwave Hot Standby Spur to Josey Ln WT Eight (8) Symphony Dispatch Consoles & Control Stations
Hutton Water Tank	P25 & Microwave System Management Terminals Microwave Hop to FB2 (Davis St WT) Microwave Hop to Wagon Wheel WT
Consolidated Dispatch	12 Symphony Dispatch Consoles & Control Stations Microwave Hop to Hebron WT Microwave Hop to Josey Ln WT
FB1 (Justice CTR WT)	10-Channel P25 RF Site Microwave Hop to FB2 (Davis ST WT) Microwave Hop to Spectrum Center

Harris will furnish all required cables including power, RF and control. Harris uses manufactured cables with molded connectors for the control and audio that plug into distribution panels avoiding the need for punch block connections. Each cable run will be secured with cable ties. Excess material will be folded back and neatly coiled. All cables will be labeled and included in the final as-built documentation package.

Harris will provide and install a new UPS, bypass circuitry and distribution breaker panel at each RF site and switching center. From the new distribution breaker panel, Harris will install 20A circuits to outlets above the new cabinets or racks.

All cabinets, racks, enclosures, and transmission line surge protectors will be properly grounded to the site's single point grounding system. Ground connections will be connected using approved irreversible compression connectors or irreversible lugs and splices. All painted surfaces where ground connections will be made will be scraped clean of paint and dissimilar metal connections will be treated with an anti-oxidant compound.

Harris will assemble and install antenna systems using its installation practices. Harris will provide the antenna mounting side arm kits, coaxial cable and connectors for the installation along with the required jumpers and grounding kits for each run.

Harris will run the transmission lines and properly fasten them to the ice bridge and cable ladder using the manufacturer's recommended devices and radius bends. Harris will sweep all antenna lines to verify proper installation and provide sweep print outs to be kept in the site log book for future reference.

Site Development

Harris and its selected subcontractor will perform the site development and site improvements for each site as defined in this SOW. Figure 3 summarizes the site development at new and existing sites.

Figure 2. Site Development Overview

Site Name	Tower	Shelter	Gen	UPS
Spectrum Center	163' Rooftop	(4) New Environmental Cabinets	None	New 15 KVA with 23-min runtime
Josey Lane Water Tank	200' Existing Water Tank	New 2-Room Shelter	New 50 KW Natural Gas	New 15 KVA with 23-min runtime
Hebron WT	180' Existing Water Tank	(9) New Environmental Cabinets	New 50 KW Natural Gas	New 18 KVA with 23-min runtime
Wagon Wheel WT	120' Existing Water Tank	(7) New Environmental Cabinets	New 50 KW Diesel	New 15 KVA with 23-min runtime
FB1 (Justice Center WT)	176' Existing Water Tank	(8) New Environmental Cabinets	New 50 KW Diesel	New 18 KVA with 23-min runtime
FB2 (Davis Street WT)	254' Existing Water Tank	(9) New Environmental Cabinets	New 50 KW Diesel	New 18 KVA with 23-min runtime
Hutton Water Tank	200' Existing Water Tank	(1) New Environmental Cabinet	Existing	None
Carrollton City Hall	Rooftop	Existing Equipment Room	Existing	New 12 KVA with 20-min runtime
Consolidated Dispatch	Rooftop	Existing Equipment Room	Existing	Existing

Harris will provide the site plot drawings for each site. The drawings will be used to submit and obtain construction permits and electrical permits as required. Where new facilities are proposed, Harris will construct new foundations, set shelters, erect new towers, and hang antennas. Harris will connect the customer provided AC service to each new shelter, install and connect the new generators, and construct site grounding systems to protect each new site. Existing sites will have the current ground systems tested and verified.

Responsibilities Matrix

Figure 4 lists the general project responsibilities of both parties to perform which are not specifically associated with any one site location.

Figure 3. General Requirements Responsibility Matrix

Tasks	Harris	MQC	Comments
Designate a project manager	X	X	
Manage the Harris team	X		
Establish project communications protocol, maintain communications log as req'd	X		
Participate in weekly project review meetings	X	X	
Submit weekly status reports	X		
Participate in weekly project update calls	X	X	
Participate in monthly project reviews	X	X	

Tasks	Harris	MQC	Comments
Report project progress as compared to project schedule	X		
Update project schedule monthly	X		Combined team input
Manage and control the flow of products and equipment from the factory to meet the project schedule	X		
Review change orders with customer, complete the change request form, update change register	X		
Monitor and manage risks using the Harris Risk Management Plan	X		Combined team input
Review and approve submitted design documents within two weeks or respond with revisions		X	
Provide written approval for major milestones such as CDR, Staging, ATP and Final Acceptance		X	
Provide timely responses to issues and questions		X	Communications Plan
Coordinate with other state, local, and federal government agencies, as req'd		X	
Review change orders with Harris project manager, provide approval		X	
Designate system administrators		X	
Provide access to all buildings and sites, including temporary ID badges for Harris		X	
Provide parking permits for Harris team for any restricted parking areas		X	
Provide adequate road access for delivery vehicles		X	
Arrange for temporary parking to off load equipment at all buildings and sites		X	
Clean up site, remove all debris and un-wanted construction material	X		
Testing and the removal of hazardous material found on site		X	
Provide group structure planning/fleet mapping of personalities		X	

Agreements

The following is a list of items that have been discussed and agreed to by the MQC:

- The MQC has or will be granted FCC licensed frequencies for the new system and subsystem equipment that will be installed at the sites.
- The existing lattice towers will pass the tower loading analysis (Addison Towers).
- Where Harris is not replacing generators, the existing MQC generator will be in good operational condition for continued use.
- Where Harris is not replacing UPSs, the existing MQC UPS will be in good operational condition for continued use.
- Site will be free from hazardous material.
- Harris will provide a site grounding report for each existing MQC site. The MQC can elect to upgrade the ground system themselves, contract with others, or add to the Harris contract via a change order.
- Fire station control station antenna systems will be re-used.

- All site locations and any required leasing agreements will be finalized by MQC prior to the Customer Design Review.
- A maximum of 30 days will be required for obtaining approved building permits from the time of submission.
- A maximum of 60 days will be required for zoning approvals from time of submittal with attendance at a maximum of two required planning meetings.
- GPS antennas can be mounted on the exterior wall of the Hebron, Wagon Wheel, FB2 (Davis Street) and FB1 (Justice Ctr) water tanks and an entry port can be used, or a small hole drilled through the wall if one would be needed, in the vicinity of the environmental cabinet installations to accommodate two (2) (four (4) at Hebron and FB2) ¼" GPS antenna cable. City specifications will be followed.
- A vertical cable ladder can be banded (no welding required) to the leg of the Josey Lane water tower to support antenna cabling.

Site Details

The following sections summarize the site facilities by site and define the specific site development and equipment installations that Harris has proposed and will perform.

Spectrum Center (East Tower)

Harris surveyed this site and found the following:

1) The rooftop structures were found to be in very good shape with room to install new antennas.
2) The grounding appeared to meet Harris standards.
3) A new cable port entry would be needed.
4) The current floor space will provide sufficient room.

Figure 4. Spectrum Center Site Summary

	Description
Site Owner	Granite Properties
Site Lat & Long	32-57-19.6N, 96-49-21.7W
Site Elevation	633'
Site Equipment	10-channel P25 RF Site
Tower	Building Rooftop
Penthouse Room / Environmental Cabinets	(4) new environmental cabinets (9' x 25' space)
Generator	None
UPS	New 15-KVA UPS and Bypass Switch
Compound	N/A
Grounding	Existing grounding to building ground will be tested and verified. New cabinets will be tied to Ground.
Microwave	Microwave Hot Standby Spur to Addison EOC Microwave Hop to FB1 (Justice Center WT) Microwave Hop to Josey Ln WT

Required site development work:

- Conduct rooftop structural analysis
- Conduct grounding analysis
- Decommission and remove the legacy radio and microwave equipment, and cabinets from the West Tower.
- Provide and install four new environmental cabinets equipped with redundant HVAC and lead/lag controllers, primary AC surge protection, and interior grounding
- Provide and install new 6-port cable entry port along with external ice bridge/cable supports and internal cable runway as required
- Provide and install a new 15 KVA UPS with 23-min runtime, Bypass switch and wall mounted Breaker Distribution Panel.

Figure 5. Spectrum Center Site Development Responsibility Matrix

Tasks	Harris	Customer	Comments
Arrange for access to 3rd party co-located sites		X	
Negotiate and obtain leases for all third party co-location sites ensuring site lease includes required space on the rooftop to support new cable runs and floor space in the penthouse		X	
Perform physical path surveys for each microwave path	X		
Determine best locations to mount new antennas	X	X	
Arrange for space on existing rooftop to mount new system antennas		X	
Perform Grounding Analyses	X		
Provide site plans and applicable electrical and layout plans		X	
Perform Rooftop Site Survey and Analysis and provide results at CDR.	X		
Provide up-to-date rooftop structural drawings along with a current mapping of installed antennas and cabling		X	
Arrange with 3rd party to strengthen rooftop structure if needed		X	
Arrange with 3rd party for floor space in existing penthouse		X	
Inspect and test building ground system.	X		
Provide customer site survey results report and recommendations	X		
Prepare, submit and obtain electrical permits	X		
Mark off the desired location for new environmental cabinets	X		
Arrange and provide 200A single phase 240V AC electrical service and terminate within 50-feet of new cabinets on the same floor		X	
Connect 200A single phase 240V AC electrical service to new cabinets	X		

Tasks	Harris	Customer	Comments
Provide new cable entry port with (6) new ports	X		
Install (4) new environmental cabinets	X		
Tie new cabinets to building ground	X		
Supply copper ground plate to ground all coaxial cables as they enter the cable entry port	X		
Install (1) new LMR 800 MHz Transmit antenna(s) using appropriate mounting hardware	X		
Install (1) new LMR 800 MHz Receive antenna(s) using appropriate mounting hardware	X		
Install antenna coax, connectors and jumpers using cable clamps to properly secure cable to rooftop structure.	X		
Install new Tower Top Amplifier (TTA)	X		
Install three (3) new Microwave dishes on pipe mounts with anti-sway kits.	X		
Install new Microwave waveguide.	X		
Install coaxial feed lines, secure to cable supports and grounding kits.	X		
Install antenna lightning protection devices on each run after it enters shelter via cable entry port; ground device to main ground bus bar	X		
Tag and identify each new antenna line	X		
Sweep test each new antenna line, maintain copies in site log book	X		
Install new 15 KVA UPS with 23-min runtime, bypass switch, distribution breaker panel, conduit and wire outlets above new racks	X		
Clean up site, remove all debris and un-wanted material	X		
Remove legacy LMR equipment, antennas and cabling after cutover	X		

Figure 6. Spectrum Center System Installation Responsibility Matrix

Tasks	Harris	Customer	Comments
Install new Microwave system with 8–hour DC back-up	X		
Install 10-channel P25 system	X		

Josey Lane Water Tank

Harris surveyed this site and found the following:

- The shelter installation site noted in the RFP is suitable.
- A fenced compound can be completed by building off the existing fences.
- Access to the site is already established; no access road is required.
- The water tank leg will require a cable ladder from which an ice bridge would be installed extending to the new 2-room shelter with generator.
- The antenna support structure is adequate to support new antennas without relocating existing antennas.

Figure 7. Josey Lane WT Site Summary

	Description
Site Owner	City of Carrollton
Site Lat & Long	32-58-40.4 N, 96-53-27.2 W
Site Elevation	522’
Site Equipment	10-channel P25 RF Site
Tower	Use existing 200’ Water Tank
Shelter / Environmental Cabinets	New 11.5’ x 30’ shelter
Generator	New 50 KW natural gas generator
UPS	New 15-KVA UPS and Bypass Switch
Compound	New 30’ x 50’ compound
Grounding	Existing exterior grounding will be tested and verified. New shelter ground ring will be tied to existing water tank ground.
Microwave	Microwave Hop to Consolidated Dispatch Microwave Hot Standby Link to Carrolton Dispatch Microwave Hop to Spectrum Center

Required site development work:

- Conduct water tank antenna support structural analysis
- Conduct grounding analysis
- Develop 30’ x 50’ fenced compound off of existing fence line
- Construct a shelter foundation
- Provide and install a new 11.5’ x 30’ 2-room shelter with 50 KW natural gas powered generator
- Construct a new shelter exterior ground ring and tie into the water tank ground system
- Construct a water tank leg cable ladder and connect to the new 2-room shelter with a ~35’ ice bridge
- Provide and install a new 15 KVA UPS with 23-min runtime, Bypass Switch and wall mounted Breaker Distribution Panel.

Figure 8. Josey Lane WT Site Development Responsibility Matrix

Tasks	Harris	Customer	Comments
Perform physical path surveys for each microwave path	X		
Determine best locations to mount new antennas	X	X	
Perform Grounding Analysis	X		
Provide existing site plans and applicable electrical and layout plans		X	
Perform water tank antenna support structure analysis and provide results at CDR.	X		
Provide up-to-date antenna support structure drawings along with a current mapping of installed antennas and cabling	X	X	Both teams to work to understand the details
Provide customer with site survey results report and recommendations	X		
Provide space on existing antenna support structure to mount new system antennas		X	
Stake out the desired location for shelter and compound	X		
Have an architectural firm, develop site compound plot drawings of compound showing new shelter location	X		
Obtain all required zoning permits and approvals		X	
Prepare, submit and obtain construction permits for new shelter	X		
Prepare, submit and obtain electrical permits	X		
Construct site fences	X		
Construct full slab shelter foundation	X		
Transport, off load and set new 11.5' x 30' 2-room shelter with new 50 KW natural gas generator	X		
Arrange and provide electric power and natural gas service within 50-feet of the new shelter location.		X	Provide utility transformers if necessary to provide the required AC pwr.
Provide primary power H-frame meter base with disconnects within 50' of new shelter		X	
Trench in 200A single phase 240V AC electrical service to new shelter	X		
Connect 200A single phase 240V AC electrical service to new shelter	X		
Trench in natural gas line to new generator	X		
Connect power runs from generator to new shelter	X		
Install equipment racks, connect to ground and connect to AC power	X		
Provide factory generator technician to provide first start service	X		

Tasks	Harris	Customer	Comments
Build off existing fence line creating a 30' x 50' compound	X		
Construct exterior ground system for shelter and fence corner posts	X		
Construct exterior ground system for new shelter and tie into existing water tank ground, connect to fence corner posts	X		
Install a new cable ice bridge between water tank and shelter, and new tower cable ladder to support new cable runs	X		
Supply copper ground plate for mounting on water tank leg, to ground all coaxial cables as they leave the water tank on the cable ice bridge.	X		
Install (1) new LMR 800 MHz Transmit antenna(s) using appropriate mounting hardware	X		
Install (1) new LMR 800 MHz Receive antenna(s) using appropriate mounting hardware	X		
Install antenna coax, connectors and jumpers using cable clamps to properly secure cable to tower.	X		
Install new Tower Top Amplifier (TTA)	X		
Install three (3) new Microwave dishes on pipe mounts with anti-sway kits.	X		
Install new Microwave waveguide.	X		
Install coaxial feed lines, secure to cable ladder(s), add grounding kits at the top, bottom and on ice bridge.	X		
Install antenna lightning protection devices on each run after it enters shelter via cable entry port; ground device to main ground bus bar	X		
Tag and identify each new antenna line	X		
Sweep test each new antenna line, maintain copies in site log book	X		
Install new 15 KVA UPS with bypass switch, distribution breaker panel, conduit and wire outlets above new racks	X		
Clean up site, remove all debris and un-wanted material	X		

Figure 9. Josey Lane WT System Installation Responsibility Matrix

Tasks	Harris	Customer	Comments
Install 10-channel P25 system	X		
Install new Microwave system with 8–hour DC back-up	X		

Hebron Water Tower

Harris surveyed this site and found the following:

- The main floor has adequate floor space for the installation of environmental cabinets.
- Existing cable runways can be used.
- The new natural gas generator will be placed at the NW corner of the tower.
- Photos were taken of the existing water tank antenna structure. There are sufficient cable ports to access the water tank top. The existing antenna support structure is inadequate to support new antennas and will require additional support development.

Figure 10. Hebron Water Tower Site Summary

	Description
Site Owner	City of Carrollton
Site Lat & Long	33-01-23N, 96-54-38W
Site Elevation	525’
Site Equipment	10-channel P25 RF Site IP Simulcast Control Point Network Switching Center
Tower	Existing 180’ Water Tower
Shelter / Environmental Cabinets	Ten (10) new environmental cabinets placed on the main floor to the left of the entrance close to the existing cable run
Generator	New 50 KW natural gas generator
UPS	New 18-KVA UPS and Bypass Switch
Compound	Main floor of water tank
Grounding	Environmental cabinets, cable ladder/bridge and generator will all be tied back to the water tank ground; grounding will be tested and verified
Microwave	Microwave Hop to Consolidated Dispatch Microwave Hop to Wagon Wheel WT

Required site development work:

- Conduct grounding analysis
- Conduct water tank antenna support structural analysis
- Complete construction of the generator compound
- Construct generator foundation
- Install a 50 KW natural gas generator. Install ATS inside water tank.
- Provide and install ten (10) new environmental cabinets equipped with redundant HVAC and lead/lag controllers, primary AC surge protection, and interior grounding within a fenced area.
- Provide and install a new 18 KVA UPS with 23-min runtime, Bypass Switch and wall mounted Breaker Distribution Panel.
- Tie generator, environmental cabinets, cable runway and cable ladder to the water tank ground system.

Figure 11. Hebron Water Tower Site Development Responsibility Matrix

Tasks	Harris	Customer	Comments
Perform physical path surveys for each microwave path	X		
Determine best locations to mount new antennas	X	X	
Arrange for space on existing water tank antenna support structure to mount new system antennas		X	
Perform grounding analysis	X		
Provide existing site plans and applicable electrical and layout plans		X	
Perform water tank antenna support structural analysis and provide results at CDR.	X		
Provide up-to-date antenna structural support drawings along with a current mapping of installed antennas and cabling	X	X	Both teams to work to understand the details
Provide the required floor space in the water tank		X	
Inspect and test water tank building ground.	X		
Provide customer site survey results report and recommendations	X		
Prepare, submit and obtain electrical permits	X		
Mark off the desired location for new environmental cabinets	X		
Arrange and provide 200A single phase 240V AC electrical service and terminate within 50-feet of new cabinets on the same floor		X	
Connect 200A single phase 240V AC electrical service to new cabinets	X		
Construct generator foundation and complete generator compound	X		
Transport, off load and set new 50 KW natural gas generator on pad. Install ATS in water tank.	X		
Trench in generator electrical service and control circuits to ATS mounted inside water tank	X		
Provide factory generator technician to provide first start	X		
Install ten (10) new environmental cabinets	X		
Tie new cabinets to building ground	X		
Supply copper ground plate to ground all coaxial cables as they enter the cable entry port	X		
Install (1) new LMR 800 MHz Transmit antenna(s) using appropriate mounting hardware	X		
Install (1) new LMR 800 MHz Receive antenna(s) using appropriate mounting hardware	X		

Install antenna coax, connectors and jumpers using cable clamps to properly secure cable to rooftop structure.	X		
Install new Tower Top Amplifier (TTA)	X		
Install (2) new Microwave dishes on pipe mounts with anti-sway kits.	X		
Install new Microwave waveguide.	X		
Install coaxial feed lines, secure to cable supports and grounding kits.	X		
Install antenna lightning protection devices on each run after it enters shelter via cable entry port; ground device to main ground bus bar	X		
Tag and identify each new antenna line	X		
Sweep test each new antenna line, maintain copies in site log book	X		
Install new 18 KVA UPS with 20-min runtime, bypass switch, distribution breaker panel, conduit and wire outlets above new racks	X		
Clean up site, remove all debris and un-wanted material	X		

Figure 12. Hebron Water Tank Installation Responsibility Matrix

Tasks	Harris	Customer	Comments
Install new Microwave system with 8–hour DC back-up	X		
Install 10-channel P25 system	X		
Install Simulcast Control Point	X		
Install the Network Switching Center (NSC)	X		

Wagon Wheel Water Tank

Harris surveyed this site and found the following:

- The second floor has adequate floor space for the installation of environmental cabinets.
- A cable ladder will be required to support antenna cables and depending on the final placement of the cabinets, a cable runway as well.
- The new diesel generator will be placed to the left of the existing generator and the compound enclosure completed in the same fashion.
- The water tank antenna structure has sufficient cable ports to access the water tank top and antenna support structure. The antenna support structure is adequate to support new antennas without relocating existing antennas.

Figure 13. Wagon Wheel WT Site Summary

	Description
Site Owner	City of Coppell
Site Lat & Long	32-58-02.4 N, 97-01-24.5 W
Site Elevation	518’
Site Equipment	10-channel P25 RF Site
Tower	Use existing 153’ water tank
Shelter / Environmental Cabinets	Seven (7) new environmental cabinets placed on the second floor to the left of the existing cable and climbing ladders
Generator	New 50 KW diesel generator
UPS	New 15-KVA UPS and Bypass Switch
Compound	Second floor of the water tank
Grounding	Environmental cabinets, cable ladder/bridge and generator will all be tied back to the water tank ground; grounding will be tested and verified
Microwave	Microwave Hop to Hebron WT Microwave Hop to Hutton Water Tank

Required site development work:

- Conduct grounding analysis
- Conduct water tank antenna support structural analysis
- Complete construction of the generator compound
- Construct generator foundation
- Install a 50 KW diesel generator. Install ATS inside water tank.
- Provide and install seven (7) new environmental cabinets equipped with redundant HVAC and lead/lag controllers, primary AC surge protection, and interior grounding
- Provide and install ice bridge and cable ladder as required
- Provide and install a new 15 KVA UPS with 23 min runtime, Bypass Switch and wall mounted Breaker Distribution Panel.
- Tie generator, environmental cabinets, cable runway and cable ladder to the water tank ground system.

Figure 14. Wagon Wheel WT Site Development Responsibility Matrix

Tasks	Harris	Customer	Comments
Perform physical path surveys for each microwave path	X		
Determine best locations to mount new antennas	X	X	
Arrange for space on existing water tank antenna support structure to mount new system antennas		X	
Perform grounding analysis	X		
Provide existing site plans and applicable electrical and layout		X	

Tasks	Harris	Customer	Comments
plans			
Perform water tank antenna support structural analysis and provide results at CDR.	X		
Provide up-to-date antenna structural support drawings along with a current mapping of installed antennas and cabling	X	X	Both teams to work to understand the details
Provide the required floor space in the water tank		X	
Inspect and test water tank building ground.	X		
Provide customer with site survey results report and recommendations	X		
Prepare, submit and obtain electrical permits	X		
Mark off the desired location for new environmental cabinets	X		
Arrange and provide 200A single phase 240V AC electrical service and terminate within 50-feet of new cabinets on the same floor		X	
Connect 200A single phase 240V AC electrical service to new cabinets	X		
Construct generator foundation and complete generator compound	X		
Transport, off load and set new 50 KW diesel generator on pad. Install ATS in water tank.	X		
Trench in generator electrical service and control circuits to ATS mounted inside water tank	X		
Fill generator fuel tank (first fill)	X		
Provide factory generator technician to provide first start service	X		
Provide cable entry ports penetrating the water tank top adjacent to the antenna structural support		X	
Install seven (7) new environmental cabinets	X		
Tie new cabinets to building ground	X		
Supply copper ground plate to ground all coaxial cables as they enter the cable entry port	X		
Install (1) new LMR 800 MHz Transmit antenna(s) using appropriate mounting hardware	X		
Install (1) new LMR 800 MHz Receive antenna(s) using appropriate mounting hardware	X		
Install antenna coax, connectors and jumpers using cable clamps to properly secure cable to rooftop structure.	X		
Install new Tower Top Amplifier (TTA)	X		
Install two (2)new Microwave dishes on pipe mounts with anti-	X		

Tasks	Harris	Customer	Comments
sway kits.			
Install new Microwave waveguide.	X		
Install coaxial feed lines, secure to cable supports and grounding kits.	X		
Install antenna lightning protection devices on each run after it enters shelter via cable entry port; ground device to main ground bus bar	X		
Tag and identify each new antenna line	X		
Sweep test each new antenna line, maintain copies in site log book	X		
Install new 15 KVA UPS with 23 min runtime, bypass switch, distribution breaker panel, conduit and wire outlets above new racks	X		
Clean up site, remove all debris and un-wanted material	X		
Remove legacy LMR equipment, antennas and cabling after cutover	X		

Figure 15. Wagon Wheel WT System Installation Responsibility Matrix

Tasks	Harris	Customer	Comments
Install new Microwave system with 8–hour DC back-up	X		
Install 10-channel P25 system	X		

FB1 (Justice Center Water Tank)

Harris surveyed this site and found the following:

- The ground floor has adequate floor space for the installation of new environmental cabinets to the right of the existing cabinets.
- The existing cage will be reused to surround the new cabinets once the old system has been decommissioned.
- A new cable ladder will be required to support antenna cables and depending on the final placement of the cabinets, a cable runway as well.
- The water tank antenna structure has sufficient cable ports to access the water tank top and antenna support structure. During the site survey a large crack was found at the base of currently mounted antenna which was patched with an additional support by the MQC. No other cracks were noted on the structure at that time and it is felt that the antenna support structure is adequate to support new antennas without relocating existing antennas. If any other cracks are noted during installation, work will be halted, the MQC notified immediately, and a fix action put into place by Harris.

Figure 16. FB1 (Justice Center WT) Site Summary

	Description
Site Owner	City of Farmers Branch
Site Lat & Long	32-55-29.9 N, 96-51-12.3 W
Site Elevation	587’
Site Equipment	10-channel P25 System
Tower	Use existing 176’ water tank
Shelter / Environmental Cabinets	Seven (7) new environmental cabinets placed to the right of the existing cabinets
Generator	New 50 KW diesel generator
UPS	New 18-KVA UPS and Bypass Switch
Compound	Ground floor of water tank
Grounding	Environmental cabinets and cable ladder/runway will all be tied back to the water tank ground; grounding will be tested and verified
Microwave	Microwave Hop to FB2 (Davis ST WT) Microwave Hop to Spectrum Center

Required site development work:

- Conduct grounding analysis
- Conduct water tank antenna support structural analysis
- Provide and install a new 50 KW diesel generator within a new enclosure built using materials similar to existing site generator enclosures; Harris will install generator enclosure within 50’ of the water tank. Install ATS inside water tank.
- Provide and install seven (7) new environmental cabinets equipped with redundant HVAC and lead/lag controllers, primary AC surge protection, and interior grounding
- Provide and install cable runway and cable ladder as required
- Provide and install a new 18 KVA UPS with 23-min runtime, Bypass Switch and wall mounted Breaker Distribution Panel.
- Tie generator, environmental cabinets, cable runway and cable ladder to the water tank ground system.

Figure 17. FB1 (Justice Center WT) Site Development Responsibility Matrix

Tasks	Harris	Customer	Comments
Perform physical path surveys for each microwave path	X		
Determine best locations to mount new antennas	X	X	
Arrange for space on existing water tank antenna support structure to mount new system antennas		X	
Perform grounding analysis	X		
Provide existing site plans and applicable electrical and layout plans		X	
Perform water tank antenna support structural analysis and	X		

Tasks	Harris	Customer	Comments
provide results at CDR.			
Provide up-to-date antenna structural support drawings along with a current mapping of installed antennas and cabling	X	X	Both teams to work to understand the details
Provide the required floor space in the water tank		X	
Inspect and test water tank building ground.	X		
Provide customer site survey results report and recommendations	X		
Prepare, submit and obtain electrical permits	X		
Mark off the desired location for new environmental cabinets	X		
Arrange and provide 200A single phase 240V AC electrical service and terminate within 50-feet of new cabinets on the same floor		X	
Connect 200A single phase 240V AC electrical service to new cabinets	X		
Construct generator foundation and compound within 50' of water tank using materials similar to existing generator enclosures	X		
Transport, off load and set new 50 KW diesel generator on pad. Install ATS in water tank.	X		
Trench in generator electrical service and control circuits to ATS mounted inside water tank	X		
Fill generator fuel tank (first fill)	X		
Provide factory generator technician to provide first start service	X		
Identify which cable entry ports to be used on the water tank top adjacent to the antenna structural support		X	
Install seven (7) new environmental cabinets	X		
Tie new cabinets to building ground	X		
Supply copper ground plate to ground all coaxial cables as they enter the cable entry port	X		
Install (1) new LMR 800 MHz Transmit antenna(s) using appropriate mounting hardware	X		
Install (1) new LMR 800 MHz Receive antenna(s) using appropriate mounting hardware	X		
Install antenna coax, connectors and jumpers using cable clamps to properly secure cable to rooftop structure.	X		
Install new Tower Top Amplifier (TTA)	X		
Provide a security fence around new environmental cabinets. Reuse the existing fence, if possible.	X		

Tasks	Harris	Customer	Comments
Supply copper ground plate to ground all coaxial cables as they enter the cable entry port	X		
Install (2) new Microwave dishes on pipe mounts with anti-sway kits.	X		
Install new Microwave waveguide.	X		
Install coaxial feed lines, secure to cable supports and grounding kits.	X		
Install antenna lightning protection devices on each run after it enters shelter via cable entry port; ground device to main ground bus bar	X		
Tag and identify each new antenna line	X		
Sweep test each new antenna line, maintain copies in site log book	X		
Install new 18 KVA UPS with 23-min runtime, bypass switch, distribution breaker panel, conduit and wire outlets above new racks	X		
Clean up site, remove all debris and un-wanted material	X		
Remove legacy LMR equipment, antennas and cabling after cutover	X		

Figure 18. FB1 (Justice Center WT) System Installation Responsibility Matrix

Tasks	Harris	Customer	Comments
Install new Microwave system with 8–hour DC back-up	X		
Install 10-channel P25 system	X		

FB2 (Davis Street Water Tank)

Harris surveyed this site and found the following:

- The second floor has adequate floor space for the installation of new environmental cabinets to the right of the existing climbing ladder.
- A new cable ladder/cable runway will be required to support antenna cables and depending on the final placement of the cabinets.
- The water tank antenna structure has sufficient cable ports to access the water tank top and antenna support structure. The antenna support structure is adequate to support new antennas without relocating existing antennas.

Figure 19. FB2 (Davis Street WT) Site Summary

	Description
Site Owner	City of Farmers Branch
Site Lat & Long	32-55-24 N, 96-55-17.4 W
Site Elevation	430’
Site Equipment	10-channel P25 RF Site IP Simulcast Control Point Network Switching Center
Tower	Re-use existing 254’ water tank
Shelter / Environmental Cabinets	Eight (8) new environmental cabinets placed to the right of the existing cabinets
Generator	New 50 KW diesel generator
UPS	New 18-KVA UPS and Bypass Switch
Compound	Second floor of water tank
Grounding	Environmental cabinets and cable ladder/runway will all be tied back to the water tank ground; grounding will be tested and verified
Microwave	Microwave Hop to Hutton Water Tower Microwave Hop to FB1 (Justice Center WT)

Required site development work:

- Conduct grounding analysis
- Conduct water tank antenna support structural analysis
- Provide and install a new 50 KW diesel generator within a new enclosure built using materials similar to existing site generator enclosures; Harris will install generator enclosure within 50’ of the water tank. Install ATS inside water tank.
- Provide and install nine (9) new environmental cabinets equipped with redundant HVAC and lead/lag controllers, primary AC surge protection, and interior grounding
- Provide and install cable runway and cable ladder as required
- Provide and install a new 18 KVA UPS with 23-min runtime, Bypass Switch and wall mounted Breaker Distribution Panel.
- Tie generator, environmental cabinets, cable runway and cable ladder to the water tank ground system.

Figure 20. FB2 (Davis Street WT) Site Development Responsibility Matrix

Tasks	Harris	Customer	Comments
Perform physical path surveys for each microwave path	X		
Determine best locations to mount new antennas	X	X	
Arrange for space on existing water tank antenna support structure to mount new system antennas		X	
Perform grounding analysis	X		

Tasks	Harris	Customer	Comments
Provide existing site plans and applicable electrical and layout plans		X	
Perform water tank antenna support structural analysis and provide results at CDR.	X		
Provide up-to-date antenna structural support drawings along with a current mapping of installed antennas and cabling	X	X	Both teams to work to understand the details
Provide the required floor space in the water tank		X	
Inspect and test water tank building ground.	X		
Provide customer site survey results report and recommendations	X		
Prepare, submit and obtain electrical permits	X		
Mark off the desired location for new environmental cabinets	X		
Arrange and provide 200A single phase 240V AC electrical service and terminate within 50-feet of new cabinets on the same floor		X	
Connect 200A single phase 240V AC electrical service to new cabinets	X		
Construct generator foundation and compound within 50' of water tank using materials similar to existing generator enclosures	X		
Transport, off load and set new 50 KW diesel generator on pad. Install ATS in water tank.	X		
Trench in generator electrical service and control circuits to ATS mounted inside water tank	X		
Fill generator fuel tank (first fill)	X		
Provide factory generator technician to provide first start service	X		
Identify the cable entry ports to be used on water tank top adjacent to the antenna structural support		X	
Install eight (8) new environmental cabinets	X		
Tie new cabinets to building ground	X		
Supply copper ground plate to ground all coaxial cables as they enter the cable entry port	X		
Install (1) new LMR 800 MHz Transmit antenna(s) using appropriate mounting hardware	X		
Install (1) new LMR 800 MHz Receive antenna(s) using appropriate mounting hardware	X		
Install antenna coax, connectors and jumpers using cable clamps to properly secure cable to rooftop structure.	X		
Install new Tower Top Amplifier (TTA)	X		

Tasks	Harris	Customer	Comments
Install two (2) new Microwave dishes on pipe mounts with anti-sway kits.	X		
Install new Microwave waveguide.	X		
Install coaxial feed lines, secure to cable supports and grounding kits.	X		
Install antenna lightning protection devices on each run after it enters shelter via cable entry port; ground device to main ground bus bar	X		
Tag and identify each new antenna line	X		
Sweep test each new antenna line, maintain copies in site log	X		
Install new 18 KVA UPS with 23 min runtime, bypass switch, distribution breaker panel, conduit and wire outlets above new racks	X		
Clean up site, remove all debris and un-wanted material	X		
Remove legacy LMR equipment, antennas and cabling after cutover	X		

Figure 21. FB2 (Davis Street WT) System Installation Responsibility Matrix

Tasks	Harris	Customer	Comments
Install new Microwave system with 8–hour DC back-up	X		
Install 10-channel P25 system	X		
Install Simulcast Control Point	X		
Install Network Switching Center (NSC)	X		

Carrollton Radio Shop/Hutton Water Tank

Harris surveyed the Radio Shop for system terminal installation and the Water Tank for Microwave installation and found the following:

- The Radio Shop and Water Tank appear to have facilities to support the proposed installations.

Figure 22. Hutton Water Tank Site Summary

	Description
Site Owner	City of Carrollton
Site Address	1420 Hutton Drive, Carrollton, TX
Site Equipment	P25 & Microwave System Management Terminals
Tower	200' Water Tank
Equipment Room	Use existing

	Description
Generator	Existing
UPS	N/A
Microwave	Microwave Hop to Wagon Wheel WT Microwave Hop to FB2 (Davis Street WT)

Required site development work:

- Electrical –
  - Connect Microwave DC Plant to customer provided primary power within 50’

Figure 23. Hutton Water Tank Site Development Responsibility Matrix

Tasks	Harris	Customer	Comments
Connect Microwave DC Plant to customer provided primary power within 50’	X		

Figure 24. Carrollton Radio Shop/Hutton WT System Installation Responsibility Matrix

Tasks	Harris	Customer	Comments
Install new Microwave system with 8–hour DC back-up	X		Hutton Water Tank
Install Management Terminal	X		Carrollton Radio Shop

Carrollton Dispatch (Back-up)

Harris surveyed this site and found the following:

- The equipment room appears to have facilities to support the proposed installations.

Figure 25. Carrollton Dispatch Site Summary

	Description
Site Owner	City of Carrollton
Site Address	1945 East Jackson, Carrollton, TX
Site Equipment	Interoperability Radios 8 Symphony Dispatch Consoles and Control Stations
Tower	2-story Rooftop
Equipment Room	Use existing
Generator	Use existing
UPS	New 12-KVA UPS and Bypass Switch
Microwave	Microwave Hot Standby Link to Josey Ln WT

Required site development work:

- Electrical –

- Install Harris provided 12 KVA UPS with wall-mounted Maintenance Bypass Switch and connect to primary AC panel located within 20'.
- Provide and install UPS output power distribution panel; connect distribution panel to equipment

Figure 26. Carrollton Dispatch Site Development Responsibility Matrix

Tasks	Harris	Customer	Comments
Connect Microwave DC Plant to customer provided primary power within 50'	X		
Install new 12 KVA UPS with 23 min runtime, bypass switch, distribution breaker panel, conduit and wire outlets above new racks	X		
Clean up site, remove all debris and un-wanted material	X		

Figure 27. Carrollton Dispatch System Installation Responsibility Matrix

Tasks	Harris	Customer	Comments
Install new Microwave system with 8–hour DC back-up	X		
Install Interoperability Radios and Network Switching Ctr	X		
Install eight (8) Symphony Dispatch Consoles and Control Stations	X		

Addison Central Fire EOC

Harris surveyed this site and found the following:

- The equipment room does not have a cable tray above the existing racks.
- The cable entry port has one open port for microwave installation.

Figure 28. Addison Central Fire EOC Site Summary

	Description
Site Owner	City of Addison
Site Address	4799 Airport Parkway, Addison, TX
Site Equipment	Microwave Only
Tower	Re-use existing ~140' SST
Equipment Room	Use existing
Generator	Use existing
UPS	New 6-KVA UPS and Bypass Switch
Grounding	Cable Tray will be tied back to building ground
Microwave	Microwave Hop to Spectrum Center

Required site development work:

- Provide and install 12’ of cable tray at a height above the eight existing racks from the side wall cable tray allowing for the largest minimum radius bend of transmission cables being installed.
- Electrical –
  - Bond cable tray in accordance with Harris Grounding specification
  - Install Harris provided 6 KVA UPS with wall-mounted Maintenance Bypass Switch to primary AC panel located within 20’.
  - Provide and install UPS output power distribution panel; connect distribution panel to equipment

Figure 29. Addison Central Fire EOC Site Development Responsibility Matrix

Tasks	Harris	Customer	Comments
Bond cable tray	X		
Connect Microwave DC Plant to customer provided primary power within 50’	X		
Install new 6 KVA UPS with 20-min runtime, bypass switch, distribution breaker panel, conduit and wire outlets above new racks	X		
Clean up site, remove all debris and un-wanted material	X		

Figure 30. Addison Central Fire EOC System Installation Responsibility Matrix

Tasks	Harris	Customer	Comments
Install new Microwave system with 8–hour DC back-up	X		

Consolidated Dispatch

Harris surveyed the prospective location. All services will be provided at this location by the building owner.

Figure 31. Consolidated Dispatch Summary

	Description
Site Owner	Cyrus One located within the city limits of the City of Carrollton
Site Address	1649 West Frankford Rd, Carrollton, TX
Site Equipment	Interoperability Radios 12 Symphony Dispatch Consoles & Control Stations
Equipment Room	will be provided by building owner
Generator	will be provided by building owner
UPS	Use Existing
Microwave	Microwave Hop to Hebron WT Microwave Hop to Josey Ln WT

Required site development work:

- None

Figure 32. Consolidated Dispatch Site Development Responsibility Matrix

Tasks	Harris	Customer	Comments
Connect Microwave DC Plant to customer provided primary power within 50'	X		
Clean up site, remove all debris and un-wanted material	X		

Figure 33. Consolidated Dispatch System Installation Responsibility Matrix

Tasks	Harris	Customer	Comments
Install new Microwave system with 8–hour DC back-up	X		
Install 12 Symphony Dispatch Consoles & Control Stations	X		

Installation Processes

Harris and its subcontractors will provide the installation and commissioning activities to ensure the new 700/800 MHz radio system and associated digital microwave system as described in the RFP specification is professionally implemented in accordance with Harris' implementation schedule and the needs of Metrocrest stakeholders. Harris will provide all the required equipment, accessories, punch-blocks, terminal strips and/or cables needed to interface to new and/or existing facilities. Optimization, troubleshooting, and adjustment of each subsystem will be Harris' responsibility.

Harris will perform all work in accordance with the applicable laws and regulations of the U.S. Department of Labor, and the State of Texas and local government agencies, meet the stated requirements of the Metrocrest Quad Cities of Addison, Carrollton, Coppell and Farmers Branch as stated in the RFP, and the following Harris specifications:

- Standards for Site Construction and Contractor Specifications LBI-39148 Rev B
- Specifications, Guidelines, and Practices, Tower Requirements and General Specifications LBI-39185 Rev C
- Antenna Systems LBI-38983 Rev G
- Site Grounding and Lightning Protection Guidelines AEL-ZT 123 46181 Rev D

Project Management Team

All Harris personnel and subcontractors assigned to MQC will be trained in accordance with these specifications and standards manuals. The Harris Project Team and Quality Control personnel will periodically review the installation work to ensure that the standards are being implemented.

Harris' Project Manager has final authority for all work. His primary responsibility will be the successful implementation, integration, optimization and acceptance of your project. He will manage all phases of this project from the beginning through acceptance. He will be responsible for the progress and quality of work to be performed, overall project cost and processing any contract changes. He will be the primary

Harris point of contact and all official communications regarding the project will be held between him and MQC's project manager.

The Harris project manager will be assisted by a Site Manager/Field Project Manager who will be on-site and have face-to-face daily contact with MQC. He will be responsible for ensuring all the necessary tools, equipment and transportation are available to professionally and successfully complete all site preparations and equipment staging, installation, optimization, testing, and commissioning activities.

The Project Manager will focus solely upon the Radio Communication Project from contract signing to acceptance of the system. The Radio Communications Project is the implementation of the new P25 Trunked Radio system and associated digital microwave system for the MQC.

The MQC fully expects that the assigned Project Manager complete the entire project. In the event that this is not the case, any replacement will have the same capabilities as the originally assigned PM. The MQC reserve the right to approve or disapprove the selection and assignment of the PM. These requirements also extend to Assistant PMs.

The Harris installation team will install the new P25 and microwave equipment at the locations disclosed in the system design and integrate subsystems as described in the documents to provide an end-to-end network solution.

Upon completion of design review and factory tests, Harris' first installation priority will be to install the Network Switching Center and Simulcast Control Point that require early installation followed by the RF site equipment. Harris will establish a site installation plan that prioritizes RF site installations, with proper consideration given to the following:

- Site construction status
- Microwave connectivity status
- Interoperability
- Other critical events

The installation plans will be developed during the "detailed design phase" of the project and presented to MQC for review and approval. The installation plans will be based on site surveys conducted by Harris personnel or its subcontractors and will include floor plan drawings, equipment rack up drawings, antenna location details, grounding standards, installation and commissioning procedures. The installation plan will coordinate all activities of Harris' personnel and our subcontractors, minimizing construction conflicts and ensuring that system implementation proceeds efficiently.

Harris understands MQC's need for the existing radio communications systems to remain fully operational during the installation of the new radio system. Where currently operational communications equipment co-exists with the installation of the new P25 system, Harris will take great care to ensure that there is little or no disruption in service. If an interruption in service is deemed unavoidable, Harris will provide the MQC Program Manager written notification detailing the nature and duration of such interruption for review and approval no less than 30 days before the interruption is to occur.

Equipment will be installed in a neat and workmanlike manner, in accordance with high standard professional practice, by competent technicians or mechanics. Personnel designated by MQC Program Manager will provide inspection and approval of all installations. Such approval will be limited in scope to the specific subsystem physical installation, and will not be construed to imply full acceptance of the

system, or subsystem. A baseline site will be built-out first and inspected. Once approved and accepted the remaining five sites will be green-lit for installation and inspected afterward.

Harris will provide MQC with a detailed listing of all equipment delivered to the site, including model numbers, serial numbers, equipment locations, firmware and software versions, and installation date. Transfer of title will occur upon delivery of the site equipment at the site and acceptance by MQC.

Notwithstanding the details presented in these specifications, it is the responsibility of Harris to verify the correctness of the material lists and suitability of devices proposed to meet the intent of the specifications.

Any equipment or parts required to provide a complete and operational system, and not specifically listed in the master parts list, will be provided by Harris without any claim for additional payment. The Harris Team will work closely with MQC personnel during the installation planning phase of the project. Harris Project Managers, Site Managers, and System Engineers will conduct periodic face-to-face meetings and conference calls to coordinate site availability and implementation processes. As site and user equipment are delivered, the inventory database will be updated and provided to MQC.

Tower Work

Experienced tower crews will install the side arms, antennas, coaxial cables, and associated hardware at MQC RF sites.

Properly sized transmission line hangers will be used to support the RF cables onto the side arms, tower, water tanks and ice bridges.

The transmission line hangers will be installed and properly spaced, in accordance with the manufacturer's specifications.

Adequate service and/or drip loops will be installed, and proper strain relief measures will be taken at all cable interfaces and shelter entrances.

To meet cable bending specifications for strain relief purposes, equipment cabinet intra-cabling will be permitted by the use of ¼" diameter coaxial cable, such as Andrew Superflex coaxial cable. These cables will be limited to:

1. 10 feet in length
2. Interconnection between the equipment RF port(s) and the cabinet feed-through or the first interference protection or multiplexing devices.

The coaxial antenna transmission line or waveguide will be cut to length. The radio equipment end of this line will terminate at a point where the lengths of jumper cables are kept as short as possible.

Transmission line or waveguide runs inside equipment shelters or buildings will be supported, every 3', with cable trays or stainless steel cable hangers. Multiple cable runs will not be bundled together, but rather, will be strung and supported adjacent to each other.

The coax cables will be professionally installed, properly terminated, and connected to lightning protectors inside the shelters. Lightning arrestors will be grounded to the internal master ground bus of the equipment shelter, equipment cabinet or equipment room.

The ends of rigid transmission line will not connect directly to the antenna, to any RF equipment interference protection or multiplexing devices.

All coaxial RF jumper cables will be high quality, low loss, cables with low interference generating type connectors. The size of the cables will be selected by Harris and will be consistent for all radio sites and applications. The cables will be cut to length.

RF jumper cables will be used to interconnect all interference protection or multiplexing devices with the coaxial antenna transmission line and radio frequency equipment.

A jumper cable will be used to interconnect the two-way radio antenna(s) to the top end of the coaxial antenna transmission line. Jumper cables used to reach a side arm mounted antenna will be shaped to form a drip loop. Jumper cable interconnections will be weather proofed by installation of cold shrink weather proofing kits, or equivalent. The use of vinyl tape is not acceptable for this purpose.

All two-way radio antenna jumper cables will be cut to length and will use type 'N' connectors except as dictated by the connector supplied with the antenna.

All coaxial cables exiting the equipment cabinets (if used) will do so through cabinet RF feed-through.

Antenna installation crews will properly tighten all RF connectors to the manufacturer's specifications and all outdoor connectors will be professionally wrapped and sealed from moisture.

After installation, the RF transmission lines and antennas will be swept with an Anritsu Site Master or equivalent cable testing device on the appropriate frequency band(s) to ensure proper performance. The baseline test data will be recorded and provided to MQC, and a copy will remain on site for future reference.

Infrastructure Equipment

Upon completion of the tower work, the RF infrastructure equipment is installed and connected to the antenna systems. The installation of the radio frequency equipment will be provided by Harris at the designated location(s) within the equipment shelters or equipment cabinets at the trunked radio and at other designated communication sites. Harris will supply and install all required equipment, accessories, punch-blocks, terminal strips and/or cables needed to interface to new and/or existing facilities.

Since MQC intends to re-use existing facilities, Harris will verify that all existing conduits, cable trays, and AC power feeds are properly grounded. Harris will provide all grounding and lightning protection equipment needed to protect the radio system that is supplied to the MQC.

The MASTR V P25 trunked stations, microwave and associated equipment will be mounted in either 86-inch standard aluminum EIA 19-inch open frame racks or Hoffman environmental cabinets. The cabinets or racks will be positioned so that 36 inches of free aisle space can be maintained. The cabinets and racks will be anchored to the floor, using at least four anchor points.

Once the physical installation of the RF equipment at a site is completed, a commissioning team will properly align, configure, program, and conduct acceptance and coverage testing per the Field Acceptance Test Plan (FATP). MQC personnel and/or their representatives will be invited to participate in the acceptance testing process. The alignment and test data will be recorded and copies provided to MQC. Copies of the individual site alignment and test data will also be provided at the sites. Additionally, site specific licenses, interconnect drawings, site drawings, and other critical information will be provided for each site. Harris recommends that this important site data be inventoried periodically, as part of the

routine preventative maintenance program, to ensure that it remains accessible to Harris and MQC maintenance resources.

Installation crews will also be responsible for the installation and commissioning of the Network Switching Center (NSC), dispatch consoles, logging recorders, alarm terminals, and other infrastructure equipment, per the detailed implementation plan.

It is preferred that all audio and control cable/wiring to and from the radio equipment be shielded. It is preferred that cable/wiring interfaced to the Public Switched Telephone Network (PSTN), if needed, be shielded up to the demarcation point.

All external equipment inter-cabling, whether NETWORK, RF, AC, AUDIO or CONTROL cables and/or wiring, will be labeled with pre-printed adhesive wire labels and be clearly visible. Markers will be placed at each end, adjacent to the connector, plug or terminus. This data will be recorded in the installation documentation.

All equipment cables or cable bundles within the shelter, to the greatest extent feasible, will be neatly tied by means of plastic tie wraps and secured by clamps to flat surfaces. All cables will be installed in a symmetrical manner; drooping, stretched, or unsupported cables will not be acceptable.

All cable/wiring bundles exiting the equipment must do so through the top of the cabinets or racks. Rubber grommets or other suitable protection will be used at cabinet knockouts to protect the cable/wiring. Splicing of NETWORK, AC, AUDIO, RF, or CONTROL cable/wiring will not be permitted.

User Equipment (Mobiles)

A mutually agreeable and detailed phase-over plan and schedule will be developed by the Harris Team and MQC personnel. Harris provides overall management and planning of the installation and test activities, while our subcontractors perform the installations. The Harris Team will schedule and coordinate the distribution of the portable and mobile user equipment, per the installation plan. All mobile radio installations will be closely coordinated with MQC and participating user agencies to minimize disruption to their operation and reduce out-of-service and unproductive time.

Experienced mobile installation crews, under the direction of Harris' Site Management and Quality Control personnel will perform the installations at user locations, local shops, and central points, as needed to complete the implementation schedule. Installation standards manuals have been developed for many vehicles, such as Crown Victoria's, Impalas, and others. Functional verification, test data, photos programming information, model and serial numbers, vehicle identification numbers, and other pertinent information will be recorded and provided to MQC. Quality inspections will also be performed by Harris to ensure the highest quality installations.

The Harris team will conduct a pre-installation survey of each vehicle to ascertain and document status of the vehicle on arrival. Any deficiencies in vehicle appearance (dents, scratches, etc) or vehicle operation (lights, wipers, AM / FM radio, etc) will be documented prior to work starting on the vehicle. A Harris representative and MQC representative will both sign off on the pre-installation survey document.

Following completion of the installation, the same survey will again be conducted to verify that there has been no negative impact to the vehicle. Any Harris created issues will be corrected and the survey updated prior to final sign off of accepted completion of each vehicle installation. A post-installation test

of the new radio operation will be witnessed and signed off by a MQC representative signifying acceptance of the installation.

In order to meet the project schedule, MQC will provide Harris with a minimum of sixteen (16) vehicles per day. The quantity will be a mix of public safety, fire, and public works from each of the four cities to reduce the number of units from any one agency in any given day.

Installations can be conducted at a facility provided by MQC, if available, or at the Harris Regional Service Center (standard sized cars, SUVs and pickup trucks only). Fire Apparatus will be installed at the customer's location. Harris will negotiate any of these possibilities to ensure minimal disruption and to expedite the project schedule.

Mobile installations performed in vehicles that are equipped with air-bag protection devices will be installed in a manner that will not in any way impede the ability of the air bag to protect the occupants during a collision.

Mobile unit installations will be coordinated with the implementation of the system infrastructure including the dispatch console systems. Training for the dispatch console operators and mobile radio operation training for each department, if requested by the individual municipality, will also be performed before the trunked mobile radio units are installed.

Harris will remove the existing radio unit (unless instructed not to) when installing the new trunked mobile radio. When removed, the existing radio, its control head, antenna, and wiring harness will be placed in an individual storage box with a label indicating the particular department of each municipality and unit number it was removed from, make and model of radio, frequency band and date removed.

At a mutually agreed time of installation, the Contractor will be given information as to the physical vehicle placement of the mobile units for each department and radio user. This work may include relocation of existing equipment. The MQC has many types of vehicles in service that will require installation of new radio equipment. If the individual City does not provide access to the vehicle and additional charges are incurred, Harris is to provide the cost for such rescheduling of the mobile installation.

Low loss Teflon RF antenna cable, or equivalent per specification, will be provided. Harris is supplying a low loss antenna cable; however it is not made out of Teflon. It is extremely weatherproof and durable. The specifications are as follows:

1) Polyethylene Foam Dielectric
- Closed cell
- Dry nitrogen gas injected- no moisture to degrade performance
- High velocity
- Low loss

2) High Performance Flexible Shielding System
- Multi-laminar aluminum composite tape bonded to the dielectric
- Provides >90dB isolation shielding (180dB cross talk)
- Bonded construction ensures 100% effective shielding
- Acts as a second moisture barrier
- Outer Braid of tinned copper:
- Provides positive means for grounding and connector attachment

3) Polyethylene Outer Jacket

- Heavy duty UV, sunlight and weather resistant, 20 to 40 year life

All wiring and cabling will be new, and will be appropriately dressed and connectorized in accordance with good engineering practices. Each main power lead will be attached to its own in-line fuse rated for the maximum current drain of the associated circuit and connected as close as practical to the battery using approved methods and hardware. Obtaining power by connecting to existing radio equipment or any other device is unacceptable.

All cabling that is exposed will be dressed with a flexible tubing and secured to the vehicle by attachment to any stationary support element using solid copper wire or fasteners. Plastic tie wraps should be used within at least 2 feet of the end connection points in areas not directly exposed to the weather.

The cable length will allow minor repositioning of the equipment to allow for changing operating conditions. A designated representative from each municipality will inspect the first installation of equipment. For following installation a designated department representative, from each municipality, will inspect each vehicular installation. Each vehicular installation will successfully complete an operational performance test and will be approved via signature of the individual municipality's department inspector.

The mobile assembly will be positioned on a mounting assembly such that the mounting plates, base plates, brackets, etc., designed for mobile communication applications. The finished assembly will be secured and remain in a fixed and motionless position under all operating conditions. It is understood that many of the vehicles used by the various municipalities use two-way radio consoles that house the control head and, in some cases, the mobile radio units. The correct mounting/face plate will be supplied for each of these installations.

Harris field implementation workflow for mobile installs is straightforward and ensures repeatable results. The workflow is as follows:

- Deliver and inventory mobile radios to MQC facilities
- Program the mobiles with the proper personalities.
- Install mobile radios per MQC specifications, with removal of existing mobile radios occurring at the same time
- Perform quality inspections
- Perform functional tests
- Record test data for delivery to MQC
- Operator training

MQC will provide representative at each of the installation locations who will be responsible for:

- Conducting the pre-installation vehicle inspection with a Harris representative
- Observing installs as they progress and verifying that all quality requirements are being met by Harris
- Providing response to questions from Harris team leader concerning equipment placement, cable routing and other questions that may arise
- Conducting post-installation vehicle inspection with a Harris representative
- Observing and verifying that final post installation operational test of radio equipment is completed and unit is functional
- Final sign-off on completed vehicle installation documentation

- MQC personnel will move all vehicles into and out of the installation work area. Harris personnel will not operate customer's vehicles.
- MQC must remove all weapons, ammunition, flammable and explosive items from vehicles prior to movement into the installation area
- MQC will remove all loose items from inside of vehicles prior to movement into the installation area. Clothing, boots, hats, turn out gear, gloves. Harris will not be responsible for lost or damaged items left in vehicles.

User Equipment (Symphony Dispatch Consoles)

Harris will supply and install all required termination blocks, terminal strips and/or cables needed to interface the new dispatch console electronics to existing facilities such as radio equipment, telephone equipment, logging recorder equipment and/or auxiliary function and/or control circuits.

All new dispatch console inter-cabling, including those that are to terminate at existing punch blocks, will be labeled with pre-printed adhesive wire markers. The markers will be placed at each cable end, adjacent to the connector or plug. All cables and/or cable bundles will be hidden from view and will be neatly secured by means of plastic tie wraps. All dispatch console cabling in each of the dispatch centers will be routed through conduits under the computer flooring, or via an approved method if conduit is not present.

All inter-cabling to the operator positions will be provided with sufficient slack to permit movement of at least 6 feet in any direction.

Harris will be responsible for the links between the dispatch console operator positions and the radio network. The physical interface is expected to include, at a minimum, the following:

1. Wire and/or network connections to the appropriate dispatch console termination points.
2. Wire and/or network connections to the appropriate audio distribution networks, and network components.
3. Proper termination of all used and unused I/O ports on audio distribution networks.

Harris will be responsible for the functional interface(s) between the radio system and the dispatch consoles for both trunked and conventional resources. The functional interface will be fully tested, for all modes of system operation including, but not limited to:

1. System operation with the Master Network Site and main Prime Simulcast Site in operation
2. System operation with the primary Master Network Site and back-up Prime Simulcast Site in operation

Equipment Removal

During cutover, Harris will work collaboratively with MQC and its user agencies to remove the existing mobile radios and install new. Following cutover, Harris will remove all existing radio equipment and ancillary subsystems replaced under this procurement. Harris will inventory these items as they are collected and record the type, model number, serial number, and MQC's inventory / asset number (where applicable) and deliver the units to a storage facility designated by each individual municipality. Each municipality will be responsible for the disposition of the removed equipment.

In some cases some accessories such as Fire Department headset and audio accessories may be retained. These will be noted by the MQC prior to removal. All radio equipment removed from service will be kept

together with any associated parts, cables, accessories, etc. Care will be taken to prevent damage to any equipment parts, cables or accessories. Each municipality will dispose of removed equipment. User equipment will be individually boxed and sealed in suitable cardboard boxes, and labeled with the following information:

1. User Department Name and Unit Number if available
2. Equipment Make, Model No. and Serial No.
3. Associated Accessories and Options

Radio Unit Upgrades

The following paragraphs describe the method by which radio units will be processed.

1. Day 1:
   a. Harris will collect all of the radios to be upgraded from each of the entities.
   b. Harris will sign documentation from customer acknowledging receipt of the equipment.
   c. Harris will document, pack and ship the units to an authorized Motorola equipment service shop for the upgrades to be performed.
   d. Equipment is shipped for overnight (next AM) delivery
2. Day 2:
   a. The authorized Motorola service shop will perform the upgrades to the equipment including:
      i. Upgrade of radio flash code
      ii. Addition of features for P25 Phase 1, P25 Phase 2 and Encryption as appropriate for each unit.
      iii. Following upgrade the units will be bench tested for verification that upgrades are properly installed and functional
      iv. Equipment will be packed for return shipment
      v. Equipment is shipped for overnight (next AM) delivery
3. Day 3:
   a. Harris will return the upgraded equipment items to each of the entities from which equipment was collected
   b. Harris and customer will verify that equipment has been upgraded and is operating with new code and features.
   c. Harris will provide documentation to MQC and request customer signature verification of equipment return, upgrades have been fully completed, and that returned units are functional.

Harris recommends conducting a “First Article” unit using this process to verify that the process, software and features provided by Motorola perform correctly and to verify that the returned unit is fully functional. Only following successful completion of the First Article unit, would the remainder of the units be submitted for this work plan execution.

Documentation

As a part of final System Acceptance, Harris will provide the “as-built” documentation. Harris will provide the MQC Program Manager with four (4) copies of the documentation in 3-ring binders and four (4) copies on CD media in the original software format (PDF, AutoCAD, Excel, and Word for drawings, spreadsheets, and text).

The general system manual that describes the overall system layouts, architecture, and its operating and failure modes will contain the following:

1. System block diagrams
2. Site layouts and floor plans of each equipment site, and dispatch facility, to scale
3. Rack face drawings, to scale
4. Drawings showing cable tray location details, to scale
5. Radio propagation coverage maps
6. Coverage Acceptance Test documentation
7. All external equipment inter-cabling, whether NETWORK, RF, AC, AUDIO or CONTROL cables and/or wiring, will be labeled with pre-printed adhesive wire markers. Markers will be placed at each end, adjacent to the connector, plug or terminus. For cables and/or wiring, within the shelter, markers will be placed at 3' intervals along the length of the cable and/or wiring
8. Interconnection drawings that show all connections between sub-assemblies, such as terminal boards, panel assemblies or other equipment, and which external connections are made, will be provided
9. Numbering and labeling of all cabling associated with remote control units
10. Numbering and labeling of all connections to termination blocks associated with the control consoles
11. Numbering and labeling of all interconnecting cabling between repeaters, the central control, any remote site controllers or processors, alarm circuits, and leased telephone company circuits, and the microwave system
12. A log of level settings for all control circuits
13. A record of telephone circuits, if used, by circuit number and telephone number for service on these circuits
14. A final microwave channelization plan
15. Documentation and labeling of transmission line routing and antenna mounting at all fixed sites, with detailed drawings showing all mounting hardware and accessories
16. Complete set of maintenance and operations manuals will be provided for the system as a whole and for each category of equipment purchased in association with this project. In addition, a complete set of maintenance and operations manuals will be placed in a secure location at each of the radio system sites
17. Manuals for OEM hardware for each component of the system
18. Any unique wiring configurations or circuit modifications that are not part of the standard equipment documentation provided will be included in the ring binder. All information as described in the previous paragraph will be included, in addition to the theory and method of operation
19. A complete inventory of all provided equipment and software including model numbers, serial numbers, version numbers in printed form and in the latest version of Microsoft Access
20. Final fleetmap configuration, with all group I.D.'s and aliases
21. A complete roster of unit I.D.'s and aliases
22. Documentation of final programming configuration for all software programmable equipment
23. A soft copy and printed copy of all equipment programming templates used in the system
24. Copies of the Hardware Acceptance Test Plan, with all recorded measurements

B. Exhibit A – Statement of Work, Attachment 1 – System Description, Revision 1

Attachment 1: System Description

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Revisions

Revision	Date	Implementer	Comments
1	05/24/13	Jeff Ecker	Original
2	01/09/14	Jeff Ecker	Modified for implementation of Consolidated Dispatch

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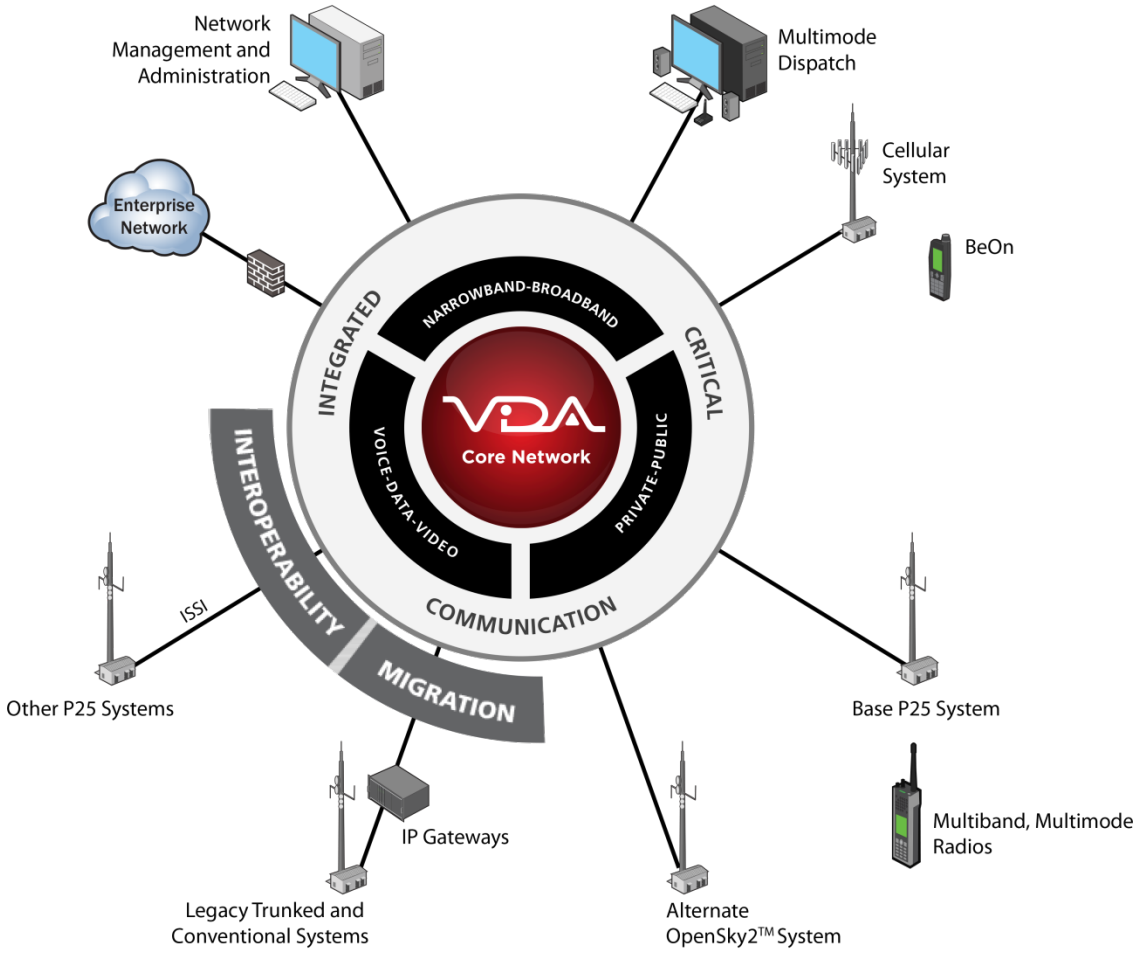
Voice Interoperability Data and Access (VIDA) Infrastructure

Harris' 'One Network' standardized design enables our engineering team to incorporate newer technologies and products as they emerge and mature. The Harris solution, with its modular scalability, enables future system growth as well as additional network technologies. Harris has designed standards compatibility into the VIDA infrastructure from its inception. Thus, the VIDA system can add new technologies and equipment natively.

Figure 1. VIDA System Infrastructure



System Overview

The following sections provide a summary of system components:

- The Network Switching Center (NSC) is located at the Hebron Water Tower with a second NSC located at FB2 (Davis Street Water Tower) for geographic redundancy. This north-south geographic split increases the survivability and fault tolerance of the network. The secondary NSC tracks the activities of the primary so that it is prepared to take over network switching duties at any time. Switchover between the primary and secondary is automatic in the event of failure of the primary. Each NSC switch will be equipped with a primary server (VIDA Management Server (VMS)), which hosts all the required system applications of the VIDA network. Additionally each site has a Unitrends backup system for rapid recovery in the event of loss of the local server data.

  There will be two (2) dispatch centers; the new consolidated dispatch center and a back-up which is also the Carrollton PD dispatch center. The consolidated dispatch center will have 10 operator consoles for the four (4) cities and two (2) training consoles. The Carrollton PD back-up center will have seven (7) consoles.

- A Unitrends server located at each NSC provides automatic/continuous backup of critical databases (radio, talkgroups and infrastructure) on and off site locations.

- An Exacom Logging Recorder is located at the primary and back-up dispatch centers to provide centralized recording for the proposed system. Each dispatch center will have two clients able to access the logging recorder.

- The Carrollton Radio Shop provides monitoring of the system with the VVMS, which hosts the Unified Administration System (UAS) and Regional Network Manager (RNM). This capability is also available at the Carrollton dispatch center.

- The system will consist of a P25 Phase 2 Simulcast system utilizing six (6) TX/RX sites, each consisting of ten (10) RF channels (18 talk paths), at Hebron Water Tank, Josey Lane Water Tank, FB1 (Justice Center Water Tank), FB2 (Davis Street Water Tank), Spectrum Center and Wagon Wheel Water Tank.

- An IP Simulcast Control Point is located with each NSC, one at the Hebron Water Tank, the other at FB2.

- All TX/RX sites reside on a microwave loop Harris has designed the microwave system so all sites reside on the loop.

  The microwave system will connect the six (6) TX/RX sites, two (2) dispatch centers, and the radio shop. Addison PD is connected via a microwave spurs going to the Addison EOC. Farmers Branch PD is connected via FB1 and Carrollton PD is connected via Carrollton Dispatch. Coppell PD will be connecting to the network via a fiber connection to be provided by the City of Coppell.

Fault tolerance was one of the major design objectives of our P25^{IP} VIDA Network design. In critical situations, system reliability is of paramount importance. A system that does not operate reliably or that changes operation dramatically during failure modes exposes its user to unacceptable risk.

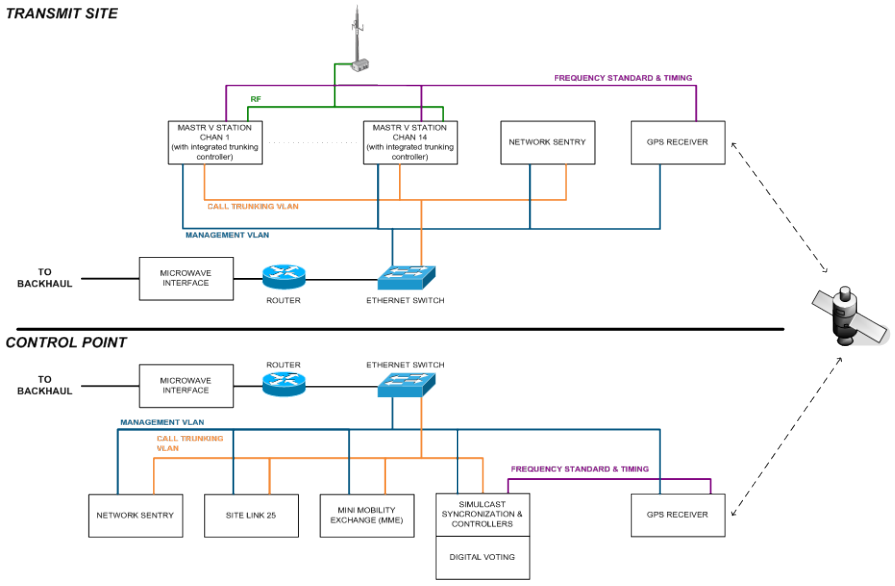
Harris' P25^{IP} uses distributed processing architecture to provide unsurpassed fault tolerance. This design philosophy concentrates on avoiding any single point or common cause failure that will force the system

to non-trunked operation. P25^{IP} VIDA Networks offer the land mobile radio user the added security of continuous trunking. Harris believes that a crisis situation, such as a storm, is the worst time to lose the call capacity and advanced features that trunking provides. In the case of catastrophic failures, P25^{IP} is designed to support a variety of user-configured operation modes to provide a managed landing rather than an uncontrolled crash.

Components of P25^{IP} Simulcast System Architecture

Within the P25^{IP} Global Positioning Satellite (GPS) Simulcast System, there is an IP control point. The IP control point location for the Metrocrest system is at the Hebron Water Tank site with a second (redundant) located at FB2. The simulcast RF sites connect to the simulcast control point with an Alcatel-Lucent loop microwave system. It is critical that this link be stable and provide accurate digital communications between the control point and the transmit sites. Harris' design is unique in the way it controls the critical simulcast parameters, frequency stability, amplitude equalization, phase equalization, and timing equalization. Figure 2 is a high-level block diagram for the P25^{IP} GPS Simulcast IP Control Point and transmit site.

Figure 2. P25^{IP} GPS Simulcast System Block Diagram



P25^{IP} Trunked Simulcast

The P25^{IP} Trunked Simulcast land mobile radio system provides a solution for coverage demands within a large territory requiring wide area communications. P25^{IP} trunked simulcast systems enhance communications in coverage areas where the size of the territory is too large for a centralized transmitter location or where the signal paths are blocked by irregular terrain or other obstacles.

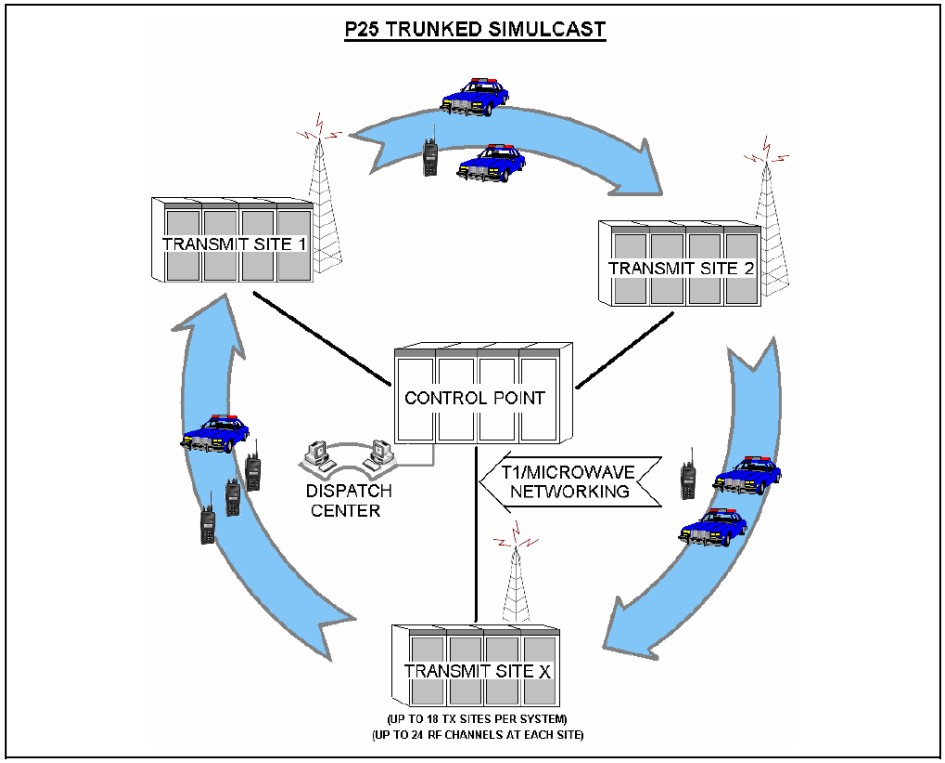
Simulcast is also an advantageous solution in areas where the available frequencies (channels) are limited since simulcast uses the same set of frequencies at each site. All transmissions are system wide. This means identical messages are transmitted from all sites, on the same frequency, and timed to arrive at receiving radios at precisely the same time. A P25^{IP} Trunked Simulcast system includes a control point

and two or more transmit sites. The transmit sites are connected to a common Control Point. The Control Point exercises system control over all transmit sites as shown in Figure 3.

P25^{IP} Trunked Simulcast systems utilize a powerful combination of technologies to maximize the call capacity on the assigned communication channels. P25 Trunked is an industry standard APCO P25 trunked digital protocol. Combining P25 with Trunked Simulcast adds benefits like extended coverage areas, trunking, and greater usage of RF bandwidth. This system provides a reliable high performance solution when the number of frequencies is limited or users must communicate over a large area or rough terrain which cannot be covered from one transmit site.

The maximum number of simulcast sites is 17. Maximum number of multi-sites is 255, maximum number of IP consoles is 400, maximum number of subscriber units is over 9 million and maximum number of talkgroups is greater than 65,000. The simulcast control point is capable of supporting 24 channels.

Figure 3. P25^{IP} Trunked Simulcast System Overview



Continuous Coverage

Simulcast provides continuous coverage over a large geographic area (wide area) using a single set of frequencies. In a simulcast system, all sites have the same set of frequencies. The same channel is the control channel at every transmit site.

Overlap Zone

The challenge of a simulcast system is to provide high quality signaling to radios in the overlap zone. An overlap zone is the geographic region where two or more signals of comparable power are received by a

single radio. To understand the overlap zone and its significance, an understanding of the concept of capture and non-capture zones is necessary. The simulcast coverage area contains two types of areas: those captured by a single site and those hearing two or more sites of approximately equal RF signal level.

- Capture Zones – A radio (receiver) is captured by an RF signal when the mean signal level is higher than other RF signal sources by a margin strong enough to suppress the weaker signal's modulation product so that data errors (missing data/voice frames) created by the mixing of the two signals do not disrupt the intended data stream from the mean signal.
- Non-Capture Zones – In the "non-capture" or "overlap" zone, the mobile receiver accepts two or more signals. These signals mix randomly producing stronger or weaker signals. If one site's received mean signal power level is within several decibels of other sites' on-frequency modulated signals, audio intermodulation and distortion may occur. Audio distortion increases to a maximum when the received carrier signals are equal. In digital communications the distortion can cause data errors and result in distortion or missing voice (data) frames. Good communication in these areas is maintained by precision system synchronization and equalization.

Control Point Basics

The Control Point is the central point for system control. The Control Point provides the necessary interfacing between two or more transmit sites and dispatcher locations. Timing references for outbound (transmit) data are generated here and sent to each transmit site and selection of the best quality inbound (receive) data from each site is managed by the Control Point equipment.

Outbound (Transmitter) Signaling

Timing (or delay) for the outbound transmissions is adjusted by each transmit site to make the timing reference signals from the Control Point and transmit site match. Control of the exact time the common outbound signal is transmitted from each Transmit site in a simulcast system is critical to areas where overlapping coverage zones exist between two simulcast transmit sites. Proper timing results in effective simulcast communications. Using the precise timing signals produced by GPS receivers to synchronize P25 Trunked Simulcast systems provides an efficient and cost-effective solution for obtaining the above conditions.

GPS receivers at all sites produce a 1pps clock signal, used for system timing. At the Control Point, the GPS timing signals are used to generate the outbound data and a timing reference which is embedded in the outbound transmit data packets which are sent to all transmit sites. The timing reference generated from the local GPS receivers at all transmit sites are compared with the recovered timing signals from the Control Point by the base station to set the proper transmit time.
In addition to the 1pps timing reference signal, the GPS receivers at the Control Point produce a 10 MHz clock for the control point traffic controller shelves and the network backbone equipment. At the transmit site the GPS receivers produce a 10 MHz clock for the station reference which is used for both precise RF carrier generation and precise control of the transmit data rate.

Inbound (Receiver) Signaling

Transmissions made by land mobile radios and received by the receivers at one or more transmit sites must be passed to the Control Point where receive data from all receivers is compared and the best quality signal is repeated and passed to the dispatch point. Unlike most voting systems, the Harris IP voting

system compares each frame of audio and is able to select the best audio faster and even in the middle of a conversation. This approach ensures that the best audio is repeated from the system.

Transmit Site Basics

Timing of the information sent out by transmit sites is critical to a successful simulcast system. Transmitter RF frequency stability, modulation levels, phase, and timing of data signals from two or more transmit sites must be matched in the overlap zone.

Each transmit site is also equipped with a Network Sentry computer system. The Network Sentry works with the Regional Network Manager (RNM) and used to monitor and set simulcast system parameters and alerts the user of possible fault conditions.

A transmit site includes both a base station transmitter and receiver for each channel as well as the common equipment required for P25 Trunked Simulcast. A transmit site may be co-located with the Control Point. The remote RF sites connect to the Control Point by an IP link. It is important that this link be stable and provides accurate digital communications between the Control Point and the transmit sites.

The APCO Project 25 TIA Standards do not define an access time for a unit to unit call for users operating within the same RF subsystem. Instead the standards define requirements for subsets which may be summed to provide the Intra-Cell Latency and Delay time. In addition, the standards allow multiple modes of accomplishing the subset requirements which result in a range of times for each subset. Subsets defined in the Standards are Trunking Request Time, Time to Grant, Transmitter Time to Key on a Traffic Channel, RFSS Throughput Delay, and Receiver Throughput Delay. Summing the worst case value for each of these requirements results in an access (PTT to grant tone) requirement of approximately 713 ms and a Voice Latency requirement of 350 ms, which results in an approximate Intra-Cell Latency and Delays requirement time of 1063 ms. The performance of Harris equipment is expected to be less than 1000 ms. This latency and delay is based on typical numbers which mean a strong signal is present at the subscriber units, the system is not loaded and blocking is not occurring.

Harris' system is capable of rearranging the queue based on a relative priority level associated with a specific radio unit. Our system design default gives highest priority to a "System All-Call", followed by "Emergency Alerts/Calls", followed by any other call in the queue.

As stated above Harris provides two levels of emergencies:

- Level One Emergencies – System All-Calls
- Level Two Emergencies – Emergency Alerts/Calls

A System All-Call is the highest level of emergency provided in the Harris P25 architecture. It basically is a broadcast transmission which can be used by a dispatcher/supervisor/administrator to distribute important information of massive emergencies or catastrophes' to ALL AGENCIES in system. Hence Harris feels that such calls warrant higher priority than any other call in the system. A "System All-Call" is rare and in day-to-day operations, regular emergency alerts/calls will still have highest priority than any other call in the queue.

ProSync

ProSync is an algorithm that tells transmit sites when to start sending data to the user radio. Data synchronization is important for high-speed data communications. In land mobile radio systems, transient impulses such as from extreme weather conditions and other noise inducing factors affect data synchronization. To achieve long term stability, Harris engineers developed the ProSync synchronization technology. ProSync is built into the control channel signaling and requires no special maintenance. Its purpose is to constantly resynchronize both the control channel and working channels using two different methods to safeguard system performance.

The control channel at each site is automatically resynchronized by folding a "re-sync" marker into the continuous control channel data stream every five seconds. After the marker is transmitted, the system restarts the control channel at all transmit sites at exactly the same time. This assures automatic resynchronization in the event of a transient induced control channel shift and the field radios continue operating without interruption or impact.

The working channel is resynchronized with every Push-To-Talk (PTT). As the radio is assigned to a working channel, the initial high-speed handshake is used to automatically resynchronize the high-speed data transmitted at all sites. This high-speed handshake occurs every time the user keys a radio; again, this resynchronization has no noticeable impact to the operator.

System Stability

In a typical simulcast system, transients produced by weather disturbances such as lightning and other sources of noise can affect data synchronization. These transients may disrupt a microwave path or cause the microwave system to switch over to hot standby. Data synchronization must be maintained to achieve overall system communication integrity in the overlap zone. Two methods are employed to assure long term synchronization and stability:

- Frequency synchronization from GPS.
- A unique High Speed Data Auto Re-Synchronization system.

The RF carrier frequency of each channel is precisely maintained within 0.1 Hz of the desired frequency to minimize distortion due to heterodyning frequencies. To achieve this level of performance, the reference oscillator at each transmitter is locked onto the 10 MHz reference signal derived from the 1.5 GHz signal from the GPS receiver. The accuracy of the 10 MHz oscillator, when locked to the GPS, is held within 1×10^{-12}.

P25^{IP} Trunked Simulcast Advanced Functionality

One of the primary goals for any communications system is to maintain communications under all conditions. This goal is paramount for public service communications. In a system requiring inter-site communications (e.g., microwave or fiber optic), there obviously is a risk of outage. Optimizing a Simulcast Communications System for maximum performance involves complex techniques that have been simplified through the use of the Harris Simulcast Optimization (ESO) tool.

P25^{IP} Trunked Simulcast Optimization

ESO is Harris' optimization tool that uses a specially designed measurement system and a computer simulation. The measurement system determines the actual signal strengths and time delays from all transmit sites simultaneously. A color coded map showing the communication quality is generated using the collected data. The effect of each site can be isolated and key parameters can be changed in the database to simulate changes to the simulcast system.

At the heart of the ESO system is a vehicle-mounted GPS receiver tied to a signal measurement and recording device. Each second, the GPS receiver supplies a position update that is compared with the position of the last measurement. As the vehicle moves through the coverage area, multiple signal measurements and the exact locations are logged for later plotting.

As an additional test, ESO also keys a portable radio and records the success of its channel request. In P25 Trunked, a radio must successfully transmit a request and receive a channel assignment from the IP control point Traffic Controller before a call is allowed to begin. This test verifies both inbound and outbound messages and provides secondary measurement of portable control channel coverage. It also pinpoints areas with local timing anomalies.

At each point on the Simulcast Optimization map, the potential RF capture and time differentials can be examined. Once it is known which site is creating interference, it can be determined how to minimize the interference. In minutes, the new coverage using the new parameters (transmit power, time delay, antenna type and orientation) can be simulated.

P25^{IP} Trunked Simulcast Control Point Equipment

The Control Point coordinates transmit and receive activities of the base stations at the TX sites, and provides interfacing to the UAS and RNM, via the Regional Site Manager Pro (RSMPro) Server, where system programming and communications interfacing takes place. All P25 signals are routed through the Control Point where synchronization and processing are performed to enhance system performance in the overlap zone. All management and control messages route to the Control Point for processing by the SiteLink and alarm signaling is routed to the Network Sentry computer.

P25^{IP} Trunked Control Point equipment consists of a single rack, having equipment for the following:

- **Traffic Controller shelves** – Equipment that generates the timing reference and outbound transmit data packets, performs voting of inbound data packets, provides channel management, and provides switching between redundant GPS references. Management of this equipment is performed by the UAS and RNM.
- **Network Sentry** – Equipment that provides alarm monitoring and reporting locally and to the Regional Network Manager (RNM).

- **Network Equipmen**t – IP switches and Router to provide connectivity to each TX site and to the VIDA network for console and multisite communications.

During normal operation, the redundant control point is under power, with the wide area router (WAR) held in standby mode. Manual switchover consists of a disable to standby notification message to the failed control point's WAR, followed by an enable message to the redundant control point's WAR. Each component of the Simulcast Control Point is redundant (as shown in the rack diagrams included under the tab labeled "System Drawings"). A Single component failure will not disable the system. Additionally, if the entire Control Point fails, the sites revert to Bypass mode of operation with the dedicated frequencies only being used at one or a subset of sites (final plan to be decided at Detailed Design Review). The system would only be in bypass mode until the Backup Simulcast Control Point is manually switched on.

The Simulcast IP controller and voting cards (Traffic Controllers) are equipped for ten (10) P25 Phase 2 channels and are capable of expanding to 24 channels with addition of cards. Routers and switches are equipped for 24 ports and capable of expansion. The combiner is equipped for ten (10) channels while the multicoupler is equipped for 16 channels. Both are capable of expansion.

The simulcast control point is capable of supporting 24 channels and 17 sites. Site separation is a factor of many items such as terrain, antenna height, types, power, timing parameters, etc. For our studies for the P25 Simulcast system proposed we used 60µs for timing in our design.

Timing (or delay) for the outbound transmissions is adjusted by each transmit site to make the timing reference signals from the Control Point and transmit site match. Control of the exact time the common outbound signal is transmitted from each Transmit site in a simulcast system is critical to areas where overlapping coverage zones exist between two simulcast transmit sites. Using the precise timing signals produced by GPS receivers to synchronize P25 Trunked Simulcast systems provides an efficient and cost-effective solution for obtaining the above conditions.

GPS receivers at all sites produce a 1 pps clock signal, used for system timing. At the Control Point, the GPS timing signals are used to generate the outbound data and a timing reference which is embedded in the outbound transmit data packets which are sent to all transmit sites. The timing reference generated from the local GPS Receivers at all transmit sites are compared with the recovered timing signals from the Control Point by the base station to set the proper transmit time.

In addition to the 1pps timing reference signal, the GPS receivers at the Control Point produce a 10 MHz clock for the control point traffic controller shelves and the network backbone equipment. At the transmit site the GPS receivers produce a 10 MHz clock for the station reference which is used for both precise RF carrier generation and precise control of the transmit data rate. The maximum amount of path delay is 35ms.

The proposed system is capable of supporting 24 RF channels and doesn't use a typical voting comparator but uses the MASTR V IP Control Point Traffic Controller Module within the Simulcast Control Point to perform voting functions that a voting comparator would perform. Additional Traffic Control Modules can be added up to the 24 channel limit.

The Control Point is the central processor for the MASTR V P25 IP Linear Simulcast system and performs all call functions, scheduling, and control. There are up to 24 Traffic Control (TC) modules at the IP Control Point, one module for each RF frequency (channel) in the simulcast system. All inbound

requests are processed and channel assignments made by the Traffic Controllers at the Control Point. Inbound signals from all TX sites and Auxiliary Receiver sites are received by the RF channel's associated TC module. The TC module processes and votes the best quality packets. The TC sends the voted packets onto dispatch consoles and other network devices such as voice recorders and VIDA Transcoders. The voted packets are also sent to the TX sites for retransmission over the associated RF channel.

The VIDA Network Sentry provides alarm and fault monitoring including system parameters, and alerts the RNM of any fault conditions.

Setup, configuration, and programming of a MASTR V P25 Trunked system is accomplished through the use of VIDA Device Manager programming software tool. VIDA Device Manager is an easy-to-use programming tool designed around a Windows-based file management system that permits users to configure and manage devices within the system.

Transmit/Receive Site

At the transmit site, the signals are processed by the site's simulcast equipment and interfaced to the remote simulcast control point controllers. In P25^{IP} GPS simulcast, there is no Site Controller computer at the transmit site. Instead, the processing is distributed in the station controllers, which eliminates the risk of a single-point failure. In the unlikely event that communication is lost between a transmit site and the control point, these station controllers will allow the site to continue local trunking. Dual GPS receivers and oscillators are located at each transmit site to ensure that the frequency of the signals is the same in the overlap zone. Each base station acts as both a transmitter and a receiver.

The remote transmit/receive site consists of the following:

- Simulcast Trunked Repeaters – P25T MASTR V
- Station Controllers – P25T Traffic Controller
- Simulcast Synchronization Unit
- Remote Alarm Unit – Network Sentry

A call is assigned at the simulcast control point controllers. The audio or data is synchronized and processed before being passed via microwave to each transmit site. The transmit site resynchronizes the audio or data, adds the appropriate delay, and passes it to the assigned station. GPS receivers provide precise timing signals at both the control point and each transmit site. This same GPS signal is used to derive the 10 MHz frequency reference for the base stations at each transmit site. For the return path, audio or data is received by the station at the transmit site. That information is analyzed for bit errors, IP packetized and sent back to the associated channel at the Control Point. The information is compared with data from other RF sites and all that is left for the channel to do is determine which site has provided the signal with the fewest bit errors. The channel then provides the best received signal to the simulcast control point controller for re-transmission. The maximum amount of path delay compensation is 100 microseconds.

Each of the RF sites includes an antenna system which includes the following items:

- The combiner is a dbSpectra model DSCC85-10D and is equipped with 10 channels expandable to 24 channels with properly spaced frequencies.
- The receive multicoupler is a TX/RX model 430-83H-01-T and is equipped with 16 channels expandable to 32 channels.

To add an RF site to the existing design another transmitter site with antenna system and GPS receivers is required. Additional Traffic Control Card(s) are required at the Simulcast Control Point(s). Additional site licenses need to be purchased. The MASTR V IP Simulcast Controller is capable of 24 RF channels

To add an RF Channel at a simulcast site, a baseband module, traffic controller module and additional combiner port needs to be added at the site. At the Simulcast Control Point an additional Traffic Controller card must be added. Additional channel licenses also need to be purchased.

The hardware/software cost to add another channel to the system is approximately $375,000 *excluding* labor and services. The overall cost will depend upon the frequency added as it affects the antenna system. Labor and services will depend highly upon the statement of work for the channel addition.

System Control

The Traffic Controller in each base station maintains all of the trunking logic. These station controllers interconnect to one another and to the Site Link 25 controller, which allows the Site Link 25 controller to collect site management information. In the event of a Site Link 25 controller failure, non-critical management features would be reduced, while all trunking features would be retained under the control of the Traffic Controller.

The Traffic Controller takes all of the trunking intelligence and control out of a single Site Controller computer and distributes them among the repeaters. These station controllers interconnect, which permits sharing of control channel information among the working channels and allows any working channel to assume the functions of the control channel. This eliminates the possibility of a site failing into conventional-only mode due to all control channel capable stations failing.

At the transmit site, the signals are processed by the site's simulcast equipment and interfaced to the remote simulcast control point controllers. In P25^{IP} GPS simulcast, there is no Site Controller computer at the transmit site. Instead, the processing is distributed in the station controllers, which eliminates the risk of a single-point failure. In the unlikely event that communication is lost between a transmit site and the control point, these station controllers will allow the site to continue local trunking. A call is assigned at the simulcast control point controllers. The audio or data is synchronized and processed before being passed via microwave or fiber to each transmit site. The transmit site resynchronizes the audio or data, adds the appropriate delay, and passes it to the assigned station. GPS receivers provide precise timing signals at both the control point and each transmit site. This same GPS signal is used to derive the 10 MHz frequency reference for the base stations at each transmit site. For the return path, audio or data is received by the station at the transmit site. That information is analyzed for bit errors, IP packetized and sent back to the associated channel at the Control Point. The information is compared with data from other RF sites and all that is left for the channel to do is determine which site has provided the signal with the fewest bit errors. The channel then provides the best received signal to the simulcast control point controller for re-transmission. The maximum amount of path delay compensation is 100 microseconds.

P25 GPS Simulcast TX/RX Site Equipment

The distributed processing architecture starts at the repeater, the heart of the P25^{IP} GPS Simulcast System. Because of this, a high-degree of fault tolerance is already built into the system, regardless of if it is a simulcast system or a multisite system. The rock-solid reliability provided by P25^{IP} is now enhanced with the introduction of the Traffic Controller described above. Competitors may bid Site Controllers and redundant Site Controllers to provide the level of reliability required by public safety agencies. With Harris' P25^{IP} GPS Simulcast System, Site Controllers are a thing of the past; Harris has SMART trunking repeaters!

P25 Phase 2 RF Sites

Each of the Metrocrest Quad Cities full-featured P25 Phase 2 sites includes:

- Ten (10) rack-mounted MASTR V repeaters and Power Amplifiers (PAs)
- Site Access Router
- Two-slot TDMA software

Figure 4. MASTR V Station

- **MASTR V™ Series Base Stations** – Incorporates P25 digital voice and data using a digital signal processor for maximum design flexibility. The MASTR V can operate in P25 Phase 1 or Phase 2 mode and is also configurable for data use.
- **SitePro™ Controllers** – The trunking controller consists of a dedicated microcomputer associated with each repeater station. This device enables trunking operation by providing signaling generation and detection, control channel assignment, and working channel repeater control. Each SitePro also has a copy of the site access database which tracks subscriber authorization. This distributed architecture across all channels in the system enhances reliability by allowing any station to act as a control channel with automatic rotation in the event of control channel failure.

Features

Architecture

The MASTR V Base Station is a P25 Phase 2 capable transceiver. The MASTR V Base Station is a digital, IP based, LMR communications base station operating within a compact shelf design. It supports IP-based remote software uploads and configuration. IP-based programming may be accomplished using the VIDA Device Manager programming tool. A built-In Self Test feature provides improved performance through remote diagnosis which minimizes down time.

The MASTR V Base Station uses a 14-slot modular multi-channel T/R shelf assembly (refer to Figure 4 above) and a 2-slot High Power Amplifier/Power Supply shelf assembly. Modules may include BaseBand Processors, Traffic Controllers, TX, and RX modules.

The TX module uses a factory programmable IQ modulator circuit capable of generating most any LMR modulation format into a Direct Digital Synthesis TX exciter circuit. Additionally, the HPA may be equipped with a Linearizer module for improved amplitude and phase noise characteristics in S-C4FM or similar modulation modes.

The RX module includes integrated front end and IF circuitry. The RX module also uses IQ demodulation circuitry. The IQ demodulator is factory programmable and can decode most amplitude and phase modulation characteristic, making it capable of receiving most analog or digital LMR modulation format.

The multichannel shelf occupies 5-RU spaces. The High Power Amplifier/Power Supply shelf occupies 2-RU spaces (per TX channel).

The MASTR V Base Station for MQC has P25 Phase 2 included at no additional charge. P25 Phase 2 can double the system's capacity via 2-slot TDMA without adding additional RF channels – future proofing your investment!

MASTR V Base Station

We are proposing our MASTR V digital base station to power secure digital trunked radio communications via Project 25. The MASTR V provides P25 Phase 2 from day 1. The MASTR V incorporates P25 digital voice and data using a digital signal processor for maximum design flexibility. The MASTR V enables IP voice and data packets to be sent over the P25 Phase 2 network and be received at the base station. This setup enables all of the advantages of Harris' IP-based technology platform including:

- Seamless integration of off-the-shelf IP data applications
- Easy interconnection of peripherals and ancillary equipment such as mobile data terminals
- Economical routing and backhaul of network data
- Redundancy benefit of distributed IP architecture, one of the key requirements for most public safety users

Figure 5. MASTR V Repeater Shelf with 4 RF Channels

The MASTR V employs linear simulcast for superior coverage and is comprised of a fully modular design. The MASTR V employs an easy-to-use software interface that provides flexibility, simplified setup, and easy field upgrades as well as remote programming. The functional design of the MASTR V base station allows the user to make changes quickly, easily, and affordably. The modular design of the base station makes maintenance and servicing simple and fast.

All MASTR V stations for Metrocrest will include P25 Phase 2. This permits MQC to double the system's capacity without adding additional RF channels. This future proofs MQC's investment.

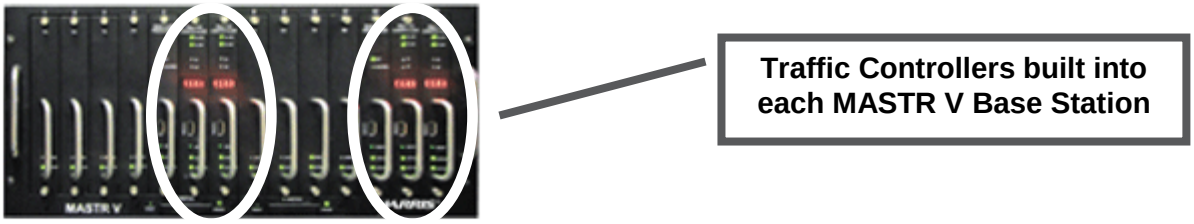
Traffic Controller – The Next Level of Redundancy

The Traffic Controller implements Project 25 call control, network management, and remote channel management. Utilizing the Traffic Controller, P25 features such as radio registration, authentication, and mobility management are available on a channel by channel basis.

The Traffic Controller interprets and directs inbound calls, processes the calls, and issues appropriate commands about handling the calls. The Traffic Controller is also responsible for the IP connectivity of the individual channels to the P25 network. The advanced processing power of the Traffic Controller monitors ongoing repeater communications, while providing routing for multisite voice and data calls. The Traffic Controller also replicates, at the site, key P25 database information to allow uninterrupted channel operation.

The Traffic Controller encapsulates P25 clear and encrypted voice and data calls into IP packets for routing throughout the P25 Phase 2 network. The packets contain P25 user and talkgroup IDs, allowing the network to operate with seamless end-to-end IP functionality. The Traffic Controller is part of every MASTR V repeater, which makes each MASTR V intelligent with the ability to take control should failure occur in the existing control channel.

Figure 6. MASTR V Controller



Control Channel / Working Channel Redundancy

An essential feature of the Harris P25^{IP} GPS Simulcast System is a fault tolerant design. All channels have the ability to function as a control channel and a working channel. Our P25^{IP} GPS Simulcast System does not limit control channel operations to just three or four channels as in other manufacturers systems. If a control channel fails, the distributed processing capabilities of the system automatically take that base station out of service, and assign any other channel as the control channel. Likewise, if a working channel fails, the distributed processing capabilities of the system automatically take that base station out of service. This operation is transparent to the end user. Furthermore, this "graceful degradation" trunking capability continues until there is only one channel left, at which time all communication from the site will be lost.

Network Sentry Alarm and Control System

Harris' Network Sentry Alarm and Control System provides real-time site status information to MQC's system management personnel through the alarm tree on the Regional Network Manager (RNM) and RNM clients.

The Network Sentry Alarm and Control System provide a full array of digital communications capabilities for fast, accurate, and efficient relay of critical information. As part of the Harris P25 GPS Simulcast System, the Network Sentry plays a crucial role in meeting the communication requirements of public safety, public service, and first responders.

The Network Sentry monitors the site call processing local area network (LAN) for call activity and fault messages. The Network Sentry ensures that data such as user, group, and channel configurations is reliably transferred to configured site devices. Management of resources is easier and more efficient with the Network Sentry because it was designed to take full advantage of the sophisticated capabilities of the Harris P25^{IP} VIDA Network.

The Network Sentry provides a detailed snapshot of the entire system, showing exact locations of problems and potential problems. Its fault monitoring services take input from the site call processing LAN, RF Power, Digital Input/Output (I/O), and Channel Test services and present alarms to external management systems via Simple Network Management Protocol (SNMP) to determine the location of the potential problems and identify in detail the severity, status, and reason for the most recent failure. This increases operator awareness, improves response time for maintaining vital communication links, and decreases repair time and system downtime.

The Network Sentry allows users to create a flexible work environment tailored to help improve efficiency and productivity. It is equipped with an array of digital Input/Outputs (I/Os) which can be configured by the user to indicate faults in devices such as tower beacons, doors, temperature alarms, etc. that require remote controlling and monitoring. This information allows users to make quick, informed decisions to meet their needs and to adapt as those needs change.

The Network Sentry continually monitors RF repeater output power and antenna RF performance and removes failed equipment from service. Failures are promptly reported to the system management team through the RNM alarm tree for maintenance action. This enables system management personnel to retrieve site specific information without having to travel to a site to physically collect this information, saving MQC time and money.

Master Network Site Configuration

System Manager and Alarm Reporting

Today's radio system administrators need tools that ensure communications systems are highly available and optimally utilized. Administrators need access to real-time system status, performance metrics, configuration, security tools, and accounting data.

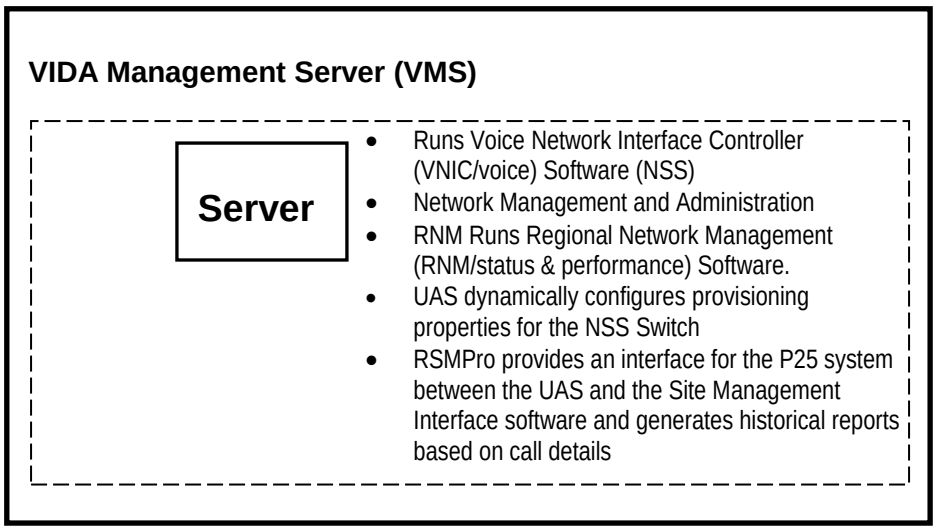
Network management and administration include the configuration, monitoring, security, and maintenance of software programs, system hardware, communications devices (user radios and consoles), and logical aggregations of these objects. A comprehensive set of network management tools is critical to any communications system. These tools provide the following functions:

- **Configuration** – setting equipment parameters to control communication between devices
- **Provisioning** – programming or downloading talkgroups and fleet mapping personalities into fixed infrastructure (e.g., consoles) and user radios
- **Administration** – enabling dispatchers, users, and agencies to utilize the system
- **Management** – monitoring equipment to ensure it is operating at peak efficiency, ability to see faults, and security management
- **Reporting** – generating outputs that are used to assess system performance, use, and operation for accounting purposes

Network Switching Center (NSC)

The heart of the VIDA network is the NSC which controls network audio/data switching and fleet administration. The proposed Metrocrest Quad Cities operates in a fully redundant NSC configuration. The NSC will be equipped with a single VMS server with the following applications as shown below:

Figure 7. NSC



Network Switching Server (NSS)

The P25 Phase 2 NSS consists of a commercial off-the-shelf server from Dell Systems which runs the voice (VNIC) software applications. The server model is selected based upon the required system capacity in terms of concurrent voice calls and data packets per hour.

The principal functions of the NSS are:

- Switching of voice and data packets and cross-site arbitration of voice access
- Switching and routing of data packets between subscriber units and fixed network hosts
- Access control of subscriber units - limiting access to only those subscribers that are duly authorized to use the system

If the Primary NSS, it's LAN/WAN, or the microwave system link were to fail, the Secondary NSS senses the loss of the Primary NSS and assumes the control of the network. The time required for the Secondary NSS to assume the control of the network depends upon which of the Primary NSS components has failed. The time could vary from less than 10 seconds up to 60 seconds.

Manual transfer from the Primary NSS to the optional Secondary NSS can be performed by the System Administrator by going to the Primary NSS, logging onto the NSS and entering a command to restart the Primary NSS as the Secondary NSS. The Secondary NSS senses the loss of the Primary NSS and will assume control of the network within 10 seconds of restarting the Primary NSS.

VIDA Management Server (VMS)

The VMS consists of a commercial-off-the-shelf server from Dell Systems which runs the NSS, RNM and UAS applications.

Regional Network Manager (RNM)

The RNM monitors the overall health of the system, provides real-time diagnostics, activity monitoring and sets system/network and element configuration parameters. A major feature of the RNM is the topology map showing all of the managed objects registered on a VIDA network (i.e., base stations, routers, etc.). The hierarchical relationships between the objects are displayed graphically, and the current status of each object and any related components is shown using color coding.

The primary functions of the RNM are:

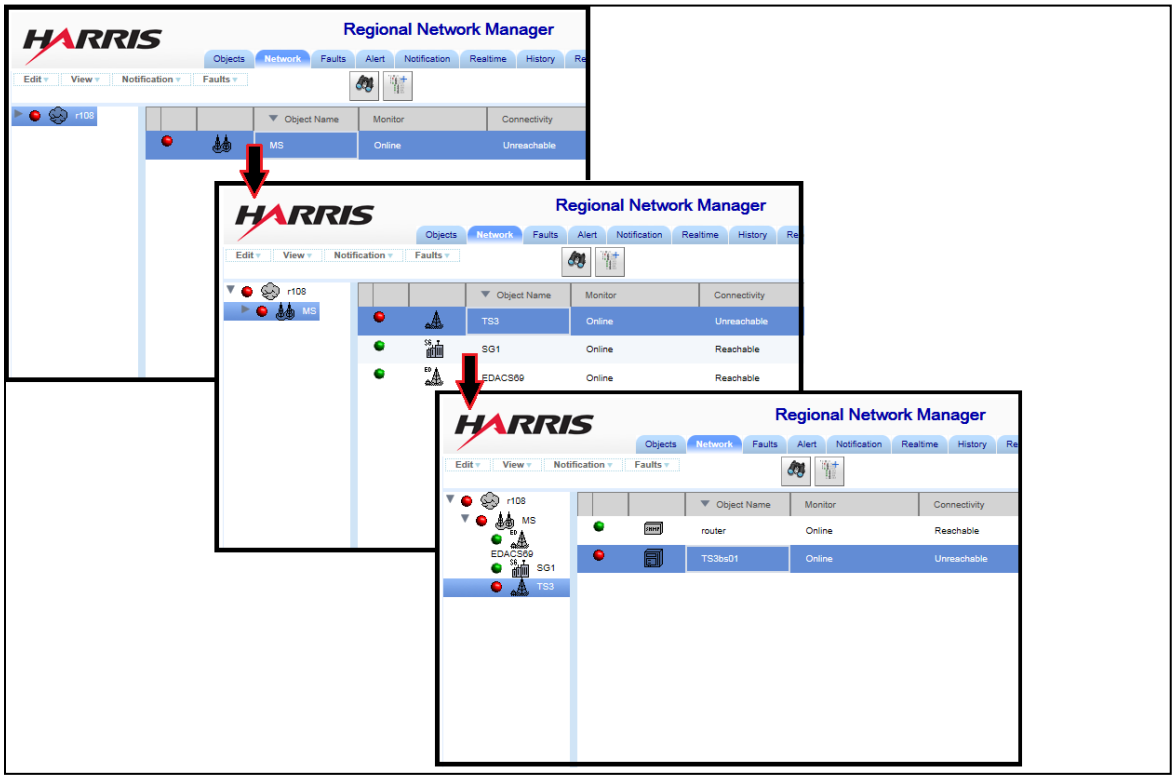
- Call activity monitoring
- Call activity reporting
- System configuration management
- Call data archive and restore
- Relay control
- Channel rotation

The RNM application may be accessed from the Carrollton Radio Shop or Carrollton Dispatch Center, or it may be accessed remotely via a PC client that resides anywhere on the radio network, such as a dispatch center. Network access requires an operating system log-in on a computer authorized to access the network. Access to the RNM requires a secure web browser.

An Audible Alert application provides an audible notification to the RNM operator of the current overall system status. Up to three different sounds (low priority alert sound, medium priority alert sound, high priority alert sound) can be assigned to various object status conditions.

The RNM also provides monitoring of the individual software packages and logs performance incidents from the NSS application. The operator can select an icon and right-click on the mouse to call up the command menus. A graphical user interface provides ease of use for network operators.

Figure 8. RNM Display



For the MQC, the RNM acquires the trap information and performance information, such as grade of service, of all the managed objects keeping the network operators up-to-date with the latest status of all domains in the network. The RNM includes specific monitoring tools such as the Network Viewer, Object List, History Browser, and Real-Time Viewer. Overall, an RNM user will find the task of network management much more efficient. RNM provides access to all alarms and available information via the SNMP interface. Harris RF devices, such as base stations and cell sites, report information to the RNM which provides SNMP proxy services to third party applications. Cisco network equipment and the Network Sentry, mentioned below, support SNMP directly.

Unified Administrative System (UAS)

The UAS is a web based application that affords system administrators the ability to make modifications to system parameters from a web browser anywhere on the network. By using the UAS, the administrator can modify database parameters such as a user's, or a group of users' priority, talkgroups, telephone-connect privileges, encryption properties, user access to specific sites, etc.

The UAS is the centralized access point from which the P25 Phase 2 system is provisioned. It is an integrated real-time administration tool based on a client-server architecture that allows multiple authenticated user access at any location connected to the network.

The UAS is platform independent, scalable, and customizable and supports any ANSI-92 compliant Relational Database Management System (RDBMS). Java Technology permits the server to run on any platform that supports the 1.3 Java Virtual Machine (JVM). This allows the use of a commercial-off-the-shelf (COTS) web-browser for System Administrators to gain access to the UAS and permits low-cost PC based terminals to be used for client access, as long as they have VPN access to the system.

The UAS provides a database of resource pools from which administrators may configure dynamic provisioning properties for the NSS Voice Switch (VNIC) and Interoperability Gateways. The VNIC maintains a number of databases that are managed through the UAS.

Examples:

- **Talkgroup Configuration –** The VNIC maintains a database of talkgroups, each of which may represent an individual user or collection of users. Talkgroup parameters include:
  - Group Number – 16 bit identification code for the group (one entry per group)
  - Group Name – Text name to display for the group (one entry per group)
  - Access Priority – One of 256 levels, (one is highest and 256 is lowest)
- **Channel Hang Time –** In message trunking, this is the period after release of PTT that the talkpath remains allocated to the previously active talkgroup. If no call ensues, the talkpath is released on expiration of the hang timer (one entry per group).
- **Talkback Timer –** The time interval after the end of a transmission within which the user must respond to the call on that received talkgroup (one entry per group).

User IDs

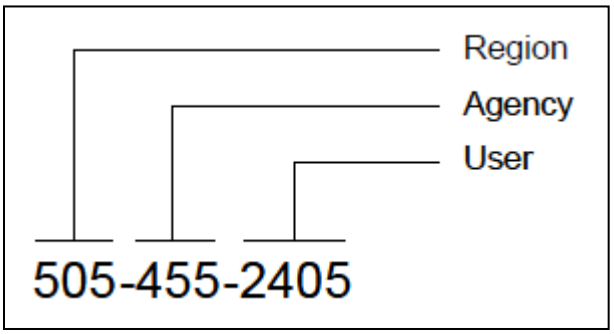
Each user on the network is assigned a unique User ID that is ultimately associated with an Agency and Region. These assignments are easily managed by the administrator.

The UAS uses the User ID's to ensure the user is authorized and to verify the user's privileges. The UAS recognizes the User ID as a 10-digit number, in hierarchical format, as shown in figure below. Typically, the User ID is defined as a concatenation of the user's home region, the agency or AOC that the user belongs to, and the ID that identifies the individual user or radio.

Talkgroup Call Priority

While the Project 25 standard only requires eight levels of priority, the Harris P25^{IP} VIDA Network leverages the recently-used priority to allow ten levels of priority, as well as additional priority levels to support preferred use by recent users, Emergency Calls and All Calls.

Figure 9. User ID Format



The Talkgroup Priority Class defines the access, queuing and data priorities of a group and are assigned on a per talkgroup or voice group basis.

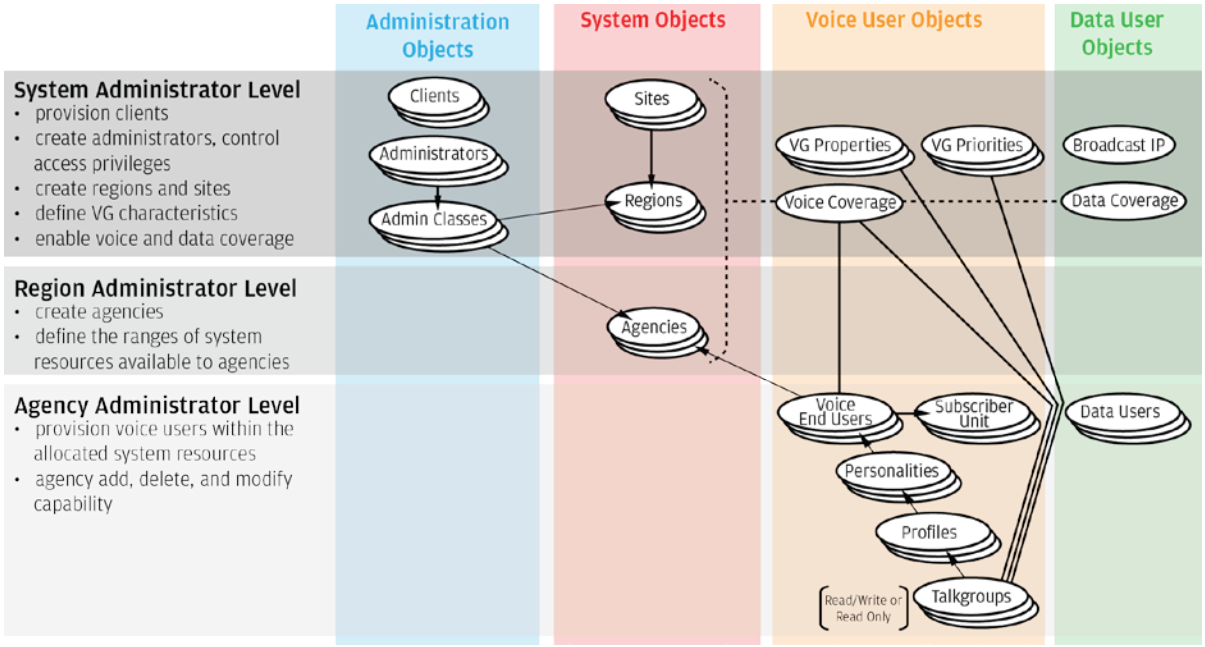
The user ID's are used for provisioning so that the proper radio personality and home region identifier is downloaded to the radio. The User ID is also used for selective calling from one subscriber to another.

Radio System Administration using the UAS

The UAS has three levels of access—system, regional, and agency—which are known as administration classes.

Assigning each administrative user to a class determines the administrator's access and capabilities, or privileges, within the UAS system. This process ensures that when users log into the UAS, they can perform only their authorized tasks and can modify only assets belonging to their particular agency. This role-based security is very important in a multi-agency radio network so that each agency can operate autonomously with security. An explanation of this designed hierarchy follows.

Figure 10. UAS Hierarchy



The UAS supports a hierarchy of three administrative levels, each with its own set of privileges. These user privileges ensure that only users with the correct levels of authorization can access or modify the secure information in the system. The administrative levels follow:

- **System Administrator Level** – This is the highest level of privilege available. Administrative users can configure system parameters, such as the System ID, Wide Area Communication Network (WACN), and RF sites. This enables the proper distribution of user database information, the establishment of system priority levels and privileges, and the monitoring of database distribution status. The creation and definition of other administrator accounts and lower level privileges can also take place. Also, this level provides the ability to perform the following functions:
  - Create administration classes for UAS administrators
  - Create UAS administrator user accounts
  - Create regions and sites
  - Create resource pools, including property, priority, and coverage classes
- **Regional Administrator Level** – This allows the user to create agencies and assign resource pools for agency administration. At the regional level, resources such as talkgroup IDs, user IDs, dispatch console IDs, and user privileges are created and allocated for use by specific agencies.
- **Agency Administrator Level** – At this level, individual agency administrative users can use the allocated resources to provision agency talkgroups, user radios, and dispatch consoles for operation on the radio network. The users also can perform the following operations:
  - Create and manage talkgroups
  - Create and manage radio users
  - Configure Public Safety Answering Point (PSAP) interfaces for dispatch consoles, logging recorders, or CAD equipment
  - Create and manage subscriber (radio) units

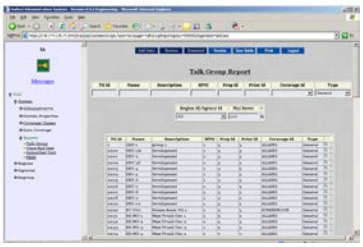
A fourth level can be created specifically for the purpose of dynamically regrouping talkgroups if required by operational practices. Dynamic regrouping allows the authorized UAS administrators to reassign radio users in various talkgroups to a predefined talkgroup, enabling them to communicate with an ad hoc collection of other users.

The UAS provides administrative users with a tool that has intuitive interfaces and integrity checking ability. Duplicate or invalid entries are not allowed, and error messages provide administrative alerts.

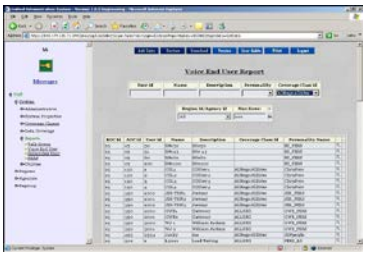
Administrative users can assign other administrators Read/Write (R/W) or Read-Only (R/O) access. Administrators with R/W access can download changes to the network based on their privileges. Administrators with R/O access can view configuration data, but they do not have permission to add, modify, or download data entries.

Generating Reports on the UAS

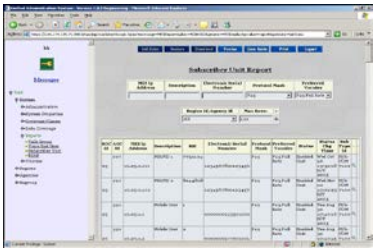
There are four types of reports, these include:



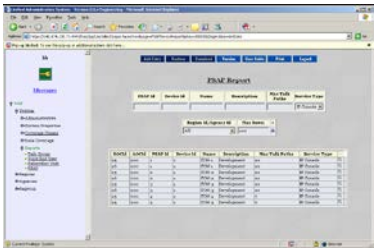
- **Talkgroup Report –** This screen enables the administrator to view the parameters for selected talkgroups. The report's content is determined by the information entered in the query fields. These fields filter the data, and the screen only displays talkgroups that meet the search criteria. This data is then listed in a tabular report format.



- **Voice End User Report –** This screen enables the administrator to view the parameters for a group of Voice End Users. The report's content is determined by the information entered in the query fields. These fields filter the data, and the screen only displays Voice End Users that meet the search criteria. This data is then listed in a tabular report format.



- **Subscriber Unit Report –** This screen enables the administrator to view the parameters for a group of Subscriber Units. The report's content is determined by the information entered in the query fields. These fields filter the data, and the screen only displays Subscriber Units that meet the search criteria. This data is then listed in a tabular report format.



- **PSAP Report –** This screen enables the administrator to view the parameters for a group of PSAPs. The report's content is determined by the information entered in the query fields. These fields filter the data, and the screen only displays PSAPs that meet the search criteria. This data is then listed in a tabular report format.

Regional Site Manager Professional (RSMPro)

The RSM Pro is a server that provides an interface for the P25 system between the UAS and the Site Management Interface software, which resides on the Network Sentry. This server is used for single region networks so they can obtain activity data.

The RSM is responsible for communicating the large database of radio system, talkgroup, and individual user information from the UAS to the RF sites. It consolidates site alarms and call activity to report site faults and alarms to the RNM. The RSM Pro includes two system management applications, the Activity Warehouse and the Device Manager, as well as the SAN.

The primary RSM Pro functions are:

- Database distribution to site RF components
- Site fault monitoring
- Call activity monitoring
- Call activity reporting
- System configuration management
- Call data archive and restoration

Activity Warehouse

The Activity Warehouse is a report-generating program used to monitor various aspects of a radio network that comes standard with the RSM Pro. It uses network-accessible web pages for initiating and delivering reports. These reports are based on IP call activity related to RF sites, consoles, gateways, and other devices on the radio network.

The Activity Warehouse performs data searches on call-logging data created and stored by network components. It can search the parameters stored within this data and report them in textual, table, and graphical formats.

This program automatically stores call detail history. Administrators can create user accounts that allow users to generate reports from the data. The call information data facilitate creation of several system reports, including:

- Number of inbound and outbound calls (Call Activity Report)
- Percentage of uptime (System Channel Uptime Report)
- Message traffic by agency (User Agency Report)
- Message traffic by transaction type (Call Activity with Events Report)
- Network bandwidth utilization (RNM Network Utilization Report)

The Activity Warehouse allows system administrators to track system usage by device and by user. It also tracks the number of talkgroup calls and the number of transmitted messages. The database logs radio user transactions (e.g., communications) and all supplemental information or unit status changes.

Authorized users can remotely generate reports and charts for call activity and related events. This remote access is allowed only through a password-protected log-in to a secure web browser. Users may access the Activity Warehouse from any PC connected to the radio network via Internet Explorer.

Call Transaction Logging Parameters

The Activity Warehouse records all call information with date and time stamps, source and destination unit/user/talkgroup IDs, and transaction type (i.e., group call, individual call, emergency call, data call). Unique unit IDs identifies all network devices, including consoles and interoperability gateways.

The Activity Warehouse call information provides a number of system-use management statistics, including:

- Number of inbound and outbound calls (Call Activity Report)

- Percentage of uptime (System Channel Uptime Report)
- Message traffic by agency (User Agency Report)
- Message traffic by transaction type (Call Activity with Events Report)
- Network bandwidth utilization (RNM Network Utilization Report)

Activity Warehouse Reports

The Activity Warehouse generates historical reports based on call details. Each report is an editable query (refer to figure below) where the user can select a custom range of details for inclusion in the report. From these reports, Windows copy-and-paste functionality will allow insertion of data into other applications. The PDF and Excel reports are also searchable through the use of PC-based productivity applications.

Figure 11. Activity Warehouse Sample Query

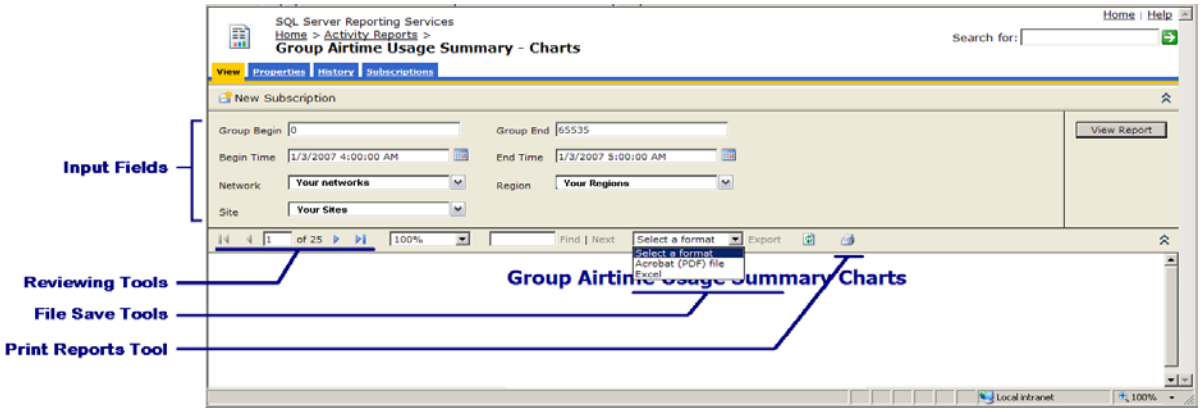
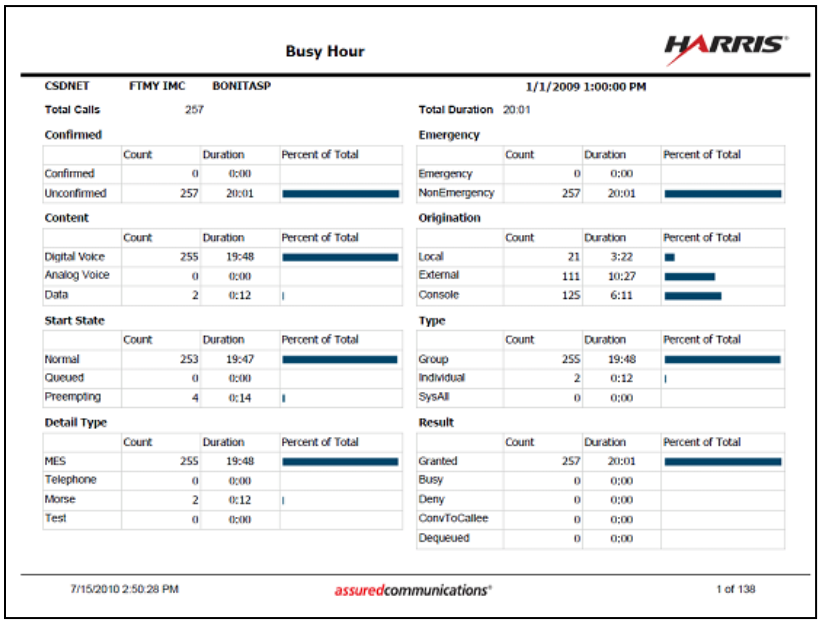


Figure 12. Example of Busy Hour Report



Busy Hour

CSDNET FTMY IMC BONITASP 1/1/2009 1:00:00 PM

Total Calls 257 Total Duration 20:01

Confirmed

	Count	Duration	Percent of Total
Confirmed	0	0:00	
Unconfirmed	257	20:01	

Emergency

	Count	Duration	Percent of Total
Emergency	0	0:00	
NonEmergency	257	20:01	

Content

	Count	Duration	Percent of Total
Digital Voice	255	19:48	
Analog Voice	0	0:00	
Data	2	0:12	

Origination

	Count	Duration	Percent of Total
Local	21	3:22	
External	111	10:27	
Console	125	6:11	

Start State

	Count	Duration	Percent of Total
Normal	253	19:47	
Queued	0	0:00	
Preempting	4	0:14	

Type

	Count	Duration	Percent of Total
Group	255	19:48	
Individual	2	0:12	
SysAll	0	0:00	

Detail Type

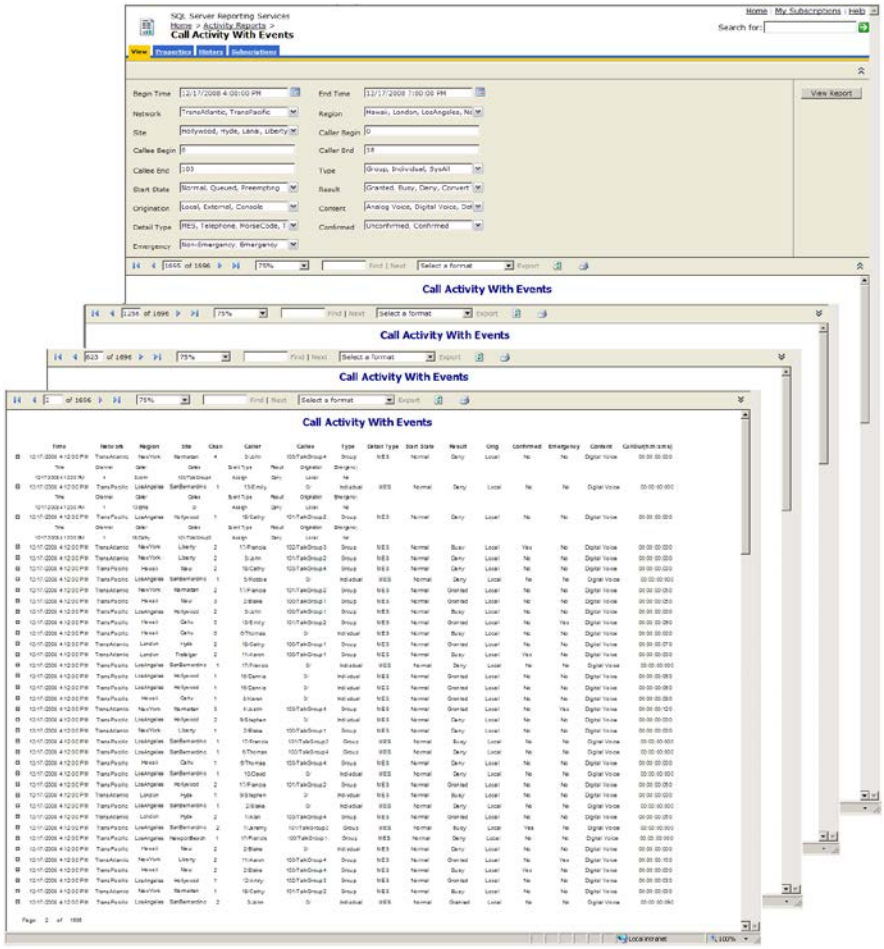
	Count	Duration	Percent of Total
MES	255	19:48	
Telephone	0	0:00	
Morse	2	0:12	
Test	0	0:00	

Result

	Count	Duration	Percent of Total
Granted	257	20:01	
Busy	0	0:00	
Deny	0	0:00	
ConvToCallee	0	0:00	
Dequeued	0	0:00	

7/15/2010 2:50:28 PM assuredcommunications® 1 of 138

Figure 13. Call Activity with Events Report



There are over 20 historical reports available in the Activity Warehouse. Figure 14 describes a sample of these various reports.

Figure 14. Activity Warehouse Reports

Report	Description
Busy Hour Report	Provides summarized statistics of the busiest hour for sites within specified regions and for a specified time period.
Call Activity Report	Shows all calls within a specified time period.
Call Activity with Events Report	Shows all calls and related events (e.g., emergency status, call completion status) within a specified time period.
Channel Profiled Statistics Report	Provides summarized system uptime and usage by RF channel on a per-hour basis.
Emergency Incident Report	Shows all emergency incidents and related emergency calls/events within a time period.

Report	Description
Events Report	Shows all events within a time period.
Group Airtime Usage Summary Report	Provides statistics for selected groups across regions and sites. Summary information is also available in graphical format.
Message Trunking Call Events Report	Shows all message trunking events within a time period.
Single User Agency Report	Provides statistics for all users with one agency for a selected time period.
System Channel Uptime Report	Provides statistics for channel uptime (time a channel was fully functional and capable of passing calls), actual airtime usage, and outage percent.
System Channel Usage Report	Provides the channel statistics for selected regions and sites for a selected time period. The report provides statistics for each channel at a site. Its information is also available in graphical format.
System Customized Report	Provides statistics for selected regions and sites. The user can choose different call category combinations to generate custom results.
System Profiled Statistics Report	Shows system usage on an hourly basis. The report provides an hourly overview of the number of units using a site and the percentage of use of certain call types.
System Usage Report	Illustrates system usage statistics for a specified region.
System Usage by Hour Report	Displays airtime, average call duration, and call count for each site on a per-hour basis.
System Utilization Report	Illustrates the summarized call statistics and unit log-on statistics for a region over a selected time period. The report provides the granted and total call results.
System Utilization Detail Report	Illustrates the summarized statistics for the system over a selected time period. The report provides data in a table format relative to the type of calls sent over a specific site during a specified time period. The report information is also available in graphical format.
User Agency Site Summary Report	Provides the summarized statistics for one user agency across a region or selected sites for a selected time period. The report information is also available in graphical format.
User Agency Summary	Provides the summarized statistics for all user agencies across a region or selected sites for a selected time period. The summary information is also available in graphical format.
User Airtime Summary	Illustrates the statistics for selected units across a region or selected sites for a selected time period.

Accounting Benefits of the Activity Warehouse

The Activity Warehouse provides detailed call reports that can be used for allocating network usage costs on a per-agency basis. Detailed call reports can be generated on a per-user, per-talkgroup, and per-agency basis.

Data from the Activity Warehouse are exportable to commonly used spreadsheet and/or database applications. This permits flexible data analysis and reporting capability.

Active Directory

Access Control and User Authentication

Microsoft Active Directory (AD) will be the primary method of controlling access to the Metrocrest Quad Cities VIDA network. This centralized service will perform authentication and authorization of users and devices to restrict unauthorized network access.

AD authentication is extended to UNIX servers with the integration of Quest Authentication Services for Solaris and Linux operating systems, and to devices that don't support the protocols (i.e. Cisco) through RADIUS. Active Directory is hosted on redundant and backup servers to ensure service availability.

Multi-Level Role-Based Accounts

Active Directory will allow Metrocrest Quad Cities' administrators to create multi-level role-based accounts. These differentiated roles are not only keyed to a user but to the machine they are accessing. The differentiated roles and centralized user management permits an administrator to not only control access to infrastructure devices, but to generate and push security policies and establish trusted websites and certifications. Active Directory Group Policies allow not only differentiation by user role, but the tandem application of joint machine and user profiles.

Workstation and Server Security

MQC servers, workstations, and network routers will be hardened with baseline security controls in accordance with generally accepted industry standards. These standards include the U.S. Defense Information Systems Agency Security Technical Implementation Guides (STIGs), the United States Government Configuration Baseline (USGCB), and the Centre for Internet Security baseline configurations. Security controls include:

- Removing unused software, services, and daemons
- Removing unnecessary rights from user and service logins to prevent end users without supervisor or administrator privileges from loading software or reconfiguring settings in any manner
- Configuring secured web browsers
- Installing host intrusion software on critical servers
- Enabling the host-based firewall to prevent denial-of-service attacks
- Installing software to defend against viruses, worms, malware and spyware and quarantine hostile code

MQC hosts will be hardened by one of two methods. The primary method is the application of security policies pushed down from Active Directory, allowing the administrator to centrally manage security policies, allowing quick updates to prevent, adapt, and cope with malicious network outbreaks. Second, Harris will utilize lockdown scripts that set the local security policies for Unix, Linux, and stand-alone Windows machines.

In conjunction with Active Directory, the MQC VIDA network will also have the capability of monitoring and recording system and event logs from a majority of the devices on the network. These logs are then forwarded to the centralized log repository for analysis by using either built in capability (e.g. Solaris or Cisco) or using a third-party application (e.g. Windows with Snare).

The MQC VIDA network will monitor and record:

- Windows Event Logs
- Windows Security Logs
- Unix System Logs
- Cisco Firewall Logs
- Cisco Router Logs
- Cisco Switch Logs

Optional Identity Assurance with Two-Factor Authentication

To minimize risk associated with identity impersonation and inappropriate account use, two-factor authentication is available to further restrict access to privileged accounts or connecting to the MQC VIDA network from an untrusted network or system. Using multiple factors (account name, account password [something you know], and a token ID [something you have]) during the authentication process provides confidence that users are trusted identities.

The two-factor solution verifies authentication requests, and enforces authentication policies across the MQC VIDA network. It is based on the existing Active Directory infrastructure and the identities, roles, and rules already present in the enterprise directory. More importantly, our solution provides a unified, vendor neutral, fully scalable infrastructure that can grow and adapt with the ever changing needs of your system.

Firewalls

Perimeter firewalls protect the MQC VIDA network by restricting unauthorized network access while detecting, preventing, and responding to network attacks, enforcing policies, and integrating high-performance security features such as state awareness, application filtering, SSL, IPSEC, and VPN.

Harris utilizes the Cisco ASA 5500 Series as their preferred perimeter firewall. Harris will secure the MQC's Network Switching Center (NSC) with Cisco ASA 5510 firewall appliances, and use Cisco ASA 5505 appliances to provide boundary firewall services and VPN Access between the MQC's VIDA network and external networks, if required.

The adaptive security appliances integrate industry-leading firewalls, unified communications security, VPN technology, and content security in a unified platform to:

- Stop attacks before they penetrate the network perimeter
- Control network and application activity
- Reduce deployment and operational costs
- Provide highly secure remote access
- Log, timestamp and send all traffic and administrative activity to the centralized logging server

MQC firewalls can be centrally managed from a centralized location through the use of the optional CiscoWorks management console. CiscoWorks will automatically alert network security personnel when a critical security event occurs.

System Integrity and Continuity - Backup and Recovery

During critical MQC operations, our team understands the importance of quickly recovering systems to bring the users and the system functionality back to full operational status. It was therefore important to find an effective enterprise backup solution that provides a cost-effective restore capability within

Metrocrest Quad Cities' critical system infrastructure. Unitrends is an affordable and easy to use data protection solution option, with the ability to grow as needed.

Agents residing on critical MQC VIDA network devices send data securely over the network to the DPU Disk-to- Disk Backup Appliance in the Network Switching Center. The DPU de-duplicates the data for storage efficiency.

Standards-based AES 256-bit encryption is then performed automatically, protecting data from unauthorized access and theft, and the data is stored on a redundant array of independent disks, for availability, and greater speed and reliability than tape-based systems. Once stored on the DPU, the data is available for rapid system restoration.

System Manager/Information Management System

A.17.1 RFP Requirement	Response
Computer platform provided	The Harris VIDA Management Server (VMS) is a management platform that supports Regional Network Management (RNM) and Unified System Administration (UAS) applications on a single server. The VMS resides on a Dell server that will be located at the Network Switching Center (NSC).
Number of terminals proposed and location	Harris VMS terminals have been proposed at Carrollton Police Department and Carrollton Radio Shop.
Number of terminals supported	There is no system level restriction on the number of management terminals the Harris VMS will support.
Dial-up and/or remote LAN capability and the connection of the Metrocrest Quad Cities Radio Shop to the network.	Client access to the Harris VMS server is supported by a LAN connection within the radio system network, and may support an external Internet connection through a firewalled access point, if desired.
Functional Capabilities	The VMS write up can be found in Tab 8.
Descriptive Brochures	Refer to "Tab 17 – Equipment and System Brochures"

A.17.2 RFP Requirement	Response
Selective Inhibit/Uninhibit	
Method of disabling a unit	The UAS application allows an authorized user to go in to the Enable/Disable a Subscriber Unit section and click the subscriber unit to enable/disable. Select the unit and hit the Save button The UAS updates the database and send change notification to the VNIC, which sends a disable or enable message to the target radio.
How long the system will "search" for a targeted unit	Until the radio is removed from the system database.
Unit's capabilities while disabled	While disabled, the unit is capable of locating and monitoring the control channel of an RF site, and awaiting an enable instruction. Radios equipped with a GPS module will also respond to a location request. No other actions are supported.

A.17.2 RFP Requirement	Response
Unit indications while disabled	The radio screen will be blank and no audio will be heard.
Steps to re-enable a disabled unit	Same procedure as 1a but select enable and Save.
Activity Reporting and Archiving	
Information Available	All activity data can be accessed for reports. This includes but is not limited to data relating to call initiation (UID of the calling radio and GID or UID of target talkgroup or unit), channel usage by call, including control channel requests not directly related to a call such as Request To Talk, and any desired aggregation of data, such as group calls by group or site channel utilization over a select period of time.
Sample Reports	Provided above in section called "Generating Reports on the UAS."
Report Generation Printing	
Manufacturer, make and model of proposed printers	The printer manufacture will be determined at time of shipment based upon current models at the time.
Recommended physical location of printers	The printers can be located at any point on the network; however it is recommended they be placed adjacent to the user/client terminals.
Database Maintenance	
Parameters controlled	The UAS is responsible for: ▪ System Administration setup and maintenance ▪ Resource pools (User IDs, talkgroups, profiles, personalities, and coverage classes) ▪ Configuring the system for OTAR ▪ Setting priorities within the system ▪ Setting system parameters ▪ Configuring the ISSI Gateway ▪ Configuring the Interoperability Gateway ▪ Generating database reports ▪ Dynamic Regrouping
Describe unit and talkgroup site access privilege capabilities. Be specific about how this process works. Does it require that the radio unit register before the change takes place, etc?	Each RF site receives a system-supplied database that includes all the user terminal UIDs and talkgroup GIDs as well as the privileges and assigned priorities of each. When a radio affiliates with an RF site, the site updates the site and VNIC database that the unit is present and of its currently selected GID. Calls can then be initialed by or routed to the radio UID or GID.
Number of separate databases that must be maintained for user authentication, user ID aliasing, alarm ID aliasing, etc.	The Harris VIDA system operates on a single unified database. The UAS generates the database from the detailed user and group and system data entered, and includes the operating configuration and user IDs for all terminals, consoles, interoperability platforms and other devices, such as logging recorders. Also included is the alarm data, including the source and destination of all designated traps.
Controller Updating	
Remote capabilities	Harris RF sites use distributed control, with each RF channel assigned a spate controller. The controllers can be updated by the Regional Site Manager (RSM)

A.17.2 RFP Requirement	Response
	pushing a UAS-originated database to them. The update can be generated by a remote request from a system administrator or by an automated process at the site when an error is suspected. Consoles, interoperability gateways logging recorders are provisioned in a similar manner.
Password protection, # of access levels	Access to the VMS is restricted by individual account and involves up to three levels of validation: account ID, password and a token of some kind. The token validation is optional.
System Diagnostic and Alarm Reporting	The RNM application provides diagnostic support through several built-in tools. Alarm reporting is by SNMP traps.
Graphical User Interface	The interface to the VMS contains a typical Windows graphical interface.

Alarm Monitoring and Reporting System

A.19.1 RFP Requirement	Response
1. Manufacturer, make and model of all equipment	Dell is the manufacture of the VMS. See equipment list in Tab 5.c for model numbers.
2. Quantity proposed and proposed location of all equipment	Harris VMS terminals have been proposed at Carrollton Police Department and Carrollton Radio Shop. The VIDA Management Server (VMS) is a feature-rich platform for accessing two applications critical to the management and administration of a VIDA network: the Regional Network Manager (RNM) and the Unified Administration System (UAS). The RNM is the consolidated point for monitoring the health and performance of VIDA network components, while the UAS is the centralized access point from which the network is provisioned.
3. Functional capabilities	The RNM is constantly communicating with registered objects connected to the RNM to ensure that they are functioning properly or reporting discrepancies.
4. Diagnostics displayed	The Regional Network Manager (RNM) monitors the overall health of the system, provides real-time diagnostics, activity monitoring and sets system/network configuration parameters. A major feature of the RNM is the topology map showing all of the managed objects registered on a P25IP VIDA Network (i.e., base stations, routers, etc.). The hierarchical relationships between the objects are displayed graphically and the current status of each object and any related components is shown using color coding. Harris' site alarm and control system provides real-time site status information to the system management personnel through the alarm tree on network management terminals. For MQC, the alarm and control system will be capable of remotely monitoring forward and reflected power and VSWR internally to the system. Additionally, the remote monitoring of I/O devices such as shelter doors, shelter temperature, and generator status is available. This enables system management personnel to retrieve site specific information without having to travel to a site to physically collect this information, saving Metrocrest time and money. Additional detailed information can be found earlier in this section titled Regional Network Manager.
5. Alarm conditions displayed	See number 4 response above. Additional detailed information can be found earlier in this section titled Regional Network Manager.
6. Sensors provided and monitored a. Radio Site Equipment	Radio site alarms are sent to the Network Sentry which in turn report to the RNM.

A.19.1 RFP Requirement	Response
b. Master Site Equipment	The Simulcast IP Control Point and NSC alarms are sent to the Network Sentry which in turn report to the RNM.
c. Dispatch Center Equipment	The console alarms are sent to the Network Sentry which in turn report to the RNM.
d. Microwave system equipment and systems.	The microwave alarms are sent to the Microwave management terminal which in turn report to the RNM.
e. Proposed communications medium for the alarm system	For the VMS, the alarms are transported over the microwave system and for the microwave portion of the system will have the TSM8000 collecting alarms from all radios via SNMP traps. The Microwave alarms are tied into the VMS, for display on the VMS monitor.
f. Descriptive brochures	Refer to the Equipment and System Brochures

Digital Microwave System

Harris has partnered with Alcatel-Lucent (ALU) to provide a microwave system to interconnect all RF sites and dispatch centers as required in the RFP. Wherever possible, all sites exist on the loop system, however for those sites (Coppell, Carrollton, and Addison dispatch) not on the loop, hot-standby spurs have been provided. ALU will also provide the 7705 MPLS routers at each site as requested in the RFP.

VIDA Network WAN Requirements

To guarantee the quality of voice through the VIDA network, all WAN links will need to strictly adhere to the following requirements. All of these requirements are necessary to provide a guaranteed level of service for voice. Failure to adhere to these requirements could result in poor audio for which Harris cannot be held accountable. In the event of audio problems, Harris will work with the customer to determine the source of the problem. If the problem is determined to be in the customer supplied backhaul, Harris will be available on a contract basis to help resolve the issue.

- **Packet Loss** - Due to the connectionless nature of UDP, and thus voice packets, minimal packet loss is tolerable in the VIDA network but could result in degraded voice quality or loss of voice.
- **Latency -** Long latencies, such as satellite links, can be handled within the VIDA network. Harris will not be held responsible for voice latency requirements if the provided WAN connection has more latency than the requirement. Any latency within the system will need to stay constant to avoid jitter. For standard implementations, latency should be less than 150 msec.
- **Jitter -** Jitter is the variability of packet delays within the same voice packet stream (talk spurt). The requirement is for the overall jitter to average to 0 and to never build up to more than 60 msec. Any streams with excessive jitter will be considered to have packet loss and Harris will not be responsible for voice quality issues.

  For example, if a voice packet is 60 milliseconds late, then it would be optimal for the next few voice packets to be early to get the average jitter back to 0. This will allow the voice buffer to build back to a stable point.
- **Layer 2 Quality of Service Requirements -** At OSI layer 2, the network shall classify all voice traffic with COS (Class of Service) priority bits value of 5 and shall place these frames in strict priority layer 2 switch queues. The strict priority queues shall be configured such that other

customer traffic is classified as lower priority and will be dropped if congestion between the flows occurs.

- **Layer 3 Quality of Service Requirements -** At OSI Layer 3, the network will recognize and forward Harris voice traffic marked using the Differentiated Services Code Point (DSCP) value of critical. The DSCP value of EF, 101110, or 46 are equivalencies indicating the critical DSCP code setting and traffic marked as such should be forwarded through the routed system, without DSCP manipulation, according to queuing mechanisms that grant this traffic strict priority over all customer traffic.
- **Bandwidth Requirements -** All of the links that are provided will need to meet or exceed the bandwidth requirements established by Harris.
- **Measurement of Requirements -** All router links will be constantly monitored using Cisco's IPSLA technology to determine packet delay, jitter, and sequencing. The router will report any link discrepancy to Harris's management system and any failure can lead to an investigation of the customer provider backhaul.

Technical Summary

The proposed Alcatel-Lucent microwave network meets and exceeds the needs of the Metrocrest Quad Cities (MQC) design priorities, including:

- Support the new and future planned growth of the P25 simulcast radio system
- Support a 50Mbps, ring protected point-to-point licensed microwave loop
- Upgradeable to 150Mbps for additional capacity as required to serve the proposed network
- An in-door and split mount 9500 Microwave Packet Radio with the packet-based system architecture solution
- A non-standby microwave ring and hot standby spur network designed to support the 7705SAR MPLS switching operations
- Exceed a one way end-to-end annual reliability of 99.9999% at the required capacity
- An antenna system designed to meet/exceed all applicable FCC requirements
- Carrier-class reliability to support mission critical and reliable wireless data communications
- A power plant that exceeds the minimum 8 hour backup operation and up to 20% growth
- A redundant network manager that will support the desired monitor and control operations

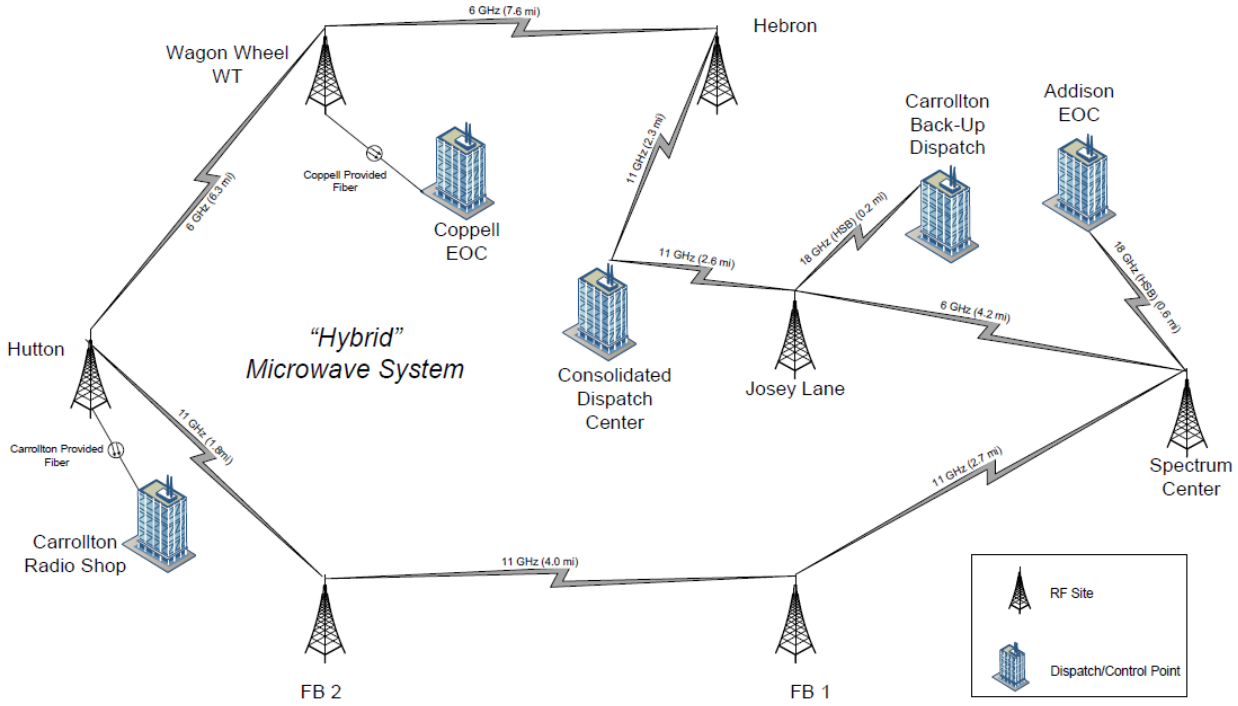
The proposed infrastructure will provide packet-based intelligence that is required for supporting new IP based services over an IP/MPLS architecture with sophisticated QoS and VLAN managed implementation to ensure that mission critical traffic is not interrupted. The RF path engineering will be designed to meet or exceed the reliability of the desired full duplex radio operation. All licensing, frequency coordination, and path analysis will be performed in accordance with the appropriate FCC microwave radio design characteristic requirements. Product training will be offered for all of the applicable products incorporated into the final system design and will be conducted as necessary to meet the end user needs. System documentation, product specification sheets, network management operational guides and maintenance manuals will also be provided for all applicable products used in the final design.

Microwave System Design

The network will utilize Alcatel-Lucent 9500 Microwave Packet Radio (MPR) and 7705 Service Aggregation Router (SAR), which are managed by the TSM-8000 Network Manager. The 9500 MPR all indoor radios will be configured as non-standby in a ring topology with all indoor and split mount monitored hot-standby radio configurations to support the required spur hops. The microwave system will initially be configured to support the currently desired 50 Mbps bandwidth requirement and can be expanded as needed using a software supported capacity growth operation or with additional radio paths as necessary to support future bandwidth need projections.

Alcatel-Lucent's Services organization provides best in class engineering, installation, configuration and testing of the networking components as well as the program management, training and assist with the system cut over. The design includes all of the microwave radio network sites in a ring configuration to support the 7705SAR MPLS switching operations.

Figure 15. Microwave Block Diagram



The main ring and spurs will be supported with 6GHz and 11GHz indoor and 18GHz split mount 9500MPR radios. The Consolidated Dispatch is unique to this scenario while the North Toll Plaza has been included as an optional hop. 7705SAR routers will be placed at each site in this solution.

Solutions Integration and Implementation

This solution creates a highly reliable, multiservice network that can meet current and projected requirements. The 9500 MPR 6 GHz and 11 GHz all indoor and 18 GHz split mount radios have been selected for this network configuration using the smallest antennas required to meet the design reliability. Elliptical waveguides will be installed for each of the 9500 MPR indoor radios and Cat5E for the split

mount hot standby radios in this design with the centerline proposed in the RF analysis unless conditions exist that require an alternate solution to ensure reliable operation. Once the antenna system installation has been completed, the 9500 MPR and 7705 SAR equipment will be installed and tested to ensure a smooth and controlled traffic cut over from the existing system. This implementation methodology applies to each site and will be coordinated by the site installation manager and local MQC representatives as necessary.

Packet Microwave Transport Network

The Alcatel-Lucent 9500 Microwave Packet Radio (MPR) provides seamless Internet Protocol (IP) migration for microwave networks. It handles traffic by packets natively, using IP instead of being locked into Time Division Multiplexing (TDM) formats, yet it still fully supports TDM circuits, providing a means to gracefully and seamlessly migrate to an all-IP infrastructure. The Alcatel-Lucent 9500 MPR offers the lowest total cost of ownership by reducing both fixed capital expenditures and recurring operational expenses.

Figure 16. 9500 MPR: MSS-8 and MPT-HL

The 9500 Microwave Packet Radio enables smooth transformation of backhaul networks from TDM to IP, providing efficient transport of multimedia traffic while supporting legacy TDM. It improves packet aggregation, increases bandwidth, optimizes Ethernet connectivity, and delivers the quality of service needed to satisfy end users.

Key Features and Benefits:

- Intelligent nodal IDU that supports up to 12 RF transceivers in hybrid or packet mode
- Millimeter wave support
- Multiservice switching capacity greater than 16 Gb/s, and up to 48 Gb/s with EAS cards
- XPIC upgradeable for very high capacity
- Ethernet rings G.8032
- Radio throughput greater than 4 Gb/s and termination of up to 192 x DS1
- Support of DS3
- Ethernet OAM 802.3ag
- Support of Synchronous Ethernet (SyncE) + SSM
- Support of LAG (Radio link (NNI) and Ethernet user interfaces (UNI))
- Multiservice aggregation layer
- Service Awareness: Offers prioritization of packets by service type, criticality and QoS requirements before transporting packets across the radio link

- Service-driven Adaptive Modulation: Allows the radio link to be fully allocated by dynamically adjusting to meet changing atmospheric conditions in the path
- Multi-Reach packet node: Offers the ability to aggregate multiple RF transceivers into a single, 10Gb baseband shelf. This baseband shelf is called the Microwave Service Switch (MSS)

7705: IP/MPLS Mission Critical Network Communication Router

The Alcatel-Lucent 7705 SAR portfolio is optimized for multiservice adaptation, aggregation and routing, especially onto a modern Ethernet and IP/MPLS infrastructure. Leveraging the powerful Service Router Operating System (SR OS), the 7705 SAR is available in compact, low power-consumption platforms that deliver highly available services over resilient and flexible network topologies.

Router-Radio: Product Convergence

The 7705 Service Aggregation Router and the 9500 Microwave Packet Radio are a high value, managed combination for flexible aggregation and backhaul. In order to support the delivery of market-leading integrated IP/MPLS and microwave mobile backhaul solutions. Alcatel-Lucent is proposing the 7705 SAR, 9500 MPR MPT-HL (Indoor Unit) and TSM-8000 Network Manager monitoring for each site configuration.

This capability brings the optimal combination of cost-efficient connectivity via microwave packet radio with the determinism, resiliency, scalability and end-to-end control and management of IP and MPLS networking. The 9500 MPR is ideally suited to enhance the 7705 SAR by adding an efficient, validated microwave transport networking capability. The new IP/MPLS-centric backhaul networks, the combination of the 7705 SAR and the 9500 MPR MPT-HL enables an attractive backhaul option with significant competitive differentiators.

Best Cost and Performance in All Scenarios

- Common Radio throughout the network (less CAPEX and OPEX)
- Reduces amount of deployed indoor equipment at each site (less CAPEX)
- E2E common OAM procedures and protection over microwave and fixed media (less OPEX)
- Low power consumption at each site (less OPEX)

Figure 17. 7705 SAR-8 (Service Aggregation Router)

The 7705 SAR brings a powerful, service-oriented capability, with compelling form factors and price points. With CLI management under the TSM-8000 management system, the 7705 SAR greatly enhances our IP/MPLS backhaul transport solution.

To provide the most efficient transport solution, the 7705 SAR can employ pseudo wire encapsulation methods to map services end to end. The use of pseudo wires ensures that the key attributes of the service are maintained, while using a cost-effective packet environment to aggregate services. In addition to pseudo wire transport, IP routing and forwarding and Virtual Private LAN Service (VPLS) are supported. Services such as Asynchronous Transfer Mode (ATM), inverse multiplexing over ATM (IMA), Ethernet, Frame Relay, HDLC and TDM traffic can be natively switched across the 7705 SAR.

The key features of the 7705 IP/MPLS routers are:

- Next generation intelligent channel bank plus MPLS router on the same chassis
  - T1, DS3, Ethernet, OC3 interfaces
  - RS232, V.35, X.21, 2-W/4-W E&M, FXS/FXO
  - Teleprotection (C. G.703, C37.94) and Auxiliary Alarm interfaces
- Flexibility to increase bandwidth and maintain security
- Leverage the cost saving from sharing resources
- Enable Cost-effective migration from TDM based services
- Resiliency and redundancy including:
  - One-for-one hitless control and switch module failover
  - Synchronization redundancy and provisioning, fault and performance management

7705 SAR can replace SONET OC3 boxes, 3/1/0 DACs, channel banks and Ethernet Switches. The advantages of this cost effective option are:

- Simplifies network design and management by eliminating up to three network elements per site
- Reduces number of spares, training, operational expenses and future proofs the network
- Maintains low capital cost without forgoing features, functionality and reliability
- Increases flexibility by better managing available bandwidth
- No single point of failure (control, fabric, power redundancy)
- Simultaneous support of TDM and IP
- DS0 grooming and add/drop functionality
- VPNs isolating TDM and IP services to provide maximum level of security
- Low latency to ensure proper operation of Teleprotection, LMR and SCADA (4ms-8ms)
- Ability to support multiple physical WAN interfaces
- Flexibility to close a ring with (OC3, DS3, nxT1 interfaces)
- Open standards, seamless interoperability with existing equipment (SONET OC3, routers etc)
- Reduced power consumption and space requirements
- Proven platform for Utility applications

The 7705 SAR is optimized for multiservice adaptation, aggregation and routing especially onto a modern Ethernet and IP/MPLS infrastructure. Leveraging the power of a full Service Router Operating System (SR-OS) and a SAR, the 7705 SAR is available in compact, low-power consumption platforms delivering highly available services over resilient and flexible network topologies.

TSM-8000 Network Manager

The TSM-8000 is a graphically oriented element management system. It is scalable through software keys to support small, medium, or large telecommunications networks. The TSM-8000 supports multiple users, multiple networks and multiple protocols. It automatically collects and stores alarm, status and performance data from the monitored transmission system equipment. This information is displayed both graphically and textually. The TSM-8000 also provides comprehensive reports for all current and historical activity for the entire network including all operator actions.

The following operational characteristics are supported by the TSM-8000:

- Provides centralized alarm monitoring functions of the Transmission system (Optics / IP/ Microwave)
  - Alarms, Performance Data and Control (switching) functions
  - TDM Circuit and VLAN Management for 9500 MPR
- Monitors and manually switches the transmission equipment itself as well as ancillary equipment
  - Interfaces with housekeeping and station alarms
  - Reports information and initiates manual switches on other equipment at the site (e.g., multiplexers, channel banks)
- Graphics based operation for ease of use
- Real time monitoring of radio networks
  - MCS-11 telemetry protocol, TL1, and SNMP
- Windows-based display of network topology
  - Point and click queries of alarms & status
  - Visual indication of events
- Multi-level organization of alarm points
- Network & sub-network levels
  - User defined network and sub-networks
  - Stations (composed user defined network elements)
  - Network elements and containers (composed of user defined alarms)

Other Subsystems

Programming Software

All radio terminal programming utilizes the Radio Program Manager (RPM) program that supports the creation of operating profiles for all user devices. The Device Manager application that runs as a utility on the Regional Site Manager Professional (RPMPro) supports the programming of all infrastructure based platforms, including the MASTR V repeaters, dispatch consoles, and the central servers, including the RVM and VNIC. Device Manager can host the RPM software, and be used to assist with the programming of radios.

Key Management Facility (KMF)

Harris can provide the ability for Metrocrest Quad Cities Administrators to push encryption keys out over the air (Over-the-Air-Rekeying or OTAR). This methodology ensures that encryption keys can be updated consistently across the subscriber fleet, and limits the outage time for bringing in radios for reprogramming. While a Key Manager is included in the system offering, the KMF allows greater management of a larger (both in users and geographically) system to the administrator.

Figure 18. Characteristics of Harris Key Management Devices

	Key Manager	Network KMF
Agencies Supported	1	5
Encryption Keys	100 per Key Card	65,000
Users	50	16,000,000
Key Generation	Manual Import	Manual Import Automatic
Key Storage	Key Cards	Key Cards Hard Drive
Key Loading (Subscriber Units)	Cabled Connection to Subscriber	Network OTAR via VIDA System
Key Loading (Network Devices)	Cabled Connection to Device	Ethernet Network Connection to VIDA System
Key Bindings	In Target Device	From UAS
Target Devices	Radios Network-Based Devices	Radios Network-Based Devices
Key Card Support	For Key Import	Key Export
User Interface	Key Entry Key Selection for Loading	Key Entry Export UKEK Database Export Key Bindings Report

The simplest solution for managing encryption keys is the Key Manager. The Key Manager is a PC-based software application which allows crypto officers and technicians to generate, store, and load keys into encryption-capable devices, including subscriber units and network infrastructure. The Key Manager provides crypto officers with the capability to generate key sets (collections of keys), bind keys from key sets to specific talkgroups, and store key sets on encrypted smart cards. It allows technicians to load

encrypted keys off of smart cards into target devices. Each subscriber device needing encryption keys must be individually cabled to the Key Manager through the serial connection on the PC. Network devices needing keying information are also keyed using a direct serial connection on the PC. The Key Manager is intended for customers who are managing a small number of crypto nets of approximately 50 or so users.

The Network KMF is a network server-based application that is used to manage large fleets of crypto nets. The Network KMF is a P25^{IP} network product that works in conjunction with the network to provide complete key management for all network devices, including subscriber devices. The Network KMF consists of a network server that generates key sets and sends OTAR messages to encryption devices. The application is integrated into and runs on the Virtual Management Server. Multiple Network KMFs can exist on the same P25^{IP} network, allowing different agencies sharing a single integrated network to control their own assets.

Exacom Logging Recorder

This design includes two (2) Fault Tolerant “Hindsight-G2” Dell T620 Multimedia Digital Logging Recorders w/NAS device for long term media Storage. The recorder module will be configured with the ability to record 66 Concurrent: IP Channels for P25 VNIC Audio, VoIP phone audio and analog telephone audio with expansion up to 360+ channels. The “Hindsight-G2” recorder will be configured with a minimum of 75,000 channel hours of on-line storage via internal (to the server) Raid-5 Hard Disk Array, featuring our new “TRU-IR” capability. Long term, archival storage will be stored on an external NAS device which features a fault tolerant design with a Raid-5 array. The NAS device will store at least 450,000 channel hours of storage. Ten (10) “Hindsight-P25 Recorder Assistant” for Windows Network Playback Software Licenses will be included with the recorder to be installed on client playback workstations. Additional “Hindsight-Net Recorder Assistant” Playback licenses will be available as an option to support additional concurrent Instant Recall/Playback and Channel Monitoring for dispatcher, supervisor or other administrative PC workstations connected to the LAN/WAN.

We have reviewed the requirements of the MQC project and are responding to this solicitation from the standpoint of functional equivalency to address the intent of the solicitation to fulfill the recording requirements. The P25 “Hindsight-G2 Dell T620” recorder as proposed was configured with 33 IP channels dedicated to P25 and Interop Gateway IP radio audio. Audio communications and associated data in a P25 environment are recorded via an IP interface over the VNIC between the "Hindsight-G2/P25" recorder and the Harris P25 radio system. This interface is defined by concurrent talkpaths or channels which allows for an unlimited amount of talkgroups to be recorded, versus dedicated talkgroups. The proposed trunked recorder dynamically allocates the talkgroups to be recorded over the IP connection. This provides for efficient use of recorder channel resources, as there is no need to statically allocate a recorder channel for each trunk, each talkgroup, or each conventional frequency to be recorded. The recorder can support simultaneous multi-channel decoding IMBE as well as AMBE and GSM if presented. Recorded communications are processed using AES encryption/decryption algorithms, and supported for either manual keying or "Over-the-Air-Re-keying" (OTAR).

We believe that the “Hindsight-G2” Model: VCR-2020AN360-G2 Series of Fault Tolerant Multimedia Digital Logging Recorder will meet or exceed the intended requirements as requested. As an example, an EXACOM state wide/multi-location networked trunked radio recording solution has been implemented for the state of Nevada as well as for the City and County of Honolulu. Additionally, EXACOM has a multiple location recording solution comprised of 8 Hindsight-Net integrated sites installed and successfully operating for the Florida State Law Enforcement contract. The Florida recorders have been

successfully operational for over 6 years. EXACOM has also deployed the many P25 Trunked logging recorder solutions through Harris for the DOD as well as Public Safety sites. Therefore we believe the proposed solution will provide the Metrocrest Quad Cities with the most advanced recorder technology available to address not only the requirements as requested, but also address future requirements as well.

Also**,** the **"Hindsight-Net" platform is "Network Ready**", with TCP/IP compatibility for LAN/WAN applications and expandability up to 2048 channels. The unique architecture of the "Hindsight-Net" platform provides for simultaneous recording and playback directly from the recorder module, independent of LAN/WAN functionality, thereby eliminating the LAN/WAN as a single point of failure. We look forward to working with you in support of fulfilling the recording requirements of the MQC project

Optional Subsystems

The following subsystems are available to add to the proposed P25 Simulcast system initially or after implementation. While not required for day-to-day use, they offer ease-of-management to the system administrator.

Over-the-Air-Programming (OTAP)

To reprogram a radio, the system administrator selects a file created by the RPM and selects the Logical ID of the radio or radios to be reprogrammed. ProFile then retrieves the desired personality file, places a series of individual data calls, and uses standard IP protocols to deliver the radio personalities to the assigned radios. The data packets are routed over the MQC VIDA network to the appropriate P25 repeater site (where the target radio is registered) and then sent over the air to the radio as standard P25 data packets.

The header of the first data call in the ProFile sequence notifies the radio that a ProFile session is commencing. This special header prevents the radio from transferring the data to an attached data device. While the radio is receiving ProFile data packets, the radio displays a unique status indicator to make the radio user aware of the process. In addition, a status indication showing the level of completion for the target radio is provided to the system administrator. The radio operator has the capability to refuse reprogramming. If programming is refused, this information is communicated to the system administrator. If the radio user needs to talk during this process, the user can interrupt the programming process simply by depressing the Push-To-Talk (PTT) button or declaring an emergency. However, the radio is unavailable for incoming voice traffic. ProFile may also be disabled via the radio menu.

As each data call is completed, the radio checks for errors and, if no errors are found, writes the data to its personality memory. Once a radio personality update is successfully completed, the radio automatically resets itself, switches to the new personality, and returns to normal operation. At this time, the old personality is marked as invalid and cannot be used by the radio. This prevents the radio from returning to the old personality.

If the personality transfer is interrupted or if reprogramming is unsuccessful, the ProFile Manager will abort the process and indicate to the system administrator that the reprogramming was not successfully completed. The radio continues to operate using the existing programming settings.
ProFile Manager informs the programming operator of the status of each attempt to program radios. Programming radios can be set up one at a time by ProFile or the user can create batch files to program multiple radios. ProFile manager will automatically retry if certain radios are not initially available

(turned off or out of coverage). ProFile will collect statistics for the operator of which radios have been successfully programmed and which were not completed.

Traffic loading due to OTAP is dependent on a number of factors including the size of the personality, the number of radios, and even the coverage conditions for the radio.

The maximum size of a radio personality is 64KB, but a typical personality is approximately 8-15KB As an estimate, a typical OTAP for a single radio can take place in approximately 30 seconds.

If the target radio happens to be in a weak coverage area, data retries will be required, adding additional time (system load) to the reprogramming of a single radio.

For these reasons, should MQC decide to purchase this option, it is highly recommended that all OTAP sessions be coordinated with the end users in order to minimize system loading and the likelihood of disturbing a particular user's operations. Particularly for programming events of large quantities of radios, it is preferred that these efforts are planned around off-peak hours, are performed under known strong coverage conditions, and are carried out with full awareness of the end user that his/her radio is going to be reprogrammed. This planning and coordination will minimize unnecessary OTAP retry traffic, increase user safety, and minimize the possibility of disruption to other system traffic.

Equipment List

Refer to Exhibit A, Attachment 3 Equipment and Spare Parts List.

Shelters, Cabinets, Generators & UPSs

Equipment Shelters

The following sections provide descriptions of the equipment shelters:

1. **Quantity and Location:**
   - Josey Lane Water Tank (1) each
2. **Manufacturer:**
   - VFP
3. **Dimensions:**
   - Josey Lane Water Tank – 11.5' x 30' 2-room
4. **Type of construction and finish:** Standard exposed aggregate. Other finishes can be priced if requested at an additional cost.
5. **Type of slab:**
   - Shelter foundations will be constructed of concrete and designed/built based on the final shelter dimensions and weight and to local soil and frost conditions.
6. **Type of fencing:**
   - All fencing will be constructed per RFP requirement 4.6.C.
   - Josey Lane Water Tank – Two (2) new runs of fencing totaling 80 linear feet will be constructed off the existing fence lines to complete a new 30' x 50' compound.
7. **Bulkhead panels:**

- The proposed shelter walls will provide a two hour Class A fire rating and are capable of stopping 30.06 rifle fire per UL752 requirements.
- Interior walls will be sheathed with 3/4" white Nupoly board, insulated with hardboard insulation providing a minimum of R-16 insulation.

8. **Grounding system:** Single point halo ground per Harris' Site Grounding and Lightning Protection - AE-LZT 123 4618-1 Rev D.
9. **Ice shield and waveguide bridge:**
   - Josey Lane Water Tank – 24" W x 35' L with (3) direct buried trapeze
10. **Lighting and electrical system:**
    - Lighting consists of:
      - Ten (10) four foot, two tube surface mounted fluorescent light fixtures
      - Two (2) exterior door lights with vandal resistant lens and photo cell control with switch override
      - Four (4) exterior 150 Watt duplex flood lights with motion sensor controls and
      - Two (2) emergency / exit lights.
      - Electrical System consists of:
      - One (1) 200 Amp, 10,000 AIC, 120/240 VAC, single phase, 60 Hz, 30 space main breaker, snap-in utility power distribution panel, in a NEMA 1 surface mount enclosure
      - One (1) 200 Amp, 10,000 AIC, 120/240 VAC, single phase, 60 Hz, 30 space main breaker, snap-in technical power distribution panel, in a NEMA 1 surface mount enclosure
      - Circuit breakers for all VFP installed equipment and customer loads as specified
      - One (1) 200 Amp, 240 Volt, fused, double pole, single throw, NEMA 1 safety switch
      - One (1) 125 Amp, 120/240 Volt enclosed circuit breaker to serve as a disconnecting means for the UPS
      - Thirteen (13) 20 Amp specification grade duplex receptacles
      - One (1) 20 Amp specification grade exterior duplex receptacle on a ground fault interrupter circuit
      - Seven (7) 20 Amp twist-lock receptacles with mating male plug ends
      - One (1) equipment AC circuit drop up to 30 Amps routed in conduit or wireway to customer specified location on the ceiling above customer equipment rack. Flexible conduit including circuit conductors will be coiled and tagged for identification with enough length to reach the floor and an additional four feet (4') of circuit conductors to be cut to length and terminated.
    - Receptacles served by the generator/UPS will have red face plates
11. **Surge suppression:**
    - AC power:
      - One (1) MOV only lightning arrestor (Transtector Model 1101-808)
      - One (1) MOV/SAD lightning arrestor (Transtector Model 1101-808MM)
      - One (1) 60 Amp, 120/240 Volt enclosed circuit breaker for lightning arrestor maintenance
    - RF transmission line:
      - One (1) 1/4" x 4" x 30" main ground bar plate assembly; Part #GBI14430W
      - One (1) 1/4" x 4" x 20" tinned exterior ground bar plate assembly; Part #301454-002
      - Control Circuits:
      - One (1) 1/4" x 4" x 12.5" telco ground bar plate assembly; Part #301458-001
12. **Doors and locks:**

- Two (2) 42" wide x 84" high insulated steel exterior doors, with stainless steel ball-bearing tamper-proof hinges, passage style lever handles, deadbolt locksets, anti-pick plates and fiberglass weather hoods / awnings.

13. **Vent fans:**
    - One (1) 3115 cfm (at 0" of H2O static pressure) equipment room exhaust fan system, including motorized intake louvers and gravity exhaust louvers with security screen, thermostat, timer, fiberglass hoods, permanent expanded metal dust filter, and exhaust insect screen.
    - One (1) generator room air intake louver with weatherhood equipped with a permanent expanded metal dust filter.
    - One (1) generator room radiator air exhaust louver with weatherhood equipped with an exhaust insect screen.
14. **Detectors (smoke, entry, high temperature, etc.):**
    - One (1) line voltage fire/smoke detector
    - One (1) intrusion alarm switch with form "C" contacts rated .1 Amps at 28 VDC
    - One (1) high temperature alarm
    - One (1) low temperature alarm
    - Two (2) humidistat alarms/sensors which will consist of single pole, double throw form C dry contact rated at 7.5 Amps (resistive) at 115 VAC, 60 Hz. Adjustment range is 20 to 80% relative humidity, one to be connected into the redundant controller for active dehumidification and one to be connected to a terminal board or coiled and tagged to send a remote alarm upon failure.
    - Two (2) air conditioner failure alarms
    - One (1) utility power failure alarm
15. **Security system:**
    - Four (4) exterior 150 Watt duplex flood lights with motion sensor controls
16. **Warranty:**
    - 1-year Bumper-to-Bumper and 10-year Limited.
17. **Include scale drawings of the floor plan, rack layouts, and exterior elevations:**
    - All drawings can be found under the tab labeled "System Drawings."
18. **Descriptive brochures:**
    - The following brochures can be found under "Tab 17 – Equipment and System Brochures."
        - VFP 10-year Limited - 1 Year Bumper-to-Bumper Warranty
        - VFP Concrete Shelter Brochure 1
        - VFP Concrete Shelter Brochure 2
        - VFP Concrete Building Specifications
        - VFP Ice Fall Calculations
        - Bard HVAC Warranty

Note: Although Harris has quoted a ½" reinforced rubber mat between each shelter and its foundation, Harris' shelter manufacturer VFP does not recommend it because it can create moisture retention problems.

Equipment Cabinets

Harris has proposed using replacement cabinets meeting the specifications of RFP section 4.8 at all sites where the environmental cabinets are in use today. The existing cabinets do not have sufficient rack space to completely install the new LMR, UPS, Microwave and DC Plant prior to the removal of the legacy systems after cutover.

It is our belief and intent that all the radio and microwave infrastructure, and associated cabling, be staged in the environmental cabinets prior to conducting the Factory Acceptance Test Plan with MQC. Doing so will provide the following benefits:

- Equipment and cabling will be fitted to the cabinets in a controlled environment (RF transmission lines excluded) and prior to FATP
- Field activities are minimized resulting in lower installation costs
- No costly rework of existing cabinets & HVAC systems are necessary
- All cabinets and associated power/HVAC systems will be new

Per RFP section A.11.1, the following describes the proposed equipment cabinets –

1. **Quantity and location:**
   - Spectrum Center: four (4) each
   - Coppell Wagon Wheel Water Tank: seven (7) each
   - FB2 Davis Street Water Tank: ten (10) each
   - FB1 Justice Center Water Tank: five (9) each
   - Hebron Water Tank: ten (10) each

2. **Manufacturer:**
   - Hoffman Pro Line
3. **Dimensions: (Floor footprint)**
   - Spectrum Center: 141.5” W x 31.02” D x 85.83” H
   - Coppell Wagon Wheel Water Tank: 141.5” W x 31.02” D x 85.83” H
   - Davis Street Water Tank: 141.5” W x 31.02” D x 85.83” H
   - Justice Center Water Tank: 117.9” W x 31.02” D x 85.83” H

   An additional 10.9” is required for each HVAC which are mounted at the ends of each cabinet row (with the exception of Spectrum Center).
4. **Type of construction and finish:**
   - Welded steel frames with rack angles mounted to frame or grid straps; External components are painted a light gray (RAL7035).
5. **Type of slab:**
   - Not Applicable
6. **Type of fencing:**
   - Farmers Branch Justice Center Water Tank (FB1): Fencing matching the existing installation will be installed.
   - Hebron: New fencing similar to FB1 will be installed.
7. **Bulkhead panels:**
   - Not Applicable
8. **Grounding system:**
   - All cabinets will be strapped together forming a common ground and tied back to building ground.
9. **Ice shield and waveguide bridge:**
   - Not Applicable
10. **Lighting and electrical system:**
    - Lighting consists of two (2) each per cabinet PANELITE™ Fluorescent Enclosure Lights Model #LF120V18.

- Electrical System consists of Primary incoming AC Load Bank, AC surge protection (noted below), Eaton Powerware 9170+ UPS and power distribution panel.

11. **Surge suppression:**
    - AC power: Atlantic Scientific ZoneMaster
    - RF transmission line grounding will be accomplished in accordance with RFP section 4.6BB.8
    - Control Circuits - Not Applicable
12. **Doors and locks:**
    - Solid doors on front and back, supplied with key locking swing handles
13. **Vent fans:**
    - Not Applicable
14. **Detectors:**
    - RFP did not specify specific requirements, therefore none quoted.
15. **Security system:**
    - Not Applicable
16. **Warranty:**
    - 1-year from date of shipment for defects and workmanship.
17. **Include scale drawings of the floor plan, rack layouts, and exterior elevations:**
    - All drawings can be found under the tab labeled “System Drawings.”
18. **Descriptive brochures:**
    - The following brochures have been highlighted with the materials being proposed in this proposal and can be found under “Tab 17 – Equipment and System Brochures” of this proposal –
        - PROLINE Frames
        - PROLINE Doors, Covers and Sides
        - PROLINE Tops & Bases
        - PROLINE Door Accessories
        - PROLINE LF120V18 Fluorescent Enclosure Light

UPS Systems

The following sections describe the UPSs:

1. **Quantity proposed and location of each UPS:**
    - Spectrum Center – one (1) each
    - Josey Lane Water Tank – one (1) each
    - Hebron Water Tank - one (1) each
    - Wagon Wheel Water Tank - one (1) each
    - FB2 Davis Street Water Tank - one (1) each
    - FB1 Justice Center Water Tank - one (1) each
    - Addison Central Fire EOC - one (1) each
    - Carrollton City Hall Dispatch - one (1) each
2. **Manufacturer, make and model #:**
    - Eaton 9170+
3. **Rated output:**
    - Spectrum Center – 15 KVA, 120/240 Volt Split Phase
    - Josey Lane Water Tank – 15 KVA, 120/240 Volt Split Phase
    - Hebron Water Tank - 18 KVA, 120/240 Volt Split Phase
    - Wagon Wheel Water Tank - 15 KVA, 120/240 Volt Split Phase
    - FB2 Davis Street Water Tank - 18 KVA, 120/240 Volt Split Phase

- FB1 Justice Center Water Tank - 18 KVA, 120/240 Volt Split Phase
- Addison Central Fire EOC - 6 KVA, 120/240 Volt Split Phase
- Carrollton City Hall Dispatch - 9 KVA, 120/240 Volt Split Phase

4. **Operating time at full load:**
   - Spectrum Center – 20 minutes
   - Josey Lane Water Tank – 20 minutes
   - Bobby Ballard Pump Station - 20 minutes
   - Wagon Wheel Water Tank - 20 minutes
   - Davis Street Water Tank - 20 minutes
   - Justice Center Water Tank - 20 minutes
   - Addison Central Fire EOC - 20 minutes
   - Carrollton City Hall Dispatch - 20 minutes
   - Consolidated Dispatch - 20 minutes
5. **Alarm outputs provided and monitored:**
   - The 9170+ provides an extensive menu of operating characteristics and alarms that can be found on pages 80-89 and 110-112 of the Eaton 9170+ Users Guide found in Tab 17 of this proposal.
6. **Floor loading:**
   - Spectrum Center – 744 lbs / 24”W x 28.5”D x 60.75”H
   - Josey Lane Water Tank – 684 lbs / 24”W x 28.5”D x 60.75”H
   - Bobby Ballard Pump Station –
     - UPS Cabinet - 491 lbs / 24’W x 28.5”D x 60.75”H
     - Ext. Battery Cabinet - 433 lbs / 17’W x 25.5”D x 33.25”H
   - Wagon Wheel Water Tank - 684 lbs / 24”W x 28.5”D x 60.75”H
   - Davis Street Water Tank - 684 lbs / 24”W x 28.5”D x 60.75”H
   - Justice Center Water Tank - 317 lbs / 17’W x 25.5”D x 33.25”H
   - Addison Central Fire EOC - 257 lbs / 17”W x 25.5”D x 33.25”H
   - Carrollton City Hall Dispatch –
     - UPS Cabinet - 465 lbs / 24”W x 28.5”D x 60.75”H
     - Ext. Battery Cabinet - 728 lbs / 24”W x 285.5”D x 47”H
   - Consolidated Dispatch –
     - UPS Cabinet - 465 lbs / 24”W x 28.5”D x 60.75”H
     - Ext. Battery Cabinet - 728 lbs / 24”W x 285.5”D x 47”H
7. **Recharge time:**
   - 4 hr after full-load resistive discharge; 8 hr after half-load resistive
8. **Battery life (years):**
   - 3 to 5 years
9. **Service bypass switching configuration:**
   - Make-Before-Break. An illustration of the bypass switch configuration (Figure 22. External Bypass Switch (L1, L2, N), Split-Phase Power Modules) can be found on page 36 of the Eaton 9170+ Users Guide found in Tab 17 of this proposal.
10. **Warranty:**
    - 5-year On-site Gold Plan
11. **Descriptive brochures:**
    - The following brochures can be found under “Tab 17 – Equipment and System Brochures” of this proposal –
      - Eaton 9170+ Product Brochure
      - Eaton 9170+ UPS Technical Specifications
      - Eaton 9170+ Users Guide

- Eaton 9170+ 12 slot UPS Drawing
- Eaton 9170+ Two-year Limited Warranty
- Eaton Gold Plans Service Agreement
- Eaton Service Plan Summary

AC Power Standby Generators

The following sections describe the AC Power Standby Generators:

1. **Quantity Proposed and Location of each generator:**
   - Josey Lane Water Tank – one (1) each 50 KW Natural Gas
   - Hebron Water Tank - one (1) each 50 KW Natural Gas
   - Wagon Wheel Water Tank - one (1) each 50 KW Diesel
   - FB2 Davis Street Water Tank - one (1) each 50 KW Diesel
2. **Manufacturer:**
   - Generac
3. **Model:**
   - Josey Lane Water Tank – SG050
   - Hebron Water Tank - SG050
   - Wagon Wheel Water Tank - SD050
   - FB2 Davis Street Water Tank - SD050
4. **Type of fuel and storage tank:**
   - Josey Lane Water Tank – Piped Natural Gas; City supplied
   - Hebron Water Tank - Piped Natural Gas; City supplied
   - Wagon Wheel Water Tank – Diesel; belly tank
   - FB2 Davis Street Water Tank - Diesel; belly tank
5. **Fuel capacity:**
   - Wagon Wheel Water Tank – 260 gallons
   - FB2 Davis Street Water Tank - Diesel; 260 gallons
6. KW rating:
   - 50 KW (all)
7. **Run time at full load:**
   - Josey Lane Water Tank – Unlimited
   - Bobby Ballard Pump Station - Unlimited
   - Wagon Wheel Water Tank – 98 hours
   - Davis Street Water Tank - 98 hours
8. **Remote starting capability:**
   - Provided from the control panel per the RFP requirement.
9. **Transfer switches:**
   - 150 Amp Generac Model GTS015 120/240 Volt Single Phase, 60 Hz with Neutral kit included and 7-day Exerciser enclosed in a NEMA-1 enclosure
10. **Alarm outputs provided and monitored:**
    - Meter package: hour, frequency, Voltage, ammeter, current
    - Alarm contacts: Includes overcrank, overspeed, low oil pressure, high engine temperature, low coolant level, low fuel level, generator run
11. **Exhaust system:**
    - Refer to the Generac Exhaust System Drawing found under Tab 17 of this proposal.
12. **Surge protection:**

- ATS is protected by the shelter MOV only lightning arrestor (Transtector Model 1101-808) and MOV/SAD lightning arrestor (Transtector Model 1101-808MM)

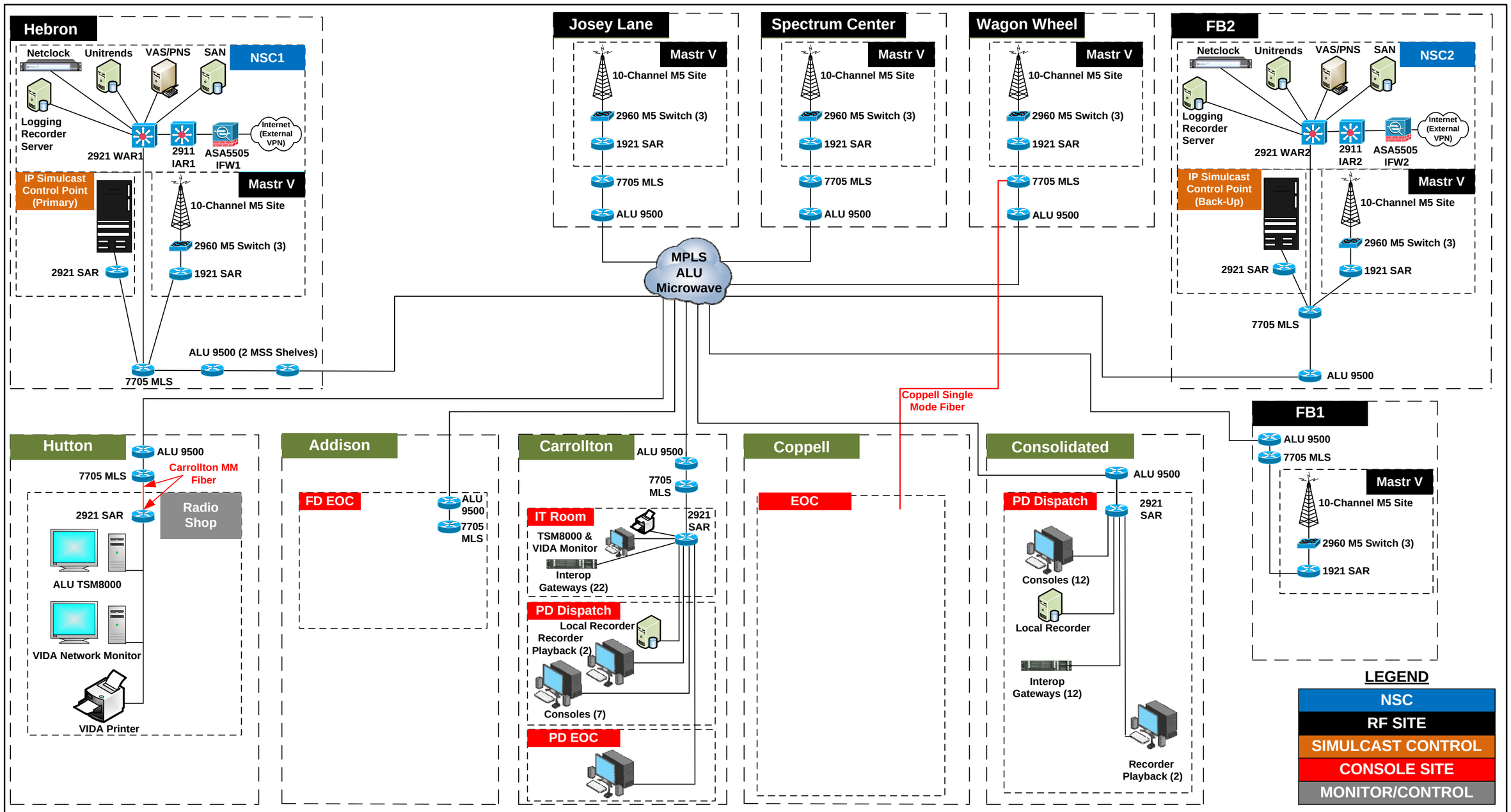
13. Warranty being provided:

- 2-year

14. Descriptive brochures:

- The following brochures can be found under "Tab 17 – Equipment and System Brochures" of this proposal –
    - Generac 35 KW Diesel Generator
    - Generac 35 KW Natural Gas Generator
    - Generac Automatic Transfer Switch
    - Generac Exhaust System Drawing
    - Generac Weather Protected Enclosure
    - Generac Fuel Base Tank
    - Generac 2-year Warranty

C. Exhibit A – Statement of Work, Attachment 2 – Block Diagrams, Revision 1



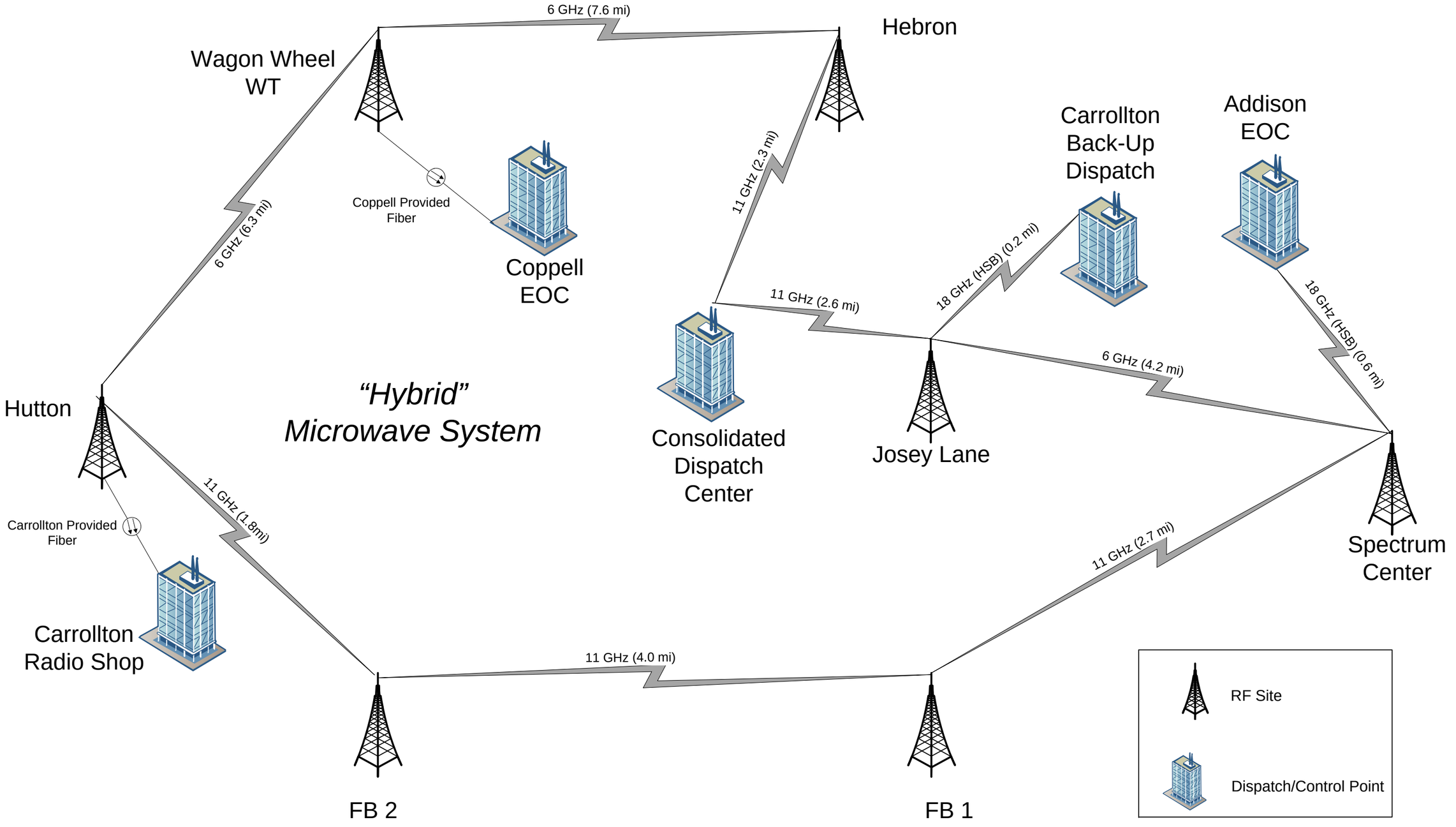
HARRIS

MBP # 12005

Metrocrest Quad Cities
P25 Simulcast System
Hybrid System Diagram

Date: 12/18/13	Fig. NA191-01
Prepared by: PA Garrett	Rev. M
Confidential, Proprietary & Competition Sensitive	

Company Proprietary and Confidential



HARRIS

MBP # 12005

Metrocrest Quad Cities
P25 Simulcast System

Date: 12/18/13	Fig. NA191-02
Prepared by: PA Garrett	Rev. M
Confidential, Proprietary & Competition Sensitive	

Company Proprietary and Confidential

Revision History

B	7/31/2013	PAG	Changed to generic logging recorder
			Added consolidated disp, changed addison link
C	8/22/2013	PAG	to 18 GHz. Added IAR.
D	8/24/2013	PAG	Deleted simulcast tab. Added fiber and telco connections.
E	9/10/2013	PAG	Combined 1921 (LR Client/consoles), combined FB1 & Dispatch, moved FB1 GW, highlighted fiber, added FB fiber, revised radio shop (added Hutton), relocated logging recorder server to WAR, changed RAR to WAR,
F	10/6/2013	PAG	Consolidated all devices into single switch at Carrollton PD
G	10/7/2013	PAG	Revised with new logging recorder configuration. Revised all dispatch centers to have a 1921 w/2960.
H	10/8/2013	PAG	Revised after discussions with NW. Replaced 1921 w/2911.
J	10/25/2013	PAG	Changed SAR from 2911 to 2921.
K	11/8/2013	PAG	Updated m/w to show dispatch vs. RF. Made ring easier to see. Added new tabs for Hybrid. Removed IGW at FB1. Removed all consoles and nw devices at Addison ex: m/w. Changed Coppell to EOC with no devices connected. Deleted m/w to Coppell and replaced w/fiber. Added consolidated dispatch. Changed title block on RF sites to black.
L	12/16/2013	PAG	Changed title block on Hybrid to reflect correct name.
M	12/18/2013	PAG	Changed IAR to 2911 to match Falcon. Deleted drawings no longer required.

HARRIS | MBP # 12005

Metrocrest Quad Cities
P25 Simulcast System

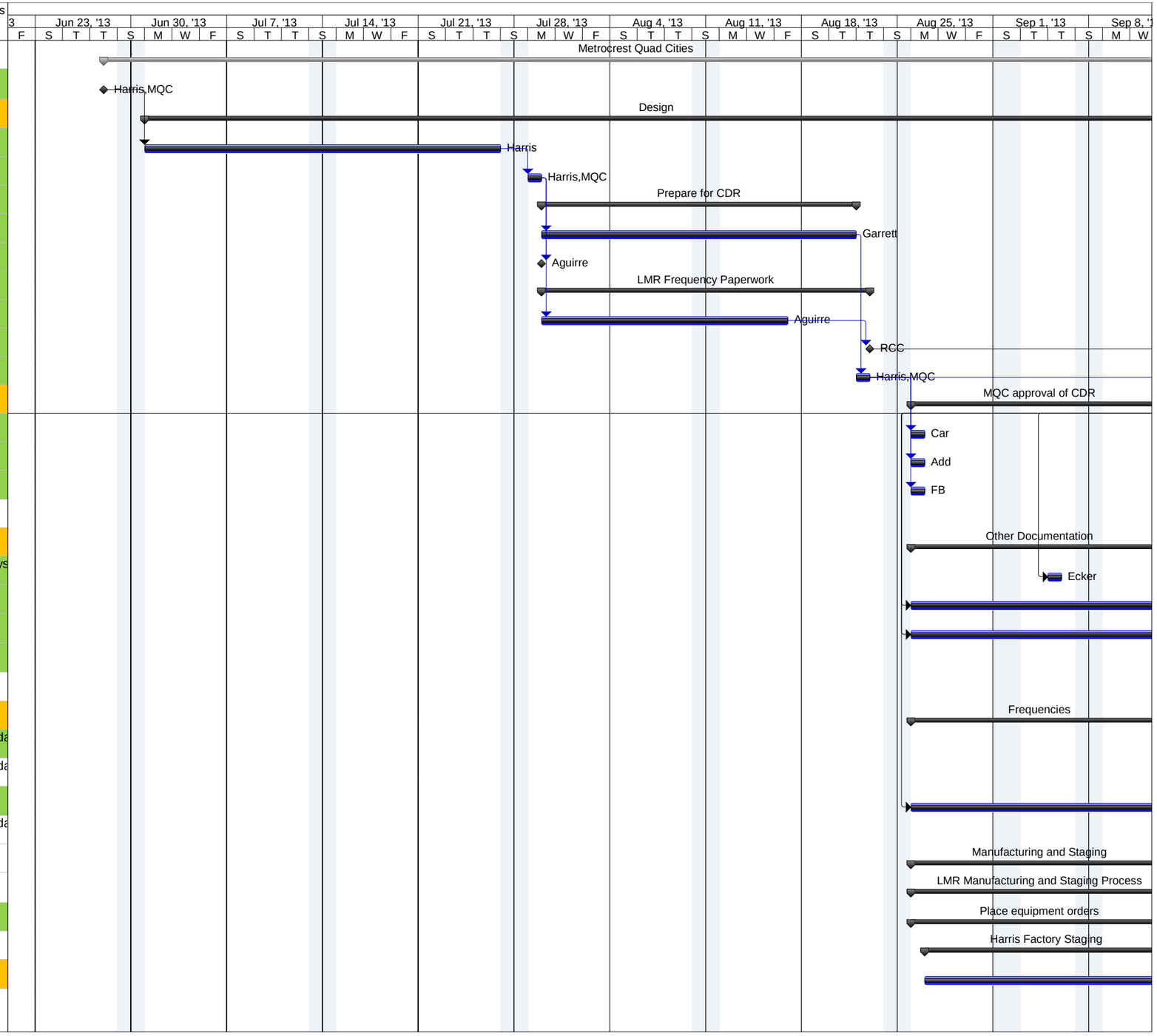
Date: 12/18/13	Fig. NA191-03
Prepared by: PA Garrett	Rev. M

Confidential, Proprietary & Competition Sensitive

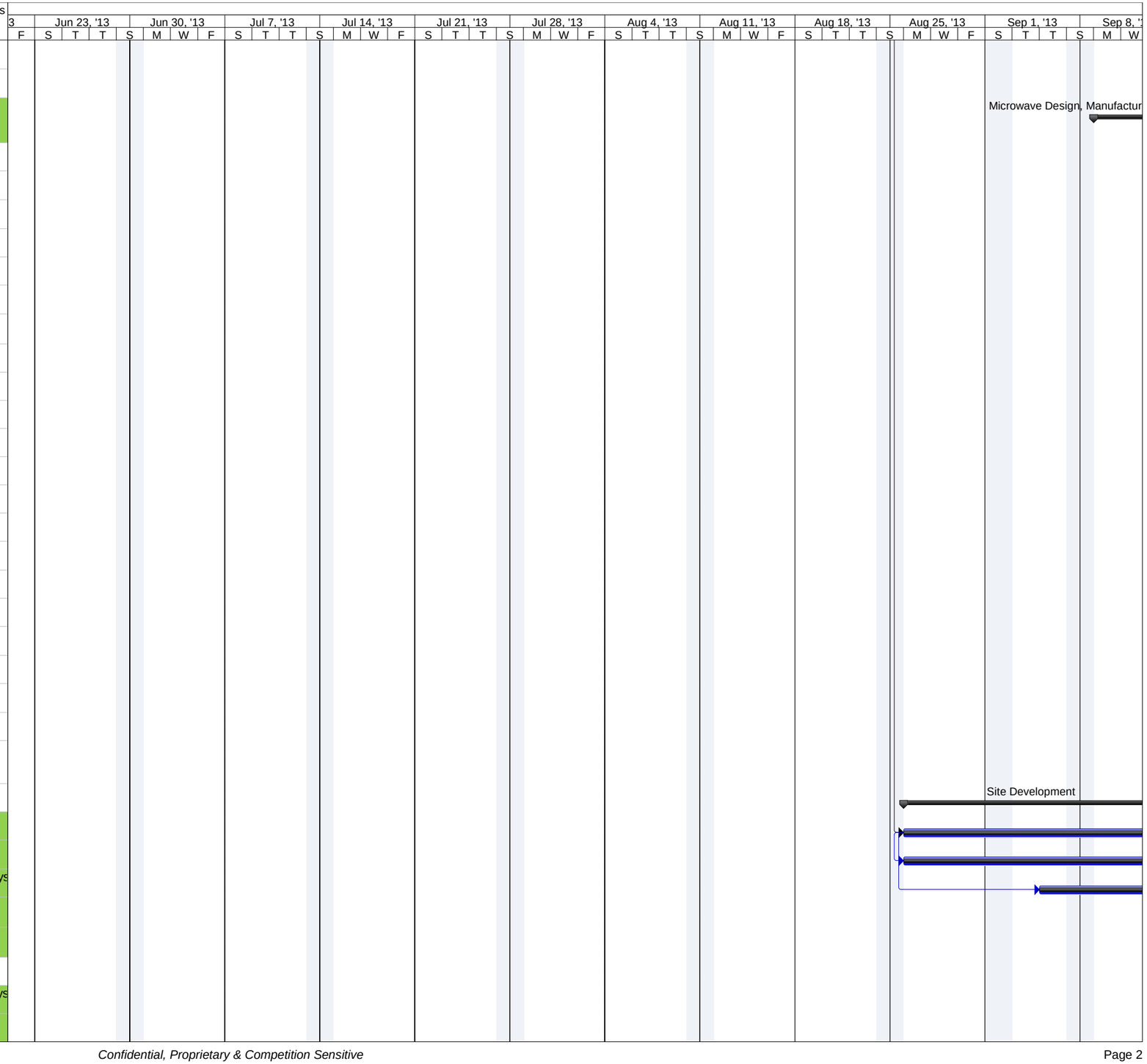
Company Proprietary and Confidential

D. Exhibit A – Statement of Work, Attachment 8 – Project Schedule, Revision 1

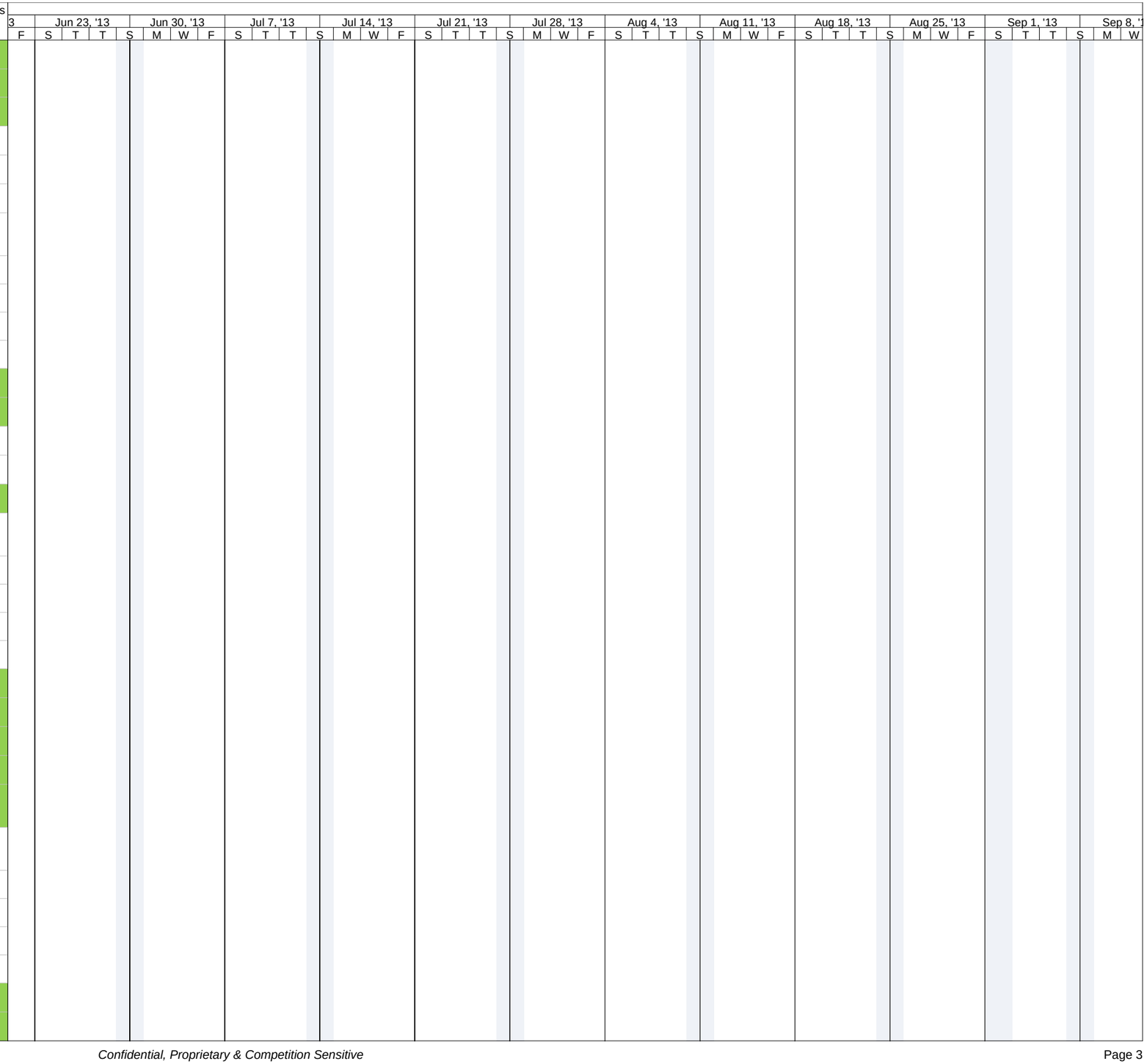
ID	WBS	Task Name	% Comple	Duration	Start	Finish	Predecessors
0	**0**	**Metrocrest Quad Cities**	**51%**	**403.5 days**	**Fri 6/28/13**	**Fri 2/20/15**	
1	**1**	**Contract Signed/Executed - RX NTP**	**100%**	**0 days**	**Fri 6/28/13**	**Fri 6/28/13**	
2	**2**	**Design**	**98%**	**133 days**	**Mon 7/1/13**	**Fri 1/17/14**	
3	2.1	Harris Internal Project Reviews & Prep	100%	19 days	Mon 7/1/13	Fri 7/26/13	1
4	2.2	Kick-off Meeting/PDR w/MQC	100%	1 day	Mon 7/29/13	Mon 7/29/13	3
5	**2.3**	**Prepare for CDR**	**100%**	**17 days**	**Mon 7/29/13**	**Wed 8/21/13**	
6	2.3.1	Prepare and finalize BoMs, site/rack drawings & floor plans	100%	17 days	Tue 7/30/13	Wed 8/21/13	4
7	2.3.2	Run RF Interference Analysis	100%	0 days	Mon 7/29/13	Mon 7/29/13	4
8	**2.4**	**LMR Frequency Paperwork**	**100%**	**18 days**	**Tue 7/30/13**	**Fri 8/23/13**	
9	2.4.1	License Prep	100%	14 days	Tue 7/30/13	Fri 8/16/13	4
10	2.4.2	License Submission	100%	0 days	Fri 8/23/13	Fri 8/23/13	9
11	***2.5***	***CDR / Project Plan***	***100%***	***1 day***	***Thu 8/22/13***	***Thu 8/22/13***	***6***
12	**2.6**	**MQC approval of CDR**	**75%**	**94 days**	**Mon 8/26/13**	**Fri 1/17/14**	
13	2.6.1	Carrollton approval of CDR	100%	1 day	Mon 8/26/13	Mon 8/26/13	11
14	2.6.2	Addison approval of CDR	100%	1 day	Mon 8/26/13	Mon 8/26/13	11
15	2.6.3	Farmers Branch approval of CDR	100%	1 day	Mon 8/26/13	Mon 8/26/13	11
16	2.6.4	Coppell approval of CDR	0%	1 day	Fri 1/17/14	Fri 1/17/14	11
17	**3**	**Other Documentation**	**95%**	**104 days**	**Mon 8/26/13**	**Fri 1/31/14**	
18	3.1	Provide detailed WBS	100%	1 day	Thu 9/5/13	Thu 9/5/13	12FS+4 days
19	3.2	Microwave Path Surveying-Path Report	100%	30 days	Mon 8/26/13	Mon 10/7/13	12
20	3.3	Detailed Transition and Cutover Plan Draft	100%	81 edays	Mon 8/26/13	Fri 11/15/13	12
21	3.4	Reviews of Transition and Cutover Plan Draft	100%	23 days	Mon 11/18/13	Fri 12/20/13	20
22	3.5	Finalization and Sign-off of Transition and Cutover Plan	25%	20 days	Mon 1/6/14	Fri 1/31/14	21
23	**4**	**Frequencies**	**99%**	**94 days**	**Mon 8/26/13**	**Fri 1/17/14**	
24	4.1	LMR Freq Submittal to FCC	100%	0 days	Wed 11/6/13	Wed 11/6/13	10FS+75 eda
25	4.2	LMR Freq FCC Approval	0%	0 days	Fri 1/17/14	Fri 1/17/14	24FS+72 eda
26	4.3	Microwave License Prep and Submission	100%	49 days	Mon 8/26/13	Fri 11/1/13	12
27	4.4	Microwave Freq FCC Approval	0%	0 days	Fri 1/17/14	Fri 1/17/14	26FS+77 eda
28	**5**	**Manufacturing and Staging**	**71%**	**159 days**	**Mon 8/26/13**	**Fri 4/18/14**	
29	**5.1**	**LMR Manufacturing and Staging Process**	**57%**	**159 days**	**Mon 8/26/13**	**Fri 4/18/14**	
30	**5.1.1**	**Place equipment orders**	**100%**	**72 days**	**Mon 8/26/13**	**Fri 12/6/13**	
37	**5.1.2**	**Harris Factory Staging**	**55%**	**158 days**	**Tue 8/27/13**	**Fri 4/18/14**	
38	5.1.2.1	Manufacture P25 Radio System	85%	103 days	Tue 8/27/13	Fri 1/31/14	36
39	5.1.2.2	Assemble and Stage P25 Infrastructure in Hoffman cabinets	0%	45 days	Mon 2/3/14	Fri 4/4/14	38



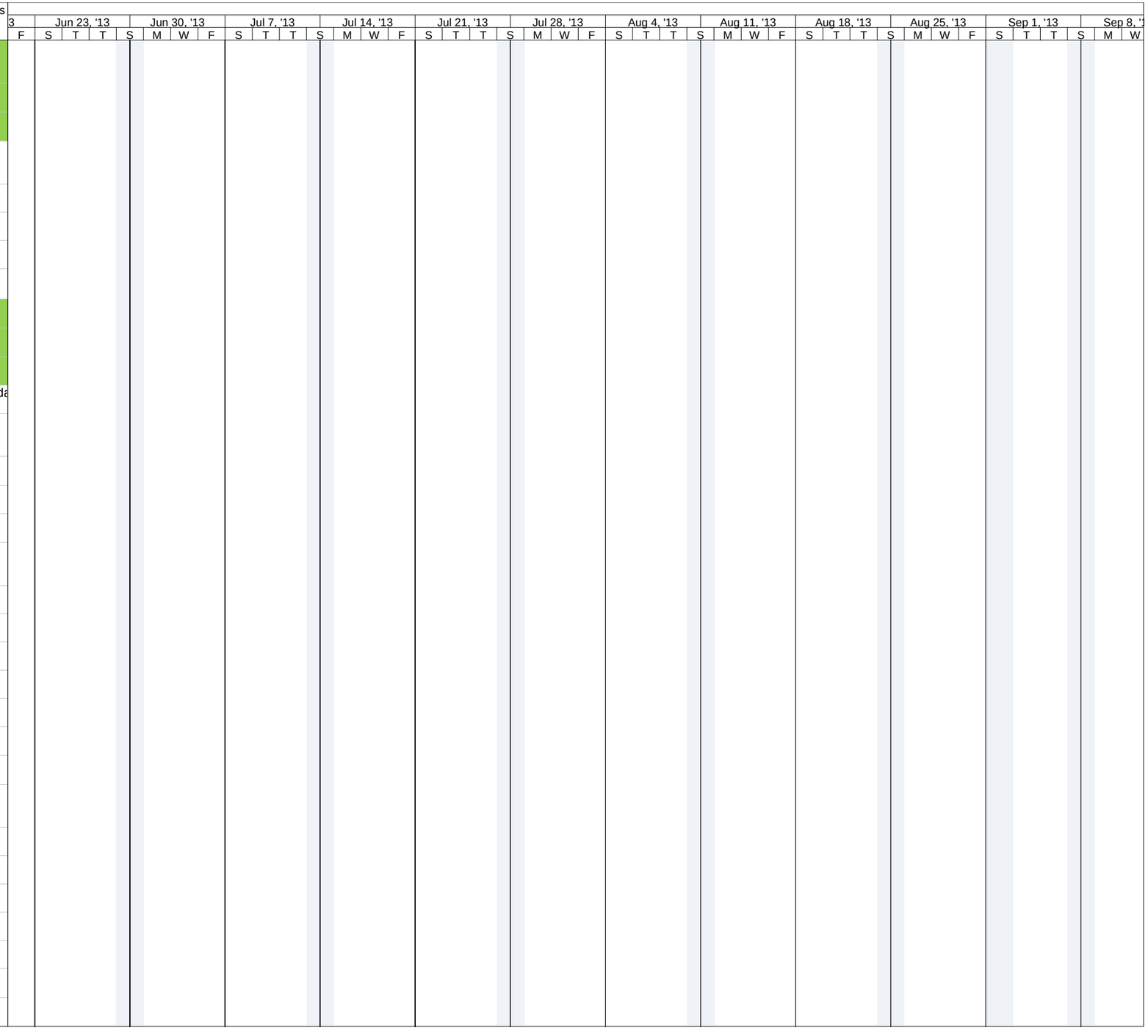
ID	WBS	Task Name	% Comple	Duration	Start	Finish	Predecessors
40	5.1.2.3	Break down and pack for shipping to the Dallas RSC	0%	5 days	Mon 4/7/14	Fri 4/11/14	39
41	5.1.2.4	Deliver equipment to the Dallas RSC	0%	5 days	Mon 4/14/14	Fri 4/18/14	40
42	**5.2**	**Microwave Design, Manufacturing and Staging Process**	**100%**	**75 days**	**Mon 9/9/13**	**Fri 1/3/14**	
49	**6**	**Training (Exec and Sys Mgr)**	**0%**	**35.5 days**	**Fri 2/14/14**	**Fri 4/4/14**	
50	6.1	MQC selects System Administrator	0%	0 days	Fri 2/14/14	Fri 2/14/14	
51	6.2	Scheduling Coordination w/Trng Dept	0%	0 days	Fri 2/21/14	Fri 2/21/14	
52	**6.3**	**System Manager Training**	**0%**	**24.5 days**	**Mon 3/3/14**	**Fri 4/4/14**	
53	6.3.1	P25IP Sys Admin Course	0%	4.5 days	Mon 3/3/14	Fri 3/7/14	
54	6.3.2	P25IP Fleet Mapping Workshop	0%	3 days	Tue 4/1/14	Fri 4/4/14	53FS+17 days
55	**7**	**Field Staging and FATP at RSC Dallas**	**0%**	**19 days**	**Mon 4/21/14**	**Thu 5/15/14**	
56	7.1	Stage Radio System	0%	10 days	Mon 4/21/14	Fri 5/2/14	41,48
57	7.2	Stage MW System	0%	10 days	Mon 4/21/14	Fri 5/2/14	56SS
58	7.3	Prepare systems for FATP	0%	5 days	Mon 5/5/14	Fri 5/9/14	56,57
59	7.4	Conduct FATP	0%	3 days	Mon 5/12/14	Wed 5/14/14	58
60	7.5	MQC approval of FATP testing	0%	1 day	Thu 5/15/14	Thu 5/15/14	59
61	**8**	**Packing and Delivery to Sites**	**0%**	**10 days**	**Mon 5/12/14**	**Sat 5/24/14**	
62	**8.1**	**All Water Tower Sites**	**0%**	**6 days**	**Fri 5/16/14**	**Fri 5/23/14**	
63	8.1.1	Break down cabinets/racks, inventory and pack	0%	3 days	Fri 5/16/14	Tue 5/20/14	60
64	8.1.2	Deliver equipment to 5 sites	0%	3 days	Wed 5/21/14	Fri 5/23/14	63
65	**8.2**	**Addison Spectrum Ctr**	**0%**	**10 days**	**Mon 5/12/14**	**Sat 5/24/14**	
66	8.2.1	Coordinate Schedule w/Capt. Spencer and Addison Airport	0%	1 day	Mon 5/12/14	Mon 5/12/14	58
67	8.2.2	Schedule Helo for lifting	0%	1 day	Tue 5/13/14	Tue 5/13/14	66
68	8.2.3	Plan out the number of pallets needed	0%	0.5 days	Wed 5/21/14	Wed 5/21/14	63
69	8.2.4	Pack pallets per lifting specs	0%	1 day	Wed 5/21/14	Thu 5/22/14	68,214
70	8.2.5	Deliver pallets to lifting location, lift to roof, position into location.	0%	1 day	Sat 5/24/14	Sat 5/24/14	67,69
71	**9**	**Site Development**	**71%**	**149 days**	**Mon 8/26/13**	**Fri 4/4/14**	
72	9.1	Develop site plots for all sites	100%	24 days	Mon 8/26/13	Fri 9/27/13	12
73	9.2	Coordinate with Cities on locations of Generators	100%	4 wks	Mon 8/26/13	Mon 9/23/13	72SS
74	9.3	Obtain construction permits	100%	37 edays	Wed 9/4/13	Fri 10/11/13	72SS+7 days
75	**9.4**	**Perform Site Grounding Analysis**	**100%**	**4.5 days**	**Mon 11/4/13**	**Fri 11/8/13**	
85	**9.5**	**Receive Equipment from vendors**	**100%**	**61 days**	**Wed 9/25/13**	**Fri 12/20/13**	
98	**9.6**	**Josey Lane Water Tank**	**41%**	**59.5 days**	**Mon 10/21/13**	**Fri 1/24/14**	
99	9.6.1	Construct shelter foundation	100%	3 days	Mon 10/21/13	Wed 10/23/13	74FS+5 days
100	9.6.2	Construct shelter ground ring	100%	2 days	Thu 10/24/13	Fri 10/25/13	99



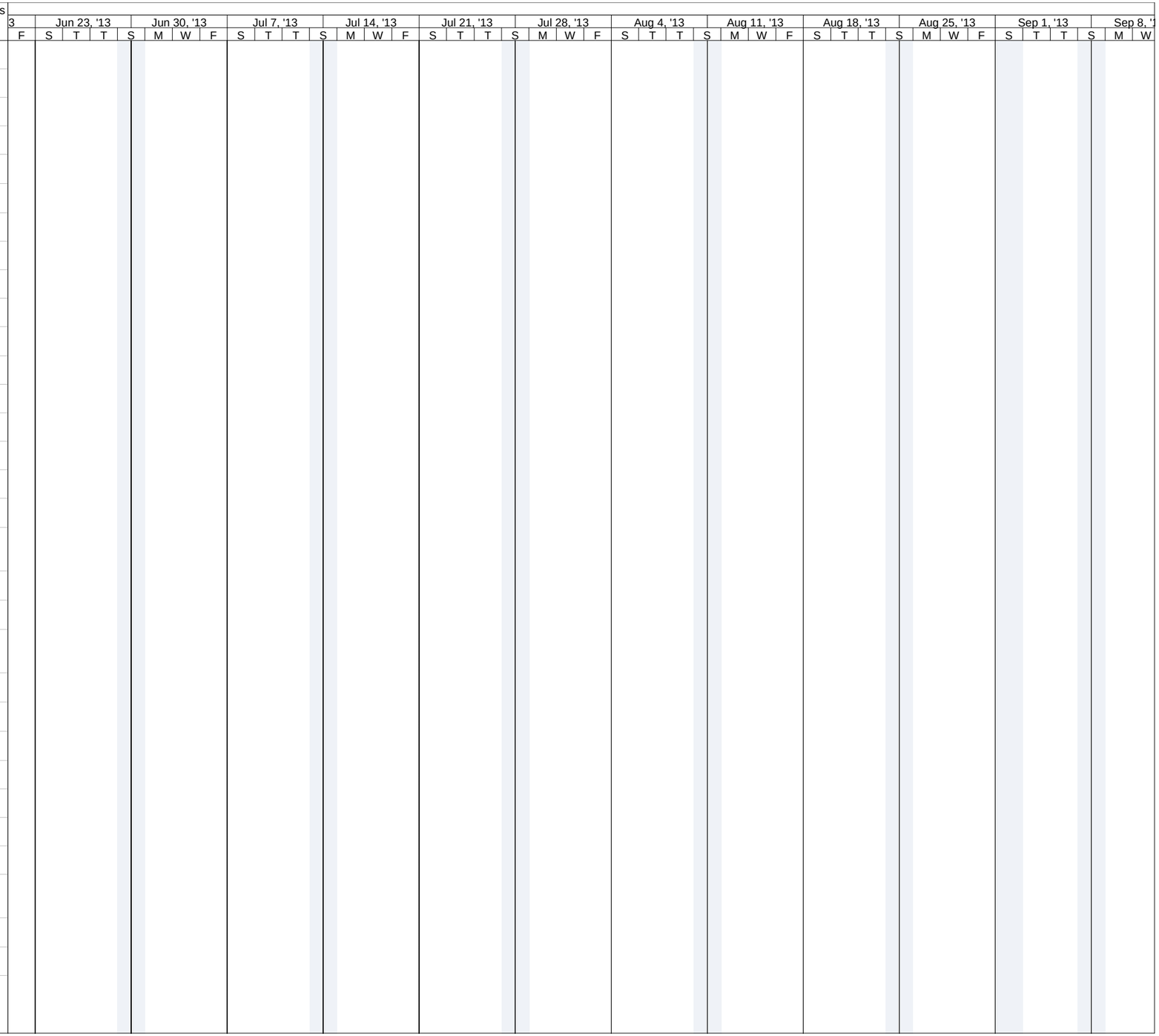
ID	WBS	Task Name	% Comple	Duration	Start	Finish	Predecessors
101	9.6.3	Verify readiness of shelter foundation	100%	0.5 days	Thu 11/7/13	Thu 11/7/13	142
102	9.6.4	Receive and set Shelter	100%	1.5 days	Fri 12/13/13	Mon 12/16/13	94
103	9.6.5	Install cable bridge & cable ladder	100%	3 days	Mon 1/6/14	Wed 1/8/14	125
104	9.6.6	Install Antennas and Cabling; verify proper cable labelling	25%	3 days	Thu 1/9/14	Mon 1/13/14	103
105	9.6.7	Receive and set Generator and connect power	0%	4 days	Tue 1/14/14	Fri 1/17/14	104
106	9.6.8	Compound/fence/weed barrier/gravel	0%	4 days	Tue 1/14/14	Fri 1/17/14	104
107	9.6.9	Install Microwave Dish and Cabling; verify proper cable labelling	0%	3 days	Mon 1/20/14	Wed 1/22/14	97,106
108	9.6.10	Perform line sweeps	0%	1 day	Thu 1/23/14	Thu 1/23/14	107
109	9.6.11	Redline drawings	0%	0.5 days	Fri 1/24/14	Fri 1/24/14	106,108
110	9.6.12	Site cleanup and inspection	0%	0.5 days	Fri 1/24/14	Fri 1/24/14	106,108
111	**9.7**	**Hebron Water Tank**	**35%**	**52.5 days**	**Mon 10/28/13**	**Wed 1/22/14**	
112	9.7.1	Construct generator compound and foundation	100%	2 days	Mon 10/28/13	Tue 10/29/13	100
113	9.7.2	Verify readiness of generator compound and foundation	100%	0.5 days	Thu 11/7/13	Thu 11/7/13	101
114	9.7.3	Install Mounting Supports on Tower Top	0%	2 days	Thu 1/9/14	Fri 1/10/14	103
115	9.7.4	Install Antennas and Cabling; verify proper cable labelling	0%	3 days	Mon 1/13/14	Wed 1/15/14	114
116	9.7.5	Install 50 KW natural gas and trench power to Water Tank	100%	3 days	Tue 11/19/13	Thu 11/21/13	143,87
117	9.7.6	Install Microwave Dish and Cabling; verify proper cable labelling	0%	3 days	Thu 1/16/14	Mon 1/20/14	115
118	9.7.7	Perform line sweeps	0%	1 day	Tue 1/21/14	Tue 1/21/14	117
119	9.7.8	Redline drawings	0%	0.5 days	Wed 1/22/14	Wed 1/22/14	118
120	9.7.9	Site cleanup and inspection	0%	0.5 days	Wed 1/22/14	Wed 1/22/14	118
121	**9.8**	**Wagon Wheel Water Tank**	**68%**	**55 days**	**Wed 10/30/13**	**Tue 1/28/14**	
122	9.8.1	Construct generator compound and foundation	100%	2 days	Wed 10/30/13	Thu 10/31/13	112
123	9.8.2	Verify readiness of generator compound and foundation	100%	0.5 days	Fri 11/8/13	Fri 11/8/13	113
124	9.8.3	Install cable bridge & cable ladder	100%	2.5 days	Mon 12/16/13	Wed 12/18/13	126FS+3 days
125	9.8.4	Install Antennas and Cabling; verify proper cable labelling	100%	2.5 days	Wed 12/18/13	Fri 12/20/13	124
126	9.8.5	Install 50 KW diesel generator and trench power to Water Tank	100%	3 days	Fri 11/22/13	Tue 11/26/13	116,88
127	9.8.6	Install Microwave Dish and Cabling; verify proper cable labelling	0%	3 days	Wed 1/22/14	Mon 1/27/14	120
128	9.8.7	Perform line sweeps	0%	1 day	Mon 1/27/14	Tue 1/28/14	127
129	9.8.8	Redline drawings	0%	0.5 days	Tue 1/28/14	Tue 1/28/14	128
130	9.8.9	Site cleanup and inspection	0%	0.5 days	Tue 1/28/14	Tue 1/28/14	128
131	**9.9**	**FB2 (Davis St Water Tank)**	**66%**	**57 days**	**Fri 11/1/13**	**Mon 2/3/14**	
132	9.9.1	Construct generator compound and foundation	100%	2 days	Fri 11/1/13	Mon 11/4/13	122
133	9.9.2	Verify readiness of generator compound and foundation	100%	0.5 days	Fri 11/8/13	Fri 11/8/13	123



ID	WBS	Task Name	% Comple	Duration	Start	Finish	Predecessors
134	9.9.3	Install 50 KW diesel generator and trench power to Water Tank	100%	3 days	Thu 12/12/13	Mon 12/16/13	
135	9.9.4	Install cable bridge & cable ladder	100%	2 days	Tue 12/17/13	Wed 12/18/13	134
136	9.9.5	Install Antennas and Cabling; verify proper cable labelling	100%	2 days	Thu 12/19/13	Fri 12/20/13	135
137	9.9.6	Install Microwave Dish and Cabling; verify proper cable labelling	0%	3 days	Tue 1/28/14	Fri 1/31/14	128
138	9.9.7	Perform line sweeps	0%	1 day	Fri 1/31/14	Mon 2/3/14	137
139	9.9.8	Redline drawings	0%	0.5 days	Mon 2/3/14	Mon 2/3/14	136,138
140	9.9.9	Site cleanup and inspection	0%	0.5 days	Mon 2/3/14	Mon 2/3/14	138,136
141	**9.10**	**FB1 (Justice Center Water Tank)**	**15%**	**66.5 days**	**Tue 11/5/13**	**Wed 2/19/14**	
142	9.10.1	Construct generator compound and foundation	100%	2 days	Tue 11/5/13	Wed 11/6/13	132
143	9.10.2	Verify readiness of generator compound and foundation	100%	0.5 days	Mon 11/11/13	Mon 11/11/13	133
144	9.10.3	Order Generator	100%	0 days	Fri 11/8/13	Fri 11/8/13	
145	9.10.4	RX Generator	0%	0 days	Wed 1/15/14	Wed 1/15/14	144FS+35 da
146	9.10.5	Install 50 KW diesel generator and trench power to Water Tank	0%	2 days	Wed 1/15/14	Thu 1/16/14	145
147	9.10.6	Install cable bridge & cable ladder	0%	2 days	Tue 2/4/14	Wed 2/5/14	140
148	9.10.7	Construct fenced compound	0%	2 days	Thu 2/6/14	Fri 2/7/14	147
149	9.10.8	Install Antennas and Cabling; verify proper cable labelling	0%	3 days	Mon 2/10/14	Wed 2/12/14	148
150	9.10.9	Install Microwave Dish and Cabling; verify proper cable labelling	0%	3 days	Thu 2/13/14	Mon 2/17/14	149
151	9.10.10	Perform Dish Line Sweeps	0%	1 day	Tue 2/18/14	Tue 2/18/14	150
152	9.10.11	Redline drawings	0%	0.5 days	Wed 2/19/14	Wed 2/19/14	151
153	9.10.12	Site cleanup and inspection	0%	0.5 days	Wed 2/19/14	Wed 2/19/14	151
154	**9.11**	**Addison Spectrum Center**	**0%**	**10.5 days**	**Wed 2/19/14**	**Wed 3/5/14**	
155	9.11.1	Install 6-port cable entry port	0%	2 days	Wed 2/19/14	Fri 2/21/14	153
156	9.11.2	Install cable bridge & cable ladder	0%	1 day	Fri 2/21/14	Mon 2/24/14	155
157	9.11.3	Install Antennas and Cabling; verify proper cable labelling	0%	3 days	Mon 2/24/14	Thu 2/27/14	156,81
158	9.11.4	Install Microwave Dish and Cabling; verify proper cable labelling	0%	3 days	Thu 2/27/14	Tue 3/4/14	157
159	9.11.5	Perform line sweeps	0%	1 day	Tue 3/4/14	Wed 3/5/14	158
160	9.11.6	Redline drawings	0%	0.5 days	Wed 3/5/14	Wed 3/5/14	159
161	9.11.7	Site cleanup and inspection	0%	0.5 days	Wed 3/5/14	Wed 3/5/14	159
162	**9.12**	**Addison Central Fire EOC**	**0%**	**10.5 days**	**Thu 3/6/14**	**Thu 3/20/14**	
163	9.12.1	Install overhead cable tray	0%	2 days	Thu 3/6/14	Fri 3/7/14	161
164	9.12.2	Install UPS with By-pass Switch	0%	4 days	Mon 3/10/14	Thu 3/13/14	163
165	9.12.3	Install Dishes and Cabling; verify proper cable labelling	0%	3 days	Fri 3/14/14	Tue 3/18/14	164

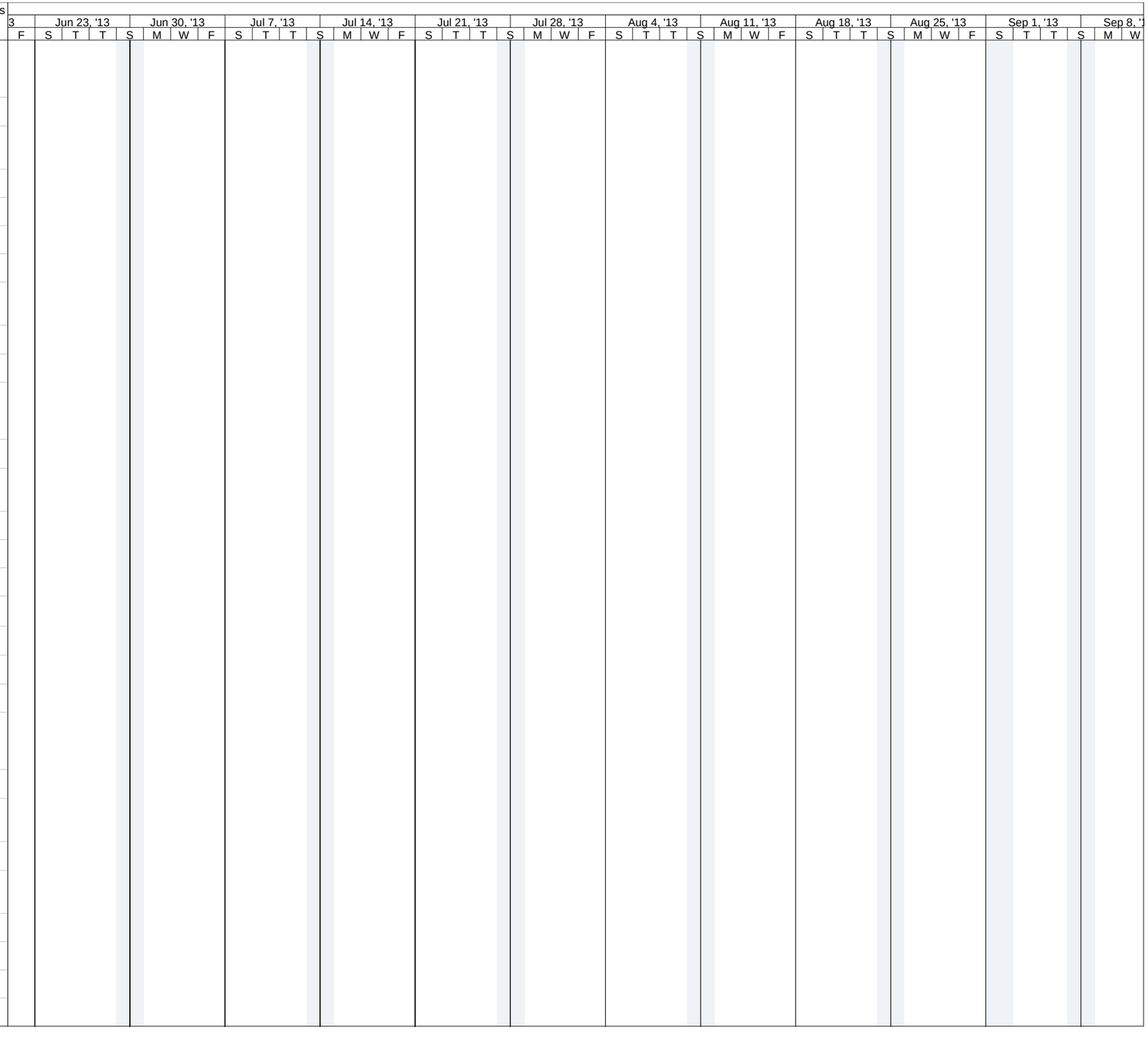


ID	WBS	Task Name	% Comple	Duration	Start	Finish	Predecessors
166	9.12.4	Perform Dish Line Sweeps	0%	1 day	Wed 3/19/14	Wed 3/19/14	165
167	9.12.5	Redline drawings	0%	0.5 days	Thu 3/20/14	Thu 3/20/14	166
168	9.12.6	Site cleanup and inspection	0%	0.5 days	Thu 3/20/14	Thu 3/20/14	166
169	**9.13**	**Carrollton City Hall Dispatch**	**0%**	**7.5 days**	**Thu 3/20/14**	**Mon 3/31/14**	
170	9.13.1	Install UPS with By-pass Switch	0%	3 days	Thu 3/20/14	Tue 3/25/14	168
171	9.13.2	Install Dishes and Cabling; verify proper cable labelling	0%	3 days	Tue 3/25/14	Fri 3/28/14	170
172	9.13.3	Perform Dish Line Sweeps	0%	1 day	Fri 3/28/14	Mon 3/31/14	171
173	9.13.4	Redline drawings	0%	0.5 days	Mon 3/31/14	Mon 3/31/14	172
174	9.13.5	Site cleanup and inspection	0%	0.5 days	Mon 3/31/14	Mon 3/31/14	172
175	**9.14**	**Carrollton Radio Shop**	**0%**	**4.5 days**	**Mon 3/31/14**	**Fri 4/4/14**	
176	9.14.1	Install Dishes and Cabling; verify proper cable labelling	0%	3 days	Mon 3/31/14	Thu 4/3/14	172
177	9.14.2	Perform Dish Line Sweeps	0%	1 day	Thu 4/3/14	Fri 4/4/14	176
178	9.14.3	Redline drawings	0%	0.5 days	Fri 4/4/14	Fri 4/4/14	177
179	9.14.4	Site cleanup and inspection	0%	0.5 days	Fri 4/4/14	Fri 4/4/14	177
180	**10**	**Infrastructure Site Installations**	**0%**	**118.5 days**	**Fri 3/28/14**	**Tue 9/16/14**	
181	**10.1**	**Carrollton City Hall**	**0%**	**12 days**	**Tue 5/27/14**	**Wed 6/11/14**	
182	10.1.1	Install Microwave Radios & DC Plant racks	0%	3 days	Tue 5/27/14	Thu 5/29/14	64
183	10.1.2	Install Primary NSC and (2) racks of Interop Radios with combiner and antenna system	0%	3 days	Tue 5/27/14	Thu 5/29/14	64
184	10.1.3	Apply power, set levels and parameters	0%	2 days	Fri 5/30/14	Mon 6/2/14	183
185	10.1.4	Connect all alarms points to alarm system	0%	1 day	Tue 6/3/14	Tue 6/3/14	184
186	10.1.5	Optimize Microwave Radios, perform Path Alignment and Radio Tests	0%	2 days	Wed 6/4/14	Thu 6/5/14	185
187	10.1.6	Install and Configure Logging Recorder	0%	2 days	Wed 6/4/14	Thu 6/5/14	185
188	10.1.7	Connect and Optimize Interop Gateways	0%	2 days	Fri 6/6/14	Mon 6/9/14	187
189	10.1.8	Reposition (5) Spectras and (1) Quantar into new cabinet	0%	1 day	Tue 6/10/14	Tue 6/10/14	188
190	10.1.9	Preliminary Functional Testing	0%	1 day	Wed 6/11/14	Wed 6/11/14	189
191	10.1.10	Redline drawings	0%	0.5 days	Wed 6/11/14	Wed 6/11/14	189
192	10.1.11	Site cleanup and inspection	0%	0.5 days	Wed 6/11/14	Wed 6/11/14	189
193	**10.2**	**Hebron Water Tank**	**0%**	**9 days**	**Wed 6/11/14**	**Mon 6/23/14**	
194	10.2.1	Set Hoffman cabinets, install HVACs and GPS Simulcast CP	0%	2 days	Wed 6/11/14	Thu 6/12/14	189
195	10.2.2	Connect cabinets to primary AC and building ground	0%	2 days	Fri 6/13/14	Mon 6/16/14	194
196	10.2.3	Install cable tray	0%	1 day	Tue 6/17/14	Tue 6/17/14	195
197	10.2.4	Make all RF cable connections, ground all equipment and connect to backhaul	0%	2 days	Wed 6/18/14	Thu 6/19/14	196

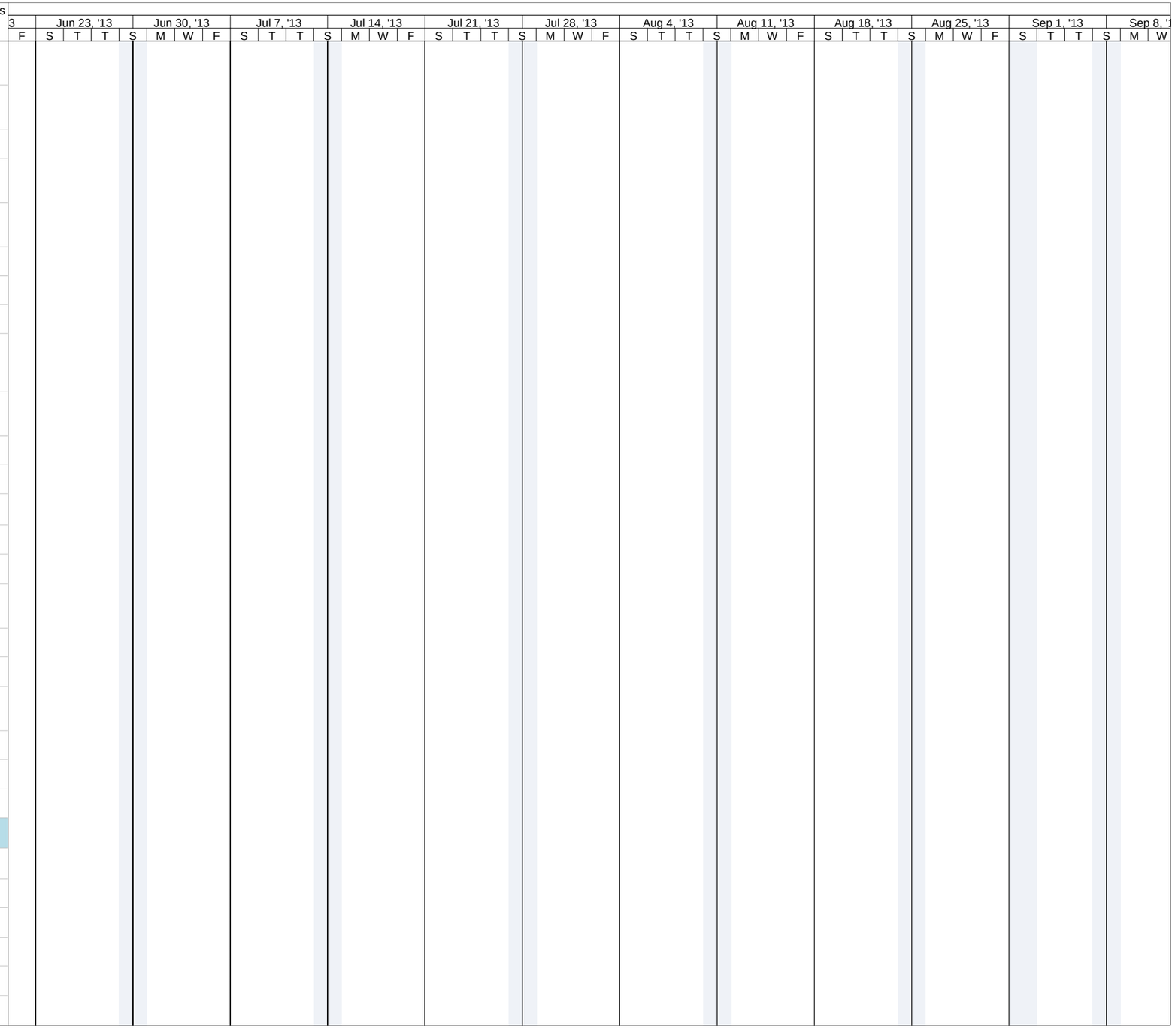


ID	WBS	Task Name	% Comple	Duration	Start	Finish	Predecessors
198	10.2.5	Connect all alarms points to alarm system	0%	1 day	Fri 6/20/14	Fri 6/20/14	197
199	10.2.6	Optimize Microwave Radio and CP, perform Path Alignment and Radio Tests	0%	2 days	Fri 6/20/14	Mon 6/23/14	197
200	10.2.7	Preliminary Functional Testing	0%	1 day	Mon 6/23/14	Mon 6/23/14	198
201	10.2.8	Redline drawings	0%	0.5 days	Mon 6/23/14	Mon 6/23/14	198
202	10.2.9	Site cleanup and inspection	0%	0.5 days	Mon 6/23/14	Mon 6/23/14	198
203	**10.3**	**Josey Lane Water Tank**	**0%**	**10 days**	**Mon 6/23/14**	**Mon 7/7/14**	
204	10.3.1	Install Microwave Radio & DC Plant racks	0%	2 days	Mon 6/23/14	Tue 6/24/14	198
205	10.3.2	Install RF equipment.	0%	2 days	Wed 6/25/14	Thu 6/26/14	204
206	10.3.3	Make all RF cable connections, ground all equipment and connect to backhaul	0%	2 days	Fri 6/27/14	Mon 6/30/14	205
207	10.3.4	Connect all alarms points to alarm system	0%	1 day	Tue 7/1/14	Tue 7/1/14	206
208	10.3.5	Optimize Microwave Radio, perform Path Alignment and Radio Tests	0%	2 days	Wed 7/2/14	Thu 7/3/14	207
209	10.3.6	Preliminary Functional Testing	0%	1 day	Mon 7/7/14	Mon 7/7/14	208
210	10.3.7	Redline drawings	0%	0.5 days	Mon 7/7/14	Mon 7/7/14	208
211	10.3.8	Site cleanup and inspection	0%	0.5 days	Mon 7/7/14	Mon 7/7/14	208
212	**10.4**	**Addison Spectrum Center**	**0%**	**75 days**	**Fri 3/28/14**	**Tue 7/15/14**	
213	10.4.1	Order HVACs	0%	0 days	Fri 3/28/14	Fri 3/28/14	
214	10.4.2	Receive HVACs	0%	0 days	Fri 4/25/14	Fri 4/25/14	213
215	10.4.3	Install HVACs	0%	1 day	Tue 5/27/14	Tue 5/27/14	214,70
216	10.4.4	Install Cable Tray	0%	1 day	Wed 7/2/14	Wed 7/2/14	207
217	10.4.5	Connect cabinets to primary AC and building ground	0%	2 days	Thu 7/3/14	Mon 7/7/14	216
218	10.4.6	Make all RF cable connections, ground all equipment and connect to backhaul	0%	2 days	Tue 7/8/14	Wed 7/9/14	217
219	10.4.7	Connect all alarms points to alarm system	0%	1 day	Thu 7/10/14	Thu 7/10/14	218
220	10.4.8	Optimize Microwave Radio, perform Path Alignment and Radio Tests	0%	2 days	Fri 7/11/14	Mon 7/14/14	219
221	10.4.9	Preliminary Functional Testing	0%	1 day	Tue 7/15/14	Tue 7/15/14	220
222	10.4.10	Redline drawings	0%	0.5 days	Tue 7/15/14	Tue 7/15/14	220
223	10.4.11	Site cleanup and inspection	0%	0.5 days	Tue 7/15/14	Tue 7/15/14	220
224	**10.5**	**Wagon Wheel Water Tank**	**0%**	**12 days**	**Tue 7/15/14**	**Wed 7/30/14**	
225	10.5.1	Set Hoffman cabinets and install HVACs	0%	3 days	Tue 7/15/14	Thu 7/17/14	220
226	10.5.2	Connect cabinets to primary AC and building ground	0%	2 days	Fri 7/18/14	Mon 7/21/14	225
227	10.5.3	Install cable tray	0%	1 day	Tue 7/22/14	Tue 7/22/14	226

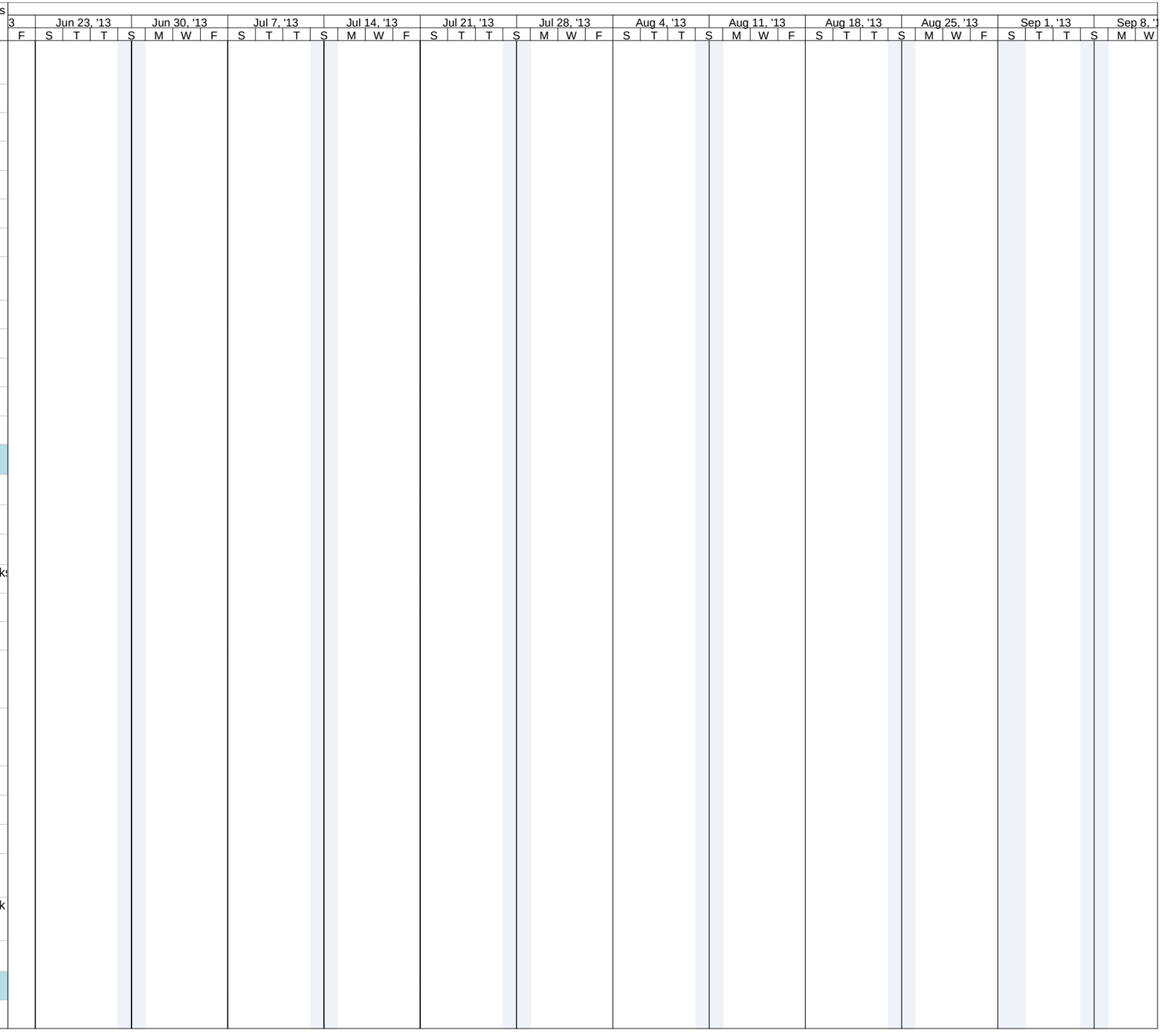
ID	WBS	Task Name	% Comple	Duration	Start	Finish	Predecessors
228	10.5.4	Make all RF cable connections, ground all equipment and connect to backhaul	0%	2 days	Wed 7/23/14	Thu 7/24/14	227
229	10.5.5	Connect all alarms points to alarm system	0%	1 day	Fri 7/25/14	Fri 7/25/14	228
230	10.5.6	Optimize Microwave Radio, perform Path Alignment and Radio Tests	0%	2 days	Mon 7/28/14	Tue 7/29/14	229
231	10.5.7	Preliminary Functional Testing	0%	1 day	Wed 7/30/14	Wed 7/30/14	230
232	10.5.8	Redline drawings	0%	0.5 days	Wed 7/30/14	Wed 7/30/14	230
233	10.5.9	Site cleanup and inspection	0%	0.5 days	Wed 7/30/14	Wed 7/30/14	230
234	**10.6**	**FB2 (Davis St Water Tank)**	**0%**	**11 days**	**Mon 7/28/14**	**Mon 8/11/14**	
235	10.6.1	Set Hoffman cabinets, install HVACs and GPS Simulcast CP	0%	2 days	Mon 7/28/14	Tue 7/29/14	229
236	10.6.2	Connect cabinets to primary AC and building ground	0%	2 days	Wed 7/30/14	Thu 7/31/14	235
237	10.6.3	Install cable tray	0%	1 day	Fri 8/1/14	Fri 8/1/14	236
238	10.6.4	Make all RF cable connections, ground all equipment and connect to backhaul	0%	2 days	Mon 8/4/14	Tue 8/5/14	237
239	10.6.5	Connect all alarms points to alarm system	0%	1 day	Wed 8/6/14	Wed 8/6/14	238
240	10.6.6	Optimize Microwave Radio, perform Path Alignment and Radio Tests	0%	2 days	Thu 8/7/14	Fri 8/8/14	239
241	10.6.7	Preliminary Functional Testing	0%	1 day	Mon 8/11/14	Mon 8/11/14	240
242	10.6.8	Redline drawings	0%	0.5 days	Mon 8/11/14	Mon 8/11/14	240
243	10.6.9	Site cleanup and inspection	0%	0.5 days	Mon 8/11/14	Mon 8/11/14	240
244	**10.7**	**FB1 (Justice Center Water Tank)**	**0%**	**13 days**	**Thu 8/7/14**	**Mon 8/25/14**	
245	10.7.1	Set Hoffman cabinets and install HVACs	0%	2 days	Thu 8/7/14	Fri 8/8/14	239
246	10.7.2	Connect cabinets to primary AC and building ground	0%	2 days	Mon 8/11/14	Tue 8/12/14	245
247	10.7.3	Install cable tray	0%	1 day	Wed 8/13/14	Wed 8/13/14	246
248	10.7.4	Make all RF cable connections, ground all equipment and connect to backhaul	0%	2 days	Thu 8/14/14	Fri 8/15/14	247
249	10.7.5	Connect all alarms points to alarm system	0%	1 day	Mon 8/18/14	Mon 8/18/14	248
250	10.7.6	Optimize Microwave Radio, perform Path Alignment and Radio Tests	0%	2 days	Tue 8/19/14	Wed 8/20/14	249
251	10.7.7	Optimize Interoperability Gateways	0%	1 day	Thu 8/21/14	Thu 8/21/14	250
252	10.7.8	Reposition (2) Spectra, (1) DeskTrak and (1) Quantar into new cabinet	0%	1 day	Fri 8/22/14	Fri 8/22/14	251
253	10.7.9	Preliminary Functional Testing	0%	1 day	Mon 8/25/14	Mon 8/25/14	252
254	10.7.10	Redline drawings	0%	0.5 days	Mon 8/25/14	Mon 8/25/14	252
255	10.7.11	Site cleanup and inspection	0%	0.5 days	Mon 8/25/14	Mon 8/25/14	252
256	**10.8**	**Addison Central Fire EOC**	**0%**	**6.5 days**	**Tue 8/19/14**	**Wed 8/27/14**	



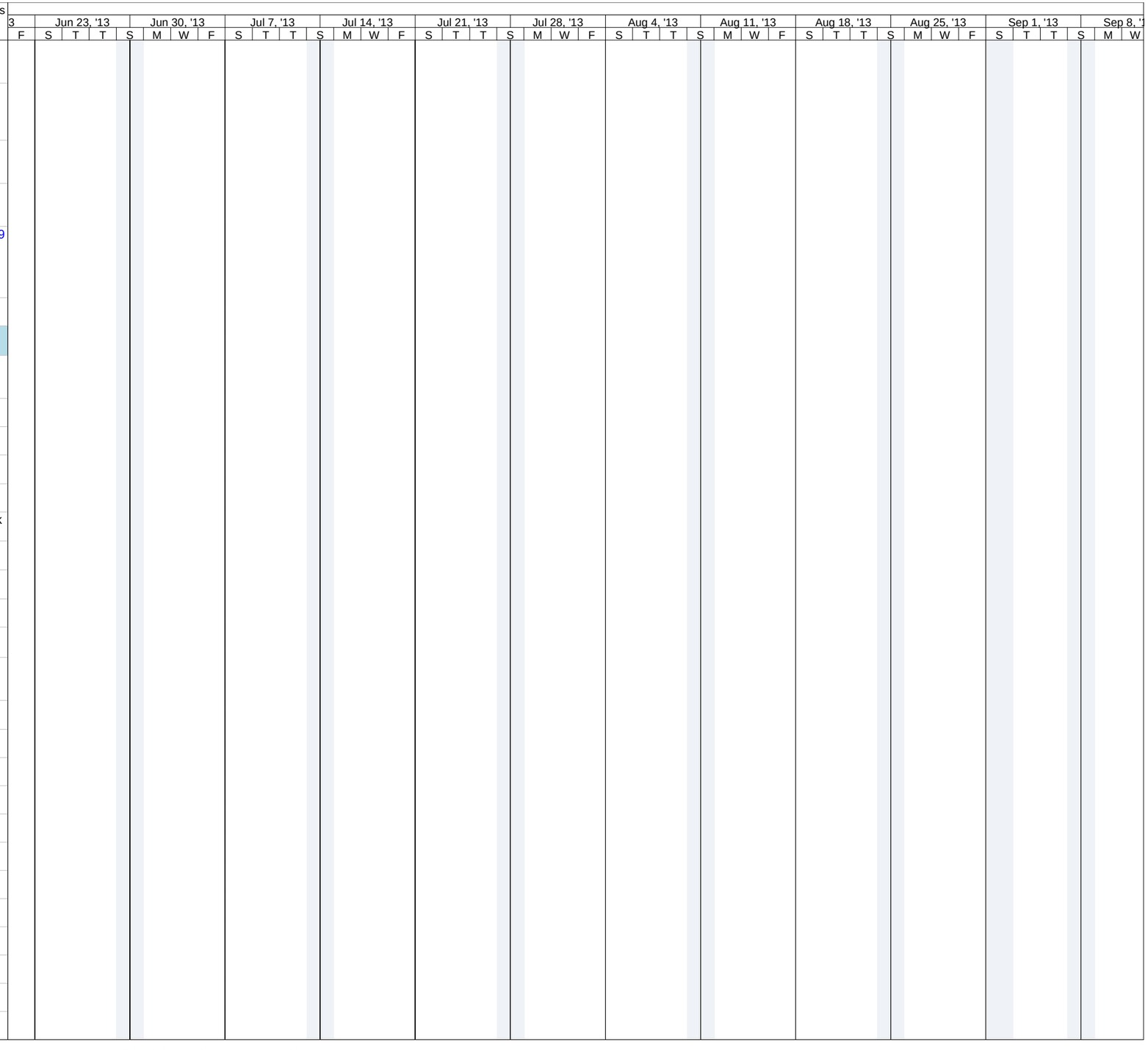
ID	WBS	Task Name	% Comple	Duration	Start	Finish	Predecessors
257	10.8.1	Install Microwave Radio & DC Plant racks, perform Path Alignment and Radio Tests	0%	2 days	Tue 8/19/14	Wed 8/20/14	249
258	10.8.2	Install (1) rack of Interoperability Radios with combiner and antenna system	0%	1 day	Thu 8/21/14	Thu 8/21/14	257
259	10.8.3	Connect and Optimize Interoperability Gateways	0%	1 day	Fri 8/22/14	Fri 8/22/14	258
260	10.8.4	Optimize Microwave Radio, perform Path Alignment and Radio Tests	0%	1 day	Mon 8/25/14	Mon 8/25/14	259
261	10.8.5	Reposition (1) CDM1250 and (1) Consolette into new cabinet	0%	1 day	Tue 8/26/14	Tue 8/26/14	260
262	10.8.6	Redline drawings	0%	0.5 days	Wed 8/27/14	Wed 8/27/14	261
263	10.8.7	Site cleanup and inspection	0%	0.5 days	Wed 8/27/14	Wed 8/27/14	261
264	**10.9**	**Carrollton Radio Shop**	**0%**	**3.5 days**	**Fri 8/22/14**	**Wed 8/27/14**	
265	10.9.1	Install Set Hoffman cabinets and install HVACs, perform Path Alignment and Radio Tests	0%	2 days	Fri 8/22/14	Mon 8/25/14	258
266	10.9.2	Optimize Microwave Radio, perform Path Alignment and Radio Tests	0%	1 day	Tue 8/26/14	Tue 8/26/14	265
267	10.9.3	Redline drawings	0%	0.5 days	Wed 8/27/14	Wed 8/27/14	266
268	10.9.4	Site cleanup and inspection	0%	0.5 days	Tue 8/26/14	Tue 8/26/14	265
269	**10.10**	**Simulcast System Final Optimization**	**0%**	**6 days**	**Tue 8/26/14**	**Thu 9/4/14**	
270	10.10.1	Perform complete system alignment and optimization.	0%	2 days	Tue 8/26/14	Thu 8/28/14	268
271	10.10.2	Verify and set simulcast timing levels with Control Point.	0%	1 day	Thu 8/28/14	Fri 8/29/14	270
272	10.10.3	Verify alarm systems and program "By-Pass mode & Alarms".	0%	1 day	Fri 8/29/14	Tue 9/2/14	271
273	10.10.4	Preliminary Functional Testing	0%	1 day	Tue 9/2/14	Wed 9/3/14	272
274	10.10.5	Verify network switches and dispatch console operation.	0%	1 day	Wed 9/3/14	Thu 9/4/14	273
275	10.10.6	Provide written certification system has been properly installed and fully optimized.	0%	0 days	Thu 9/4/14	Thu 9/4/14	274
276	**10.11**	**Site Functional Testing**	**0%**	**8 days**	**Thu 9/4/14**	**Tue 9/16/14**	
277	10.11.1	Conduct Final Site Inspections and Testing	0%	3 days	Thu 9/4/14	Tue 9/9/14	275
278	10.11.2	Resolve punch list items	0%	1 wk	Tue 9/9/14	Tue 9/16/14	277
279	***10.12***	***Infrastructure Delivered to Sites and Field Tested***	***0%***	***0 days***	***Tue 9/16/14***	***Tue 9/16/14***	***278***
280	**11**	**Dispatch Center Console Installations**	**0%**	**111.5 days**	**Mon 4/28/14**	**Fri 10/3/14**	
281	**11.1**	**Place Order for Consoles**	**0%**	**0 wks**	**Mon 4/28/14**	**Mon 4/28/14**	
282	11.2	Verify receipt of all console equipment	0%	0 days	Mon 6/16/14	Mon 6/16/14	281FS+35 days
283	**11.3**	**Dispatcher Training**	**0%**	**45 days**	**Tue 6/24/14**	**Tue 8/26/14**	
284	11.3.1	Coordinate w/Dispatch Center POCs	0%	1 day	Tue 6/24/14	Tue 6/24/14	
285	11.3.2	Scheduling Coordination w/Trng Dept	0%	1 day	Tue 6/24/14	Tue 6/24/14	



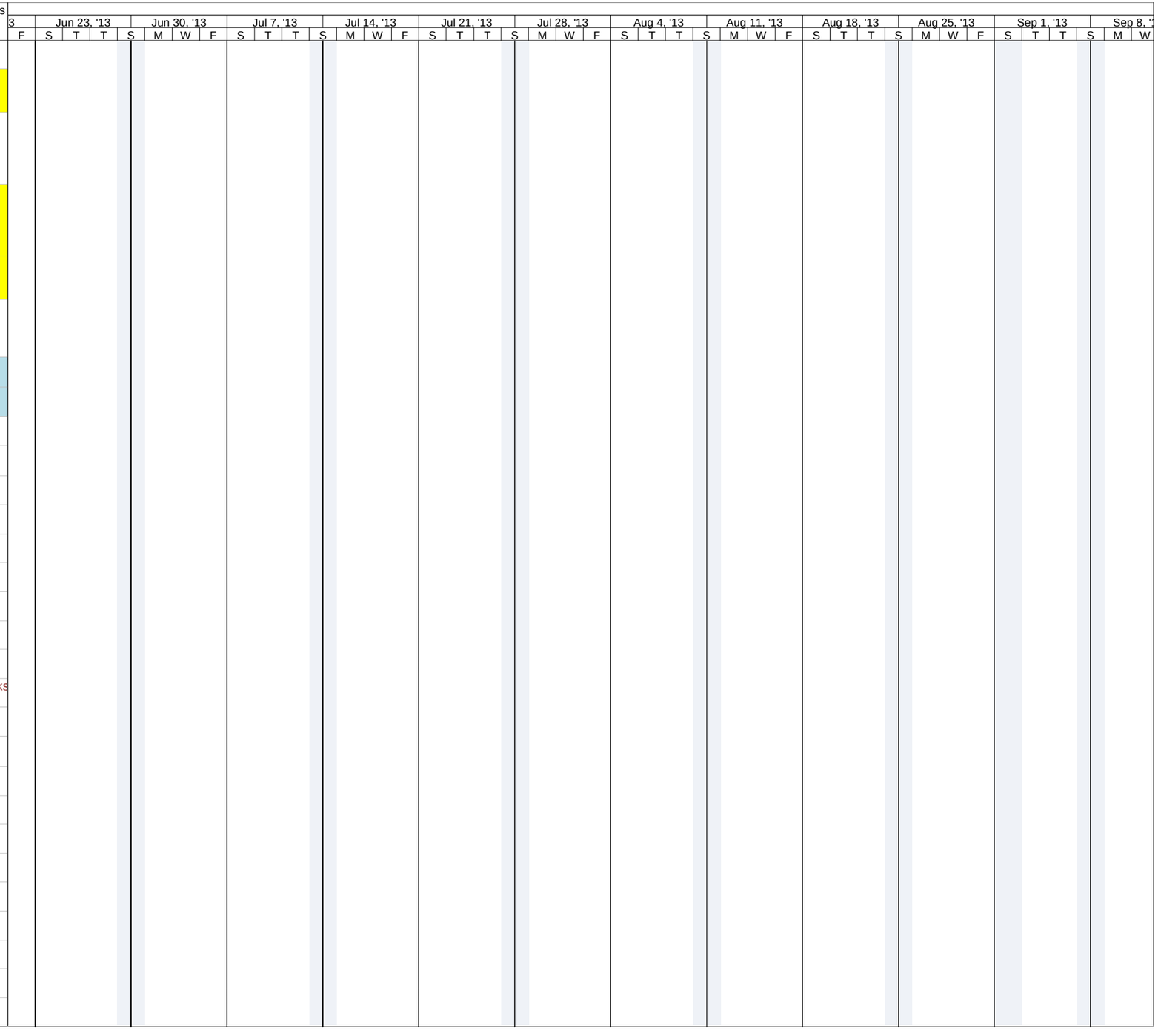
ID	WBS	Task Name	% Comple	Duration	Start	Finish	Predecessors
286	11.3.3	Console Equip Train-The-Trainer Operator Training	0%	1 day	Thu 7/24/14	Thu 7/24/14	285FS+20 days
287	11.3.4	Console Configuration Course	0%	2 days	Mon 8/25/14	Tue 8/26/14	286
288	**11.4**	**Consolidated Dispatch**	**0%**	**20.5 days**	**Wed 8/27/14**	**Thu 9/25/14**	
289	11.4.1	Install Symphony Consoles; verify proper cable labelling	0%	5 days	Tue 9/16/14	Tue 9/23/14	278,282
290	11.4.2	Redline drawings	0%	2 days	Tue 9/23/14	Thu 9/25/14	289
291	11.4.3	Console Equipment Operator Training	0%	4 days	Wed 8/27/14	Tue 9/2/14	287
292	**11.5**	**Carrollton City Hall Dispatch**	**0%**	**17.5 days**	**Wed 9/3/14**	**Fri 9/26/14**	
293	11.5.1	Replace (8) existing consoles with Symphony Consoles; verify proper cable labelling	0%	2 days	Tue 9/23/14	Thu 9/25/14	289
294	11.5.2	Redline drawings	0%	1 day	Thu 9/25/14	Fri 9/26/14	293
295	11.5.3	Console Equipment Operator Training (TBD)	0%	1 day	Wed 9/3/14	Wed 9/3/14	291
296	**11.6**	**Console Functional Testing**	**0%**	**6 days**	**Thu 9/25/14**	**Fri 10/3/14**	
297	11.6.1	Conduct Functional Test at Dispatch Centers	0%	1 day	Thu 9/25/14	Fri 9/26/14	293
298	11.6.2	Resolve punch list items	0%	1 wk	Fri 9/26/14	Fri 10/3/14	297
299	***11.7***	***Consoles Delivered, Installed and Tested***	***0%***	***0 days***	***Fri 10/3/14***	***Fri 10/3/14***	***298***
300	**12**	**Mobiles and Portables Procurement**	**0%**	**72 days**	**Mon 6/9/14**	**Thu 9/18/14**	
301	12.1	Test Developed Features for Fire Portables	0%	5 days	Mon 6/9/14	Fri 6/13/14	
302	**12.2**	**Place Order for Portables and Mobiles**	**0%**	**0 wks**	**Mon 6/16/14**	**Mon 6/16/14**	**301**
303	12.3	Ship Portables and Mobiles	0%	4 days	Tue 8/12/14	Fri 8/15/14	302FS+8 wks
304	12.4	Program Portables	0%	23 days	Mon 8/18/14	Thu 9/18/14	303
305	**13**	**Coverage Acceptance Tests**	**0%**	**42 days**	**Fri 9/19/14**	**Tue 11/18/14**	
306	13.1	Present Test Instrumentation Design and Radio Coverage Documentation Log for MQC approval	0%	0 days	Fri 9/19/14	Fri 9/19/14	308SS-2 wks
307	13.2	MQC approves Test Instrumentation Design and Radio Coverage Documentation Log	0%	0 days	Fri 10/3/14	Fri 10/3/14	308SS
308	13.3	Radio Coverage Testing Kick-Off Meeting	0%	1 day	Fri 10/3/14	Mon 10/6/14	299
309	13.4	Conduct Mobile RSSI/BER Coverage Testing	0%	3 days	Mon 10/6/14	Thu 10/9/14	308
310	13.5	Conduct Portable-In-Car Voice Quality Testing	0%	3 days	Mon 10/6/14	Thu 10/9/14	309SS
311	13.6	Conduct Critical Building Portable Voice Quality Coverage Testing	0%	17 days	Thu 10/9/14	Mon 11/3/14	310
312	13.7	Submit Acceptance Test Documentation for Review/Approval	0%	0 days	Mon 11/10/14	Mon 11/10/14	311FS+1 wk
313	**13.8**	**Test Documentation Received and Approved**	**0%**	**6 days**	**Mon 11/10/14**	**Tue 11/18/14**	**312**
314	***13.9***	***Coverage Testing Completed***	***0%***	***0 days***	***Tue 11/18/14***	***Tue 11/18/14***	***313***
315	**14**	**30-day Reliability Test**	**0%**	**27 days**	**Mon 11/10/14**	**Fri 12/19/14**	



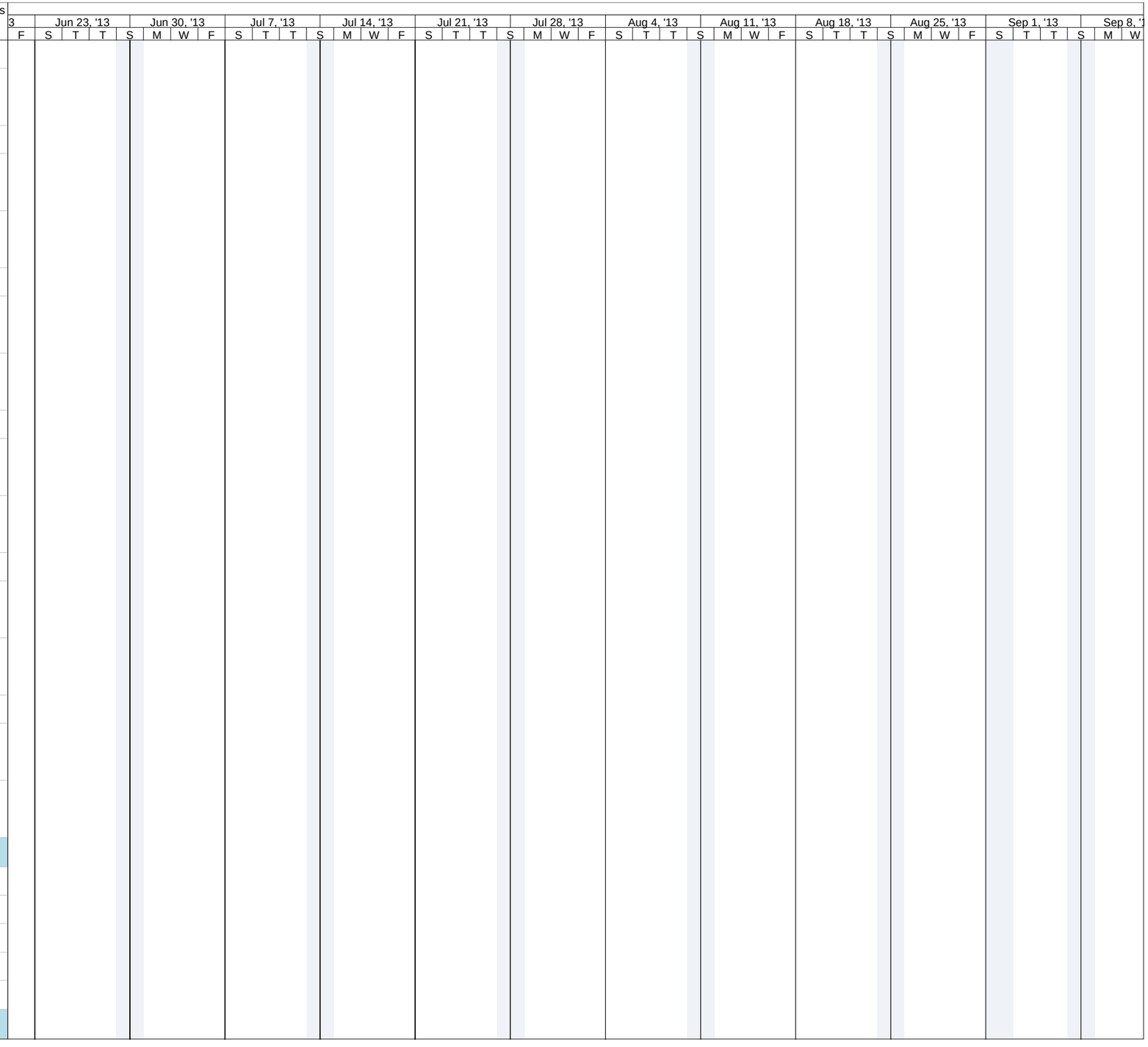
ID	WBS	Task Name	% Comple	Duration	Start	Finish	Predecessors
316	14.1	MQC to develop 30-day Reliability User Plan and select users to participate in the test	0%	6 days	Mon 11/10/14	Tue 11/18/14	312SS
317	14.2	Program portables and install/program mobiles in selected vehicles for 30-day reliability test	0%	4 days	Mon 11/10/14	Fri 11/14/14	312SS
318	14.3	User Equipment Train-The-Trainer Operator Training	0%	1 day	Mon 11/10/14	Tue 11/11/14	317SS
319	14.4	Radio Operator Training for users participating in 30-day reliability test	0%	1 day	Tue 11/11/14	Wed 11/12/14	318
320	14.5	Provide written notification that the system is ready for the burn-in test and the initial user training and initial radio field unit transitions have been completed	0%	1 day	Tue 11/18/14	Wed 11/19/14	316,317,319
321	14.6	Conduct 30-day Reliability Test	0%	30 edays	Wed 11/19/14	Fri 12/19/14	313,320
322	***14.7***	***30-Day Burn-In Successfully Completed***	***0%***	***0 days***	***Fri 12/19/14***	***Fri 12/19/14***	***321***
323	14.8	Infrastructure Warranty Begins - System infrastructure conditionally accepted.	0%	0 days	Fri 12/19/14	Fri 12/19/14	322
324	**15**	**Cutover**	**0%**	**126.5 days**	**Thu 7/17/14**	**Wed 1/28/15**	
325	**15.1**	**Planning**	**0%**	**10 days**	**Thu 7/17/14**	**Wed 7/30/14**	
326	15.1.1	Create Group Structure / Fleet Maps	0%	10 days	Thu 7/17/14	Wed 7/30/14	304SS-1 mon
327	**15.2**	**Execution of Cutover**	**0%**	**23 days**	**Fri 12/12/14**	**Wed 1/28/15**	
328	15.2.1	Begin Execution of Cutover/Transition Plan	0%	0 days	Fri 12/12/14	Fri 12/12/14	322FS-1 wk
329	15.2.2	Notify departments of cutover time.	0%	0 days	Fri 12/12/14	Fri 12/12/14	328
330	15.2.3	Remaining Radio Operator Trng	0%	17 days	Fri 12/12/14	Tue 1/20/15	329
331	15.2.4	Distribute portables	0%	17 days	Fri 12/12/14	Tue 1/20/15	329
332	**15.2.5**	**Program and Install Mobile Radios in Vehicles**	**0%**	**23 days**	**Fri 12/12/14**	**Wed 1/28/15**	
333	15.2.5.1	Planning Session to Review Installation Plan and Procedures	0%	1 day	Fri 12/12/14	Mon 12/15/14	328
334	15.2.5.2	Coordinate with Cities and prep work	0%	2 days	Mon 12/15/14	Wed 12/17/14	333
335	15.2.5.3	Carrollton PD	0%	7 days	Wed 12/17/14	Fri 1/9/15	334
336	15.2.5.4	Carrollton Fire	0%	8 days	Fri 1/9/15	Wed 1/21/15	335
337	15.2.5.5	Carrollton Other	0%	5 days	Wed 1/21/15	Wed 1/28/15	336
338	15.2.5.6	FB PD	0%	7 days	Wed 12/17/14	Fri 1/9/15	334
339	15.2.5.7	FB Fire	0%	8 days	Fri 1/9/15	Wed 1/21/15	338
340	15.2.5.8	FB Other	0%	5 days	Wed 1/21/15	Wed 1/28/15	339
341	15.2.5.9	Addison PD	0%	7 days	Wed 12/17/14	Fri 1/9/15	334
342	15.2.5.10	Addison Fire	0%	8 days	Fri 1/9/15	Wed 1/21/15	341
343	15.2.5.11	Addison Other	0%	5 days	Wed 1/21/15	Wed 1/28/15	342
344	15.2.5.12	Coppell PD	0%	7 days	Wed 12/17/14	Fri 1/9/15	334
345	15.2.5.13	Coppell Fire	0%	8 days	Fri 1/9/15	Wed 1/21/15	344

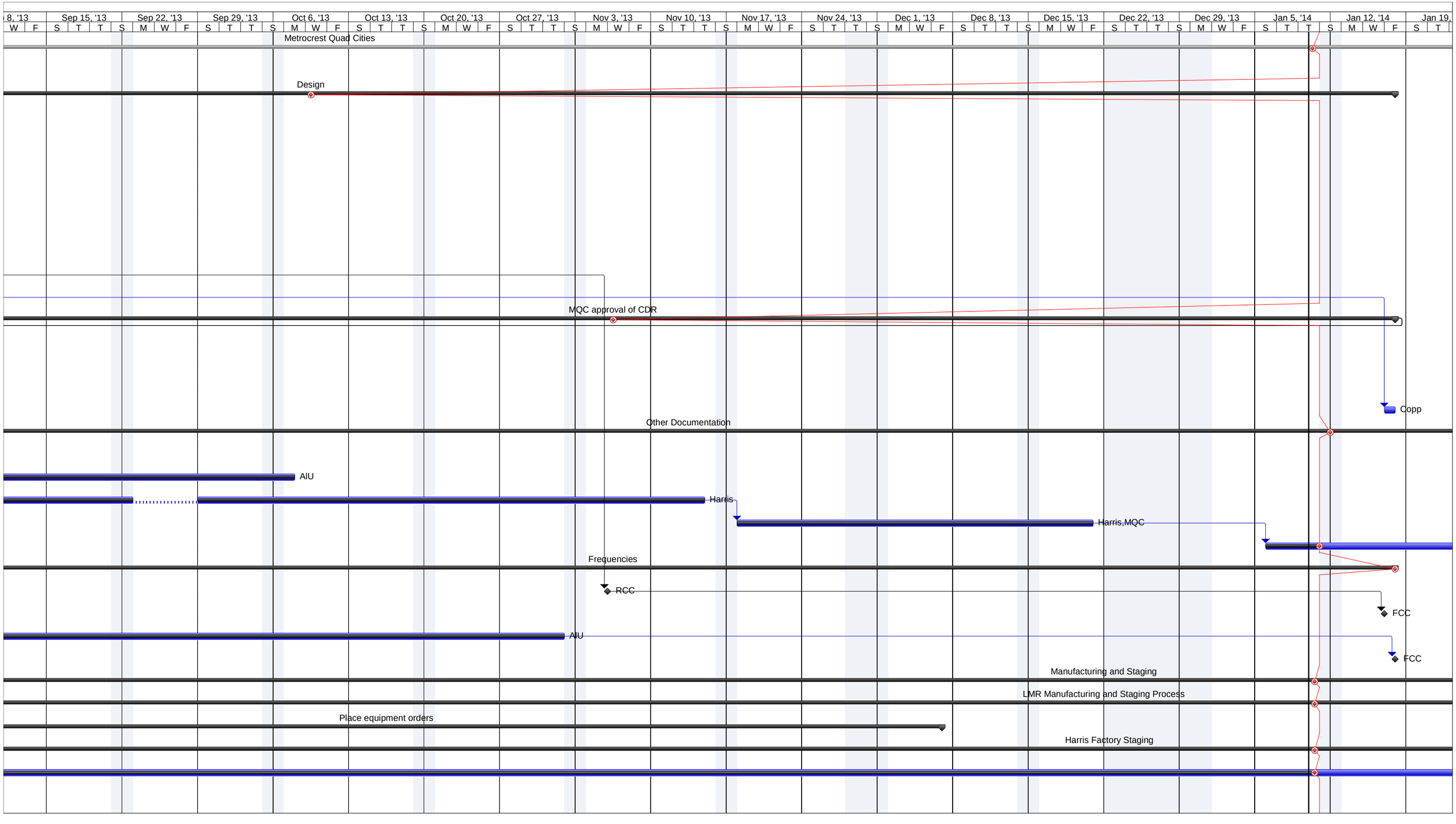


ID	WBS	Task Name	% Comple	Duration	Start	Finish	Predecessors
346	15.2.5.14	Coppell Other	0%	5 days	Wed 1/21/15	Wed 1/28/15	345
347	15.2.6	Addison Dispatch - Replace (4) existing console control stations with CS7000s	0%	1 day	Mon 12/15/14	Tue 12/16/14	333
348	15.2.7	Carrollton City Hall Dispatch - Replace (8) existing console control stations with CS7000s and new combiner/antenna system	0%	2 days	Tue 12/16/14	Thu 12/18/14	347
349	15.2.8	Coppell PD Dispatch - Replace (3) existing console control stations with CS7000s and new combiner/antenna system	0%	2 days	Thu 12/18/14	Mon 1/5/15	348
350	15.2.9	Farmers Branch Dispatch - Replace (4) existing console control stations with CS7000s	0%	1 day	Mon 1/5/15	Tue 1/6/15	349
351	15.2.10	Remote Control Station Locations - Install / Replace (19) existing control stations at with CS7000s	0%	9 days	Tue 1/6/15	Mon 1/19/15	350
352	*15.2.11*	***Completion of Radio Field Unit Installation & Testing***	*0%*	*0 days*	*Wed 1/28/15*	*Wed 1/28/15*	*351,346*
353	*15.2.12*	***Completion of Successful System Cutover***	*0%*	*0 days*	*Wed 1/28/15*	*Wed 1/28/15*	*352*
354	**16**	**Training**	**0%**	**32.5 days**	**Wed 11/26/14**	**Tue 1/27/15**	
355	**16.1**	**P25 Radio System Technician Training**	**0%**	**22 days**	**Wed 11/26/14**	**Tue 1/13/15**	
356	16.1.1	P25IP System Maintenance Course	0%	7 days	Mon 12/1/14	Tue 12/9/14	
357	16.1.2	Regional Network Manager Course	0%	2 days	Wed 12/10/14	Thu 12/11/14	356
358	16.1.3	Unified Admin System Course	0%	2 days	Fri 12/12/14	Mon 12/15/14	357
359	16.1.4	Network Operation & Maintenance	0%	4 days	Tue 12/16/14	Fri 12/19/14	358
360	16.1.5	UAC-Based Interoperability Gateway Course	0%	2 days	Mon 1/5/15	Tue 1/6/15	359
361	16.1.6	MASTR V Station Maintenance	0%	1.5 days	Wed 1/7/15	Thu 1/8/15	360
362	16.1.7	P25 Simulcast System Maintenance	0%	3 days	Thu 1/8/15	Tue 1/13/15	361
363	16.1.8	RF Maint Training	0%	5 days	Wed 11/26/14	Fri 12/5/14	331SS-2 wks
364	16.1.9	Active Directory Online Course	0%	0 days	Fri 12/5/14	Fri 12/5/14	363
365	**16.2**	**Microwave System Technicain Training**	**0%**	**17 days**	**Mon 1/5/15**	**Tue 1/27/15**	
366	16.2.1	9500 MPR Operations and Maintennace Course	0%	4 days	Mon 1/5/15	Thu 1/8/15	
367	16.2.2	TSM-8000 Operations Course	0%	2 days	Fri 1/9/15	Mon 1/12/15	366
368	16.2.3	TSM-8000 Administration Course	0%	3 days	Tue 1/13/15	Thu 1/15/15	367
369	16.2.4	SROS 9.0 Course	0%	4 days	Fri 1/16/15	Wed 1/21/15	368
370	16.2.5	7705 SAR Product Ooverview Course	0%	1 day	Thu 1/22/15	Thu 1/22/15	369
371	16.2.6	7705 SAR IP/Ethernet Backhaul Course	0%	3 days	Fri 1/23/15	Tue 1/27/15	370
372	**17**	**Legacy Equipment Removal**	**0%**	**21 days**	**Wed 1/7/15**	**Thu 2/5/15**	
373	17.1	Development of plan and process	0%	5 days	Wed 1/7/15	Wed 1/14/15	322FS+3 days
374	17.2	Approval of plan and process	0%	1 day	Wed 1/14/15	Thu 1/15/15	373



ID	WBS	Task Name	% Comple	Duration	Start	Finish	Predecessors
375	**17.3**	**Carrollton City Hall**	**0%**	**1 day**	**Wed 1/28/15**	**Thu 1/29/15**	
376	17.3.1	Removal, inventory, bag and tag equipment. Place in agreed to location for disposition.	0%	1 day	Wed 1/28/15	Thu 1/29/15	374,353
377	**17.4**	**Josey Lane WT**	**0%**	**1 day**	**Thu 1/29/15**	**Fri 1/30/15**	
378	17.4.1	Removal, inventory, bag and tag equipment. Place in agreed to location for disposition.	0%	1 day	Thu 1/29/15	Fri 1/30/15	376
379	17.4.2	Removal, inventory, bag and tag antennas and cable. Place in agreed to location for disposition.	0%	1 day	Thu 1/29/15	Fri 1/30/15	376
380	**17.5**	**Spectrum Ctr**	**0%**	**1 day**	**Fri 1/30/15**	**Mon 2/2/15**	
381	17.5.1	Removal, inventory, bag and tag equipment. Place in agreed to location for disposition.	0%	1 day	Fri 1/30/15	Mon 2/2/15	378
382	17.5.2	Removal, inventory, bag and tag antennas and cable. Place in agreed to location for disposition.	0%	1 day	Fri 1/30/15	Mon 2/2/15	379
383	**17.6**	**Wagon Wheel WT**	**0%**	**1 day**	**Mon 2/2/15**	**Tue 2/3/15**	
384	17.6.1	Removal, inventory, bag and tag equipment. Place in agreed to location for disposition.	0%	1 day	Mon 2/2/15	Tue 2/3/15	381
385	17.6.2	Removal, inventory, bag and tag antennas and cable. Place in agreed to location for disposition.	0%	1 day	Mon 2/2/15	Tue 2/3/15	382
386	**17.7**	**FB 1**	**0%**	**1 day**	**Tue 2/3/15**	**Wed 2/4/15**	
387	17.7.1	Removal, inventory, bag and tag equipment. Place in agreed to location for disposition.	0%	1 day	Tue 2/3/15	Wed 2/4/15	384
388	17.7.2	Removal, inventory, bag and tag antennas and cable. Place in agreed to location for disposition.	0%	1 day	Tue 2/3/15	Wed 2/4/15	385
389	**17.8**	**FB 2**	**0%**	**1 day**	**Wed 2/4/15**	**Thu 2/5/15**	
390	17.8.1	Removal, inventory, bag and tag equipment. Place in agreed to location for disposition.	0%	1 day	Wed 2/4/15	Thu 2/5/15	387
391	17.8.2	Removal, inventory, bag and tag antennas and cable. Place in agreed to location for disposition.	0%	1 day	Wed 2/4/15	Thu 2/5/15	388
392	***17.9***	***MQC Agreement of Complete Legacy System Removal***	***0%***	***0 days***	***Thu 2/5/15***	***Thu 2/5/15***	***391***
393	**18**	**System Acceptance**	**0%**	**11 days**	**Thu 2/5/15**	**Fri 2/20/15**	
394	18.1	Punch List items fully resolved	0%	5 days	Thu 2/5/15	Thu 2/12/15	392,353
395	18.2	Submit Final Documentation and Letter of System Acceptance	0%	1 day	Thu 2/12/15	Fri 2/13/15	394
396	18.3	Review of Final Documentation	0%	5 days	Fri 2/13/15	Fri 2/20/15	395
397	18.4	Sign Letter of System Acceptance	0%	0 days	Fri 2/20/15	Fri 2/20/15	396
398	***18.5***	***Final Acceptance – Complete System***	***0%***	***0 days***	***Fri 2/20/15***	***Fri 2/20/15***	***397***

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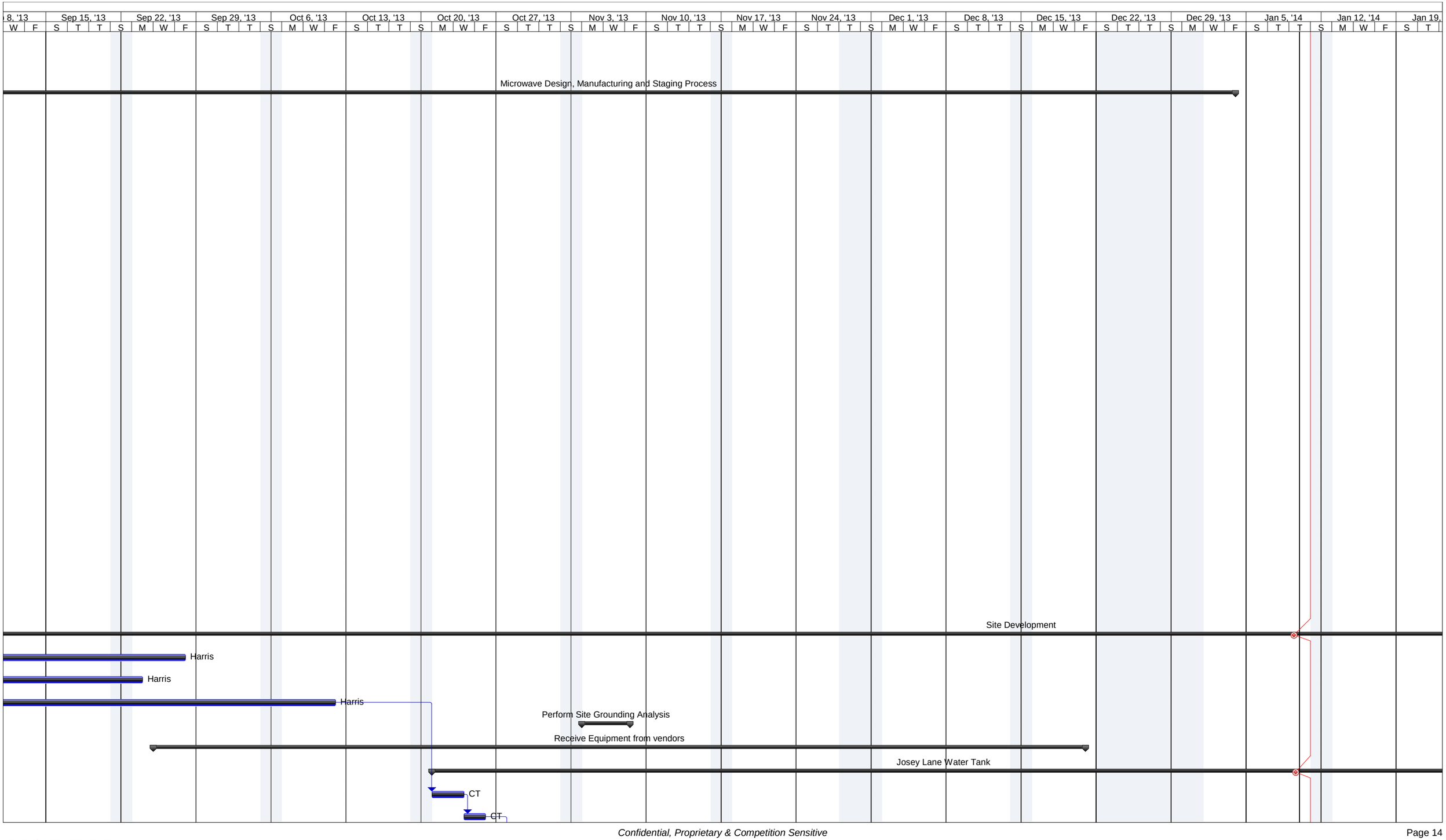
Manufacturing and Staging
LMR Manufacturing and Staging Process
Place equipment orders
Harris Factory Staging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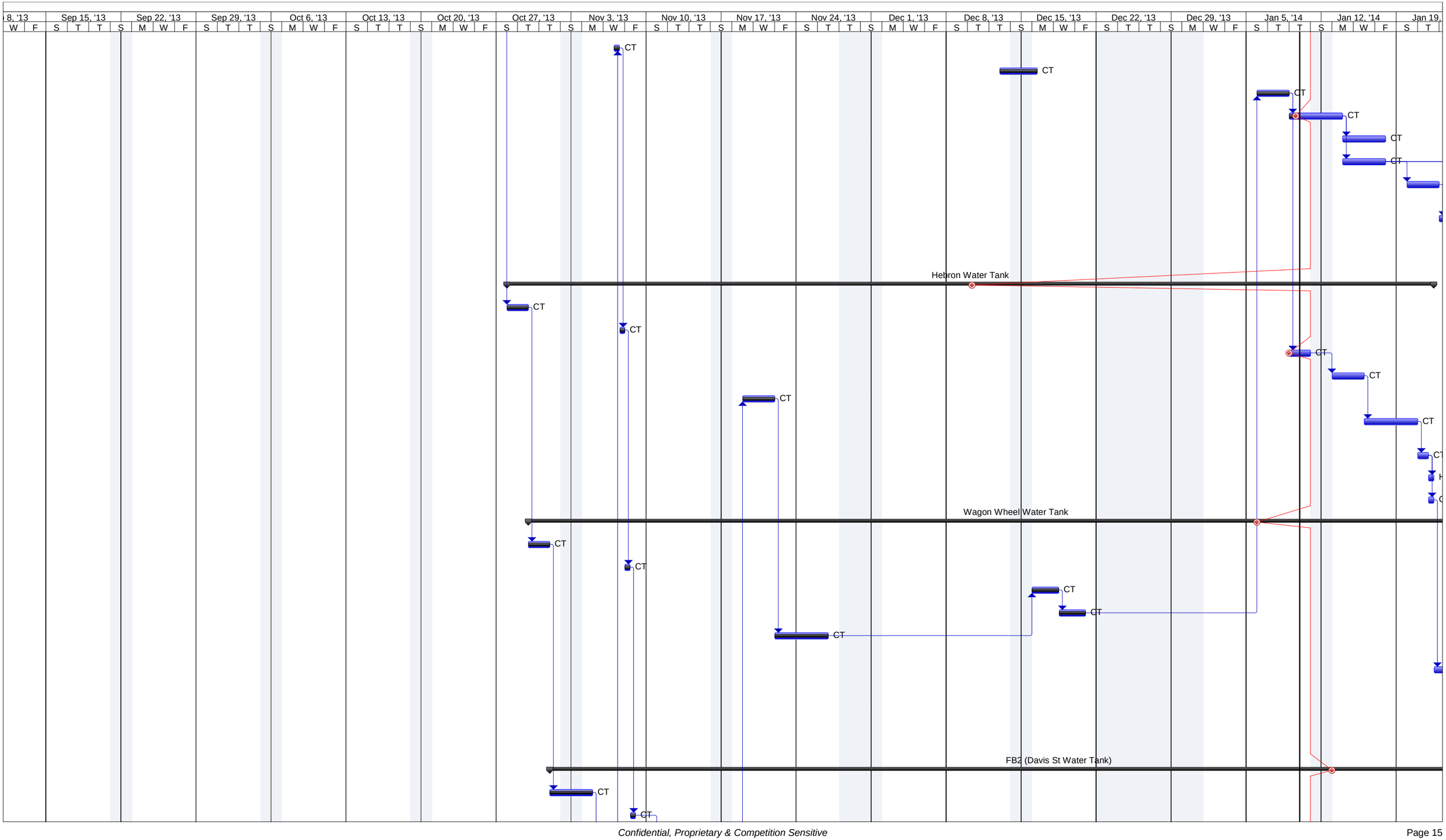
Perform Site Grounding Analysis
Receive Equipment from vendors
Josey Lane Water Tank
CT
CT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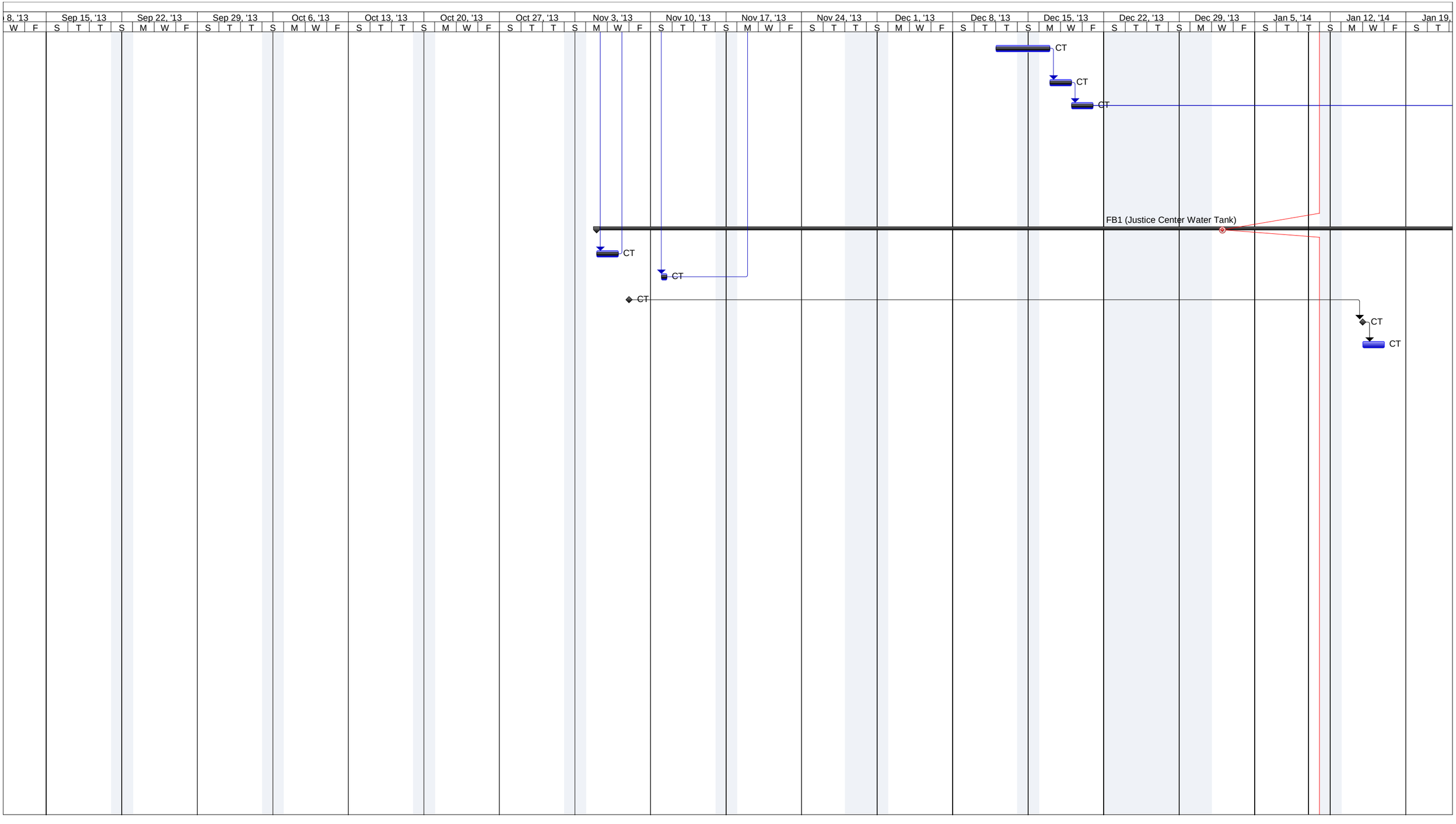
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FB1 (Justice Center Water Tank)
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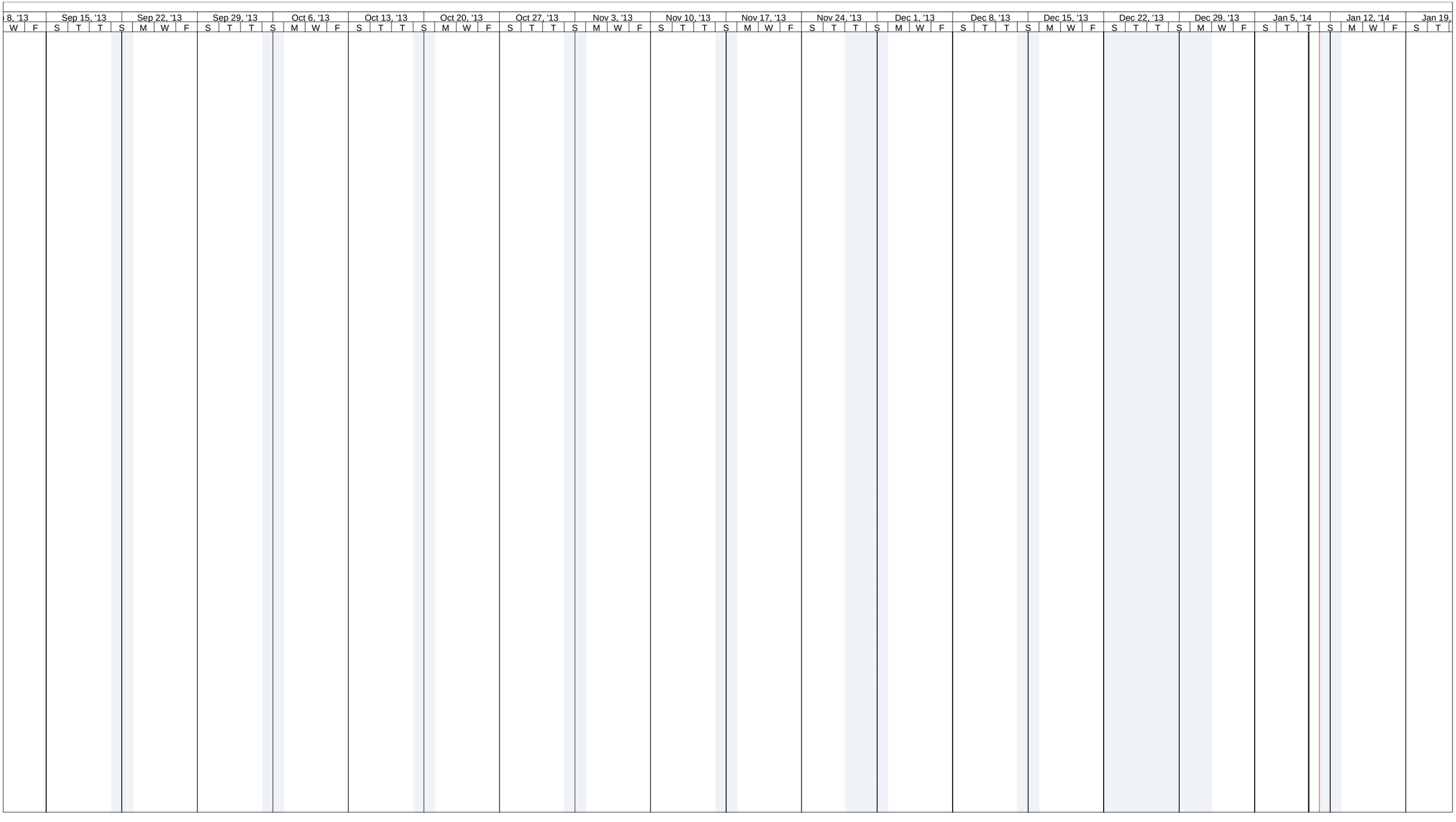
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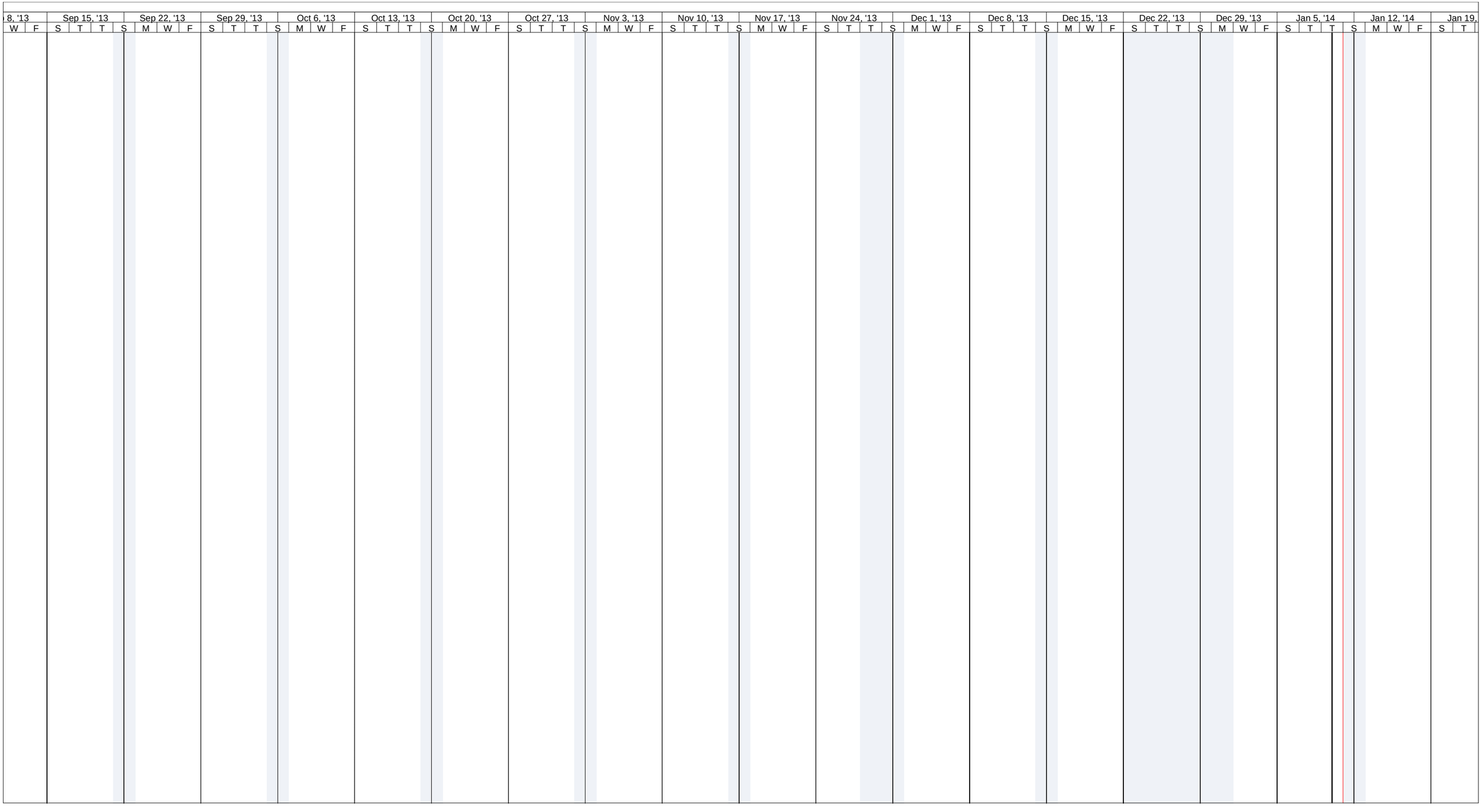
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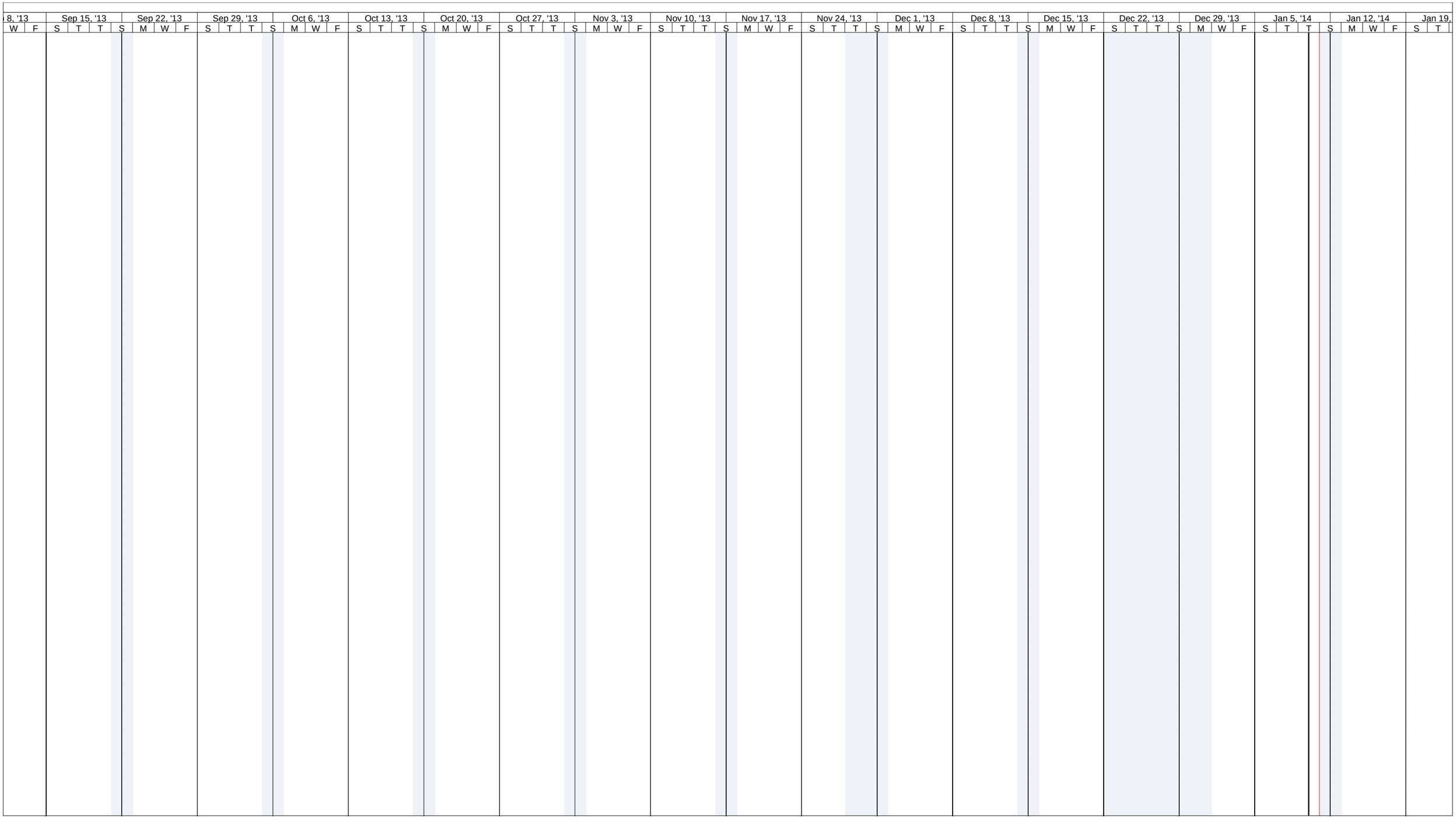
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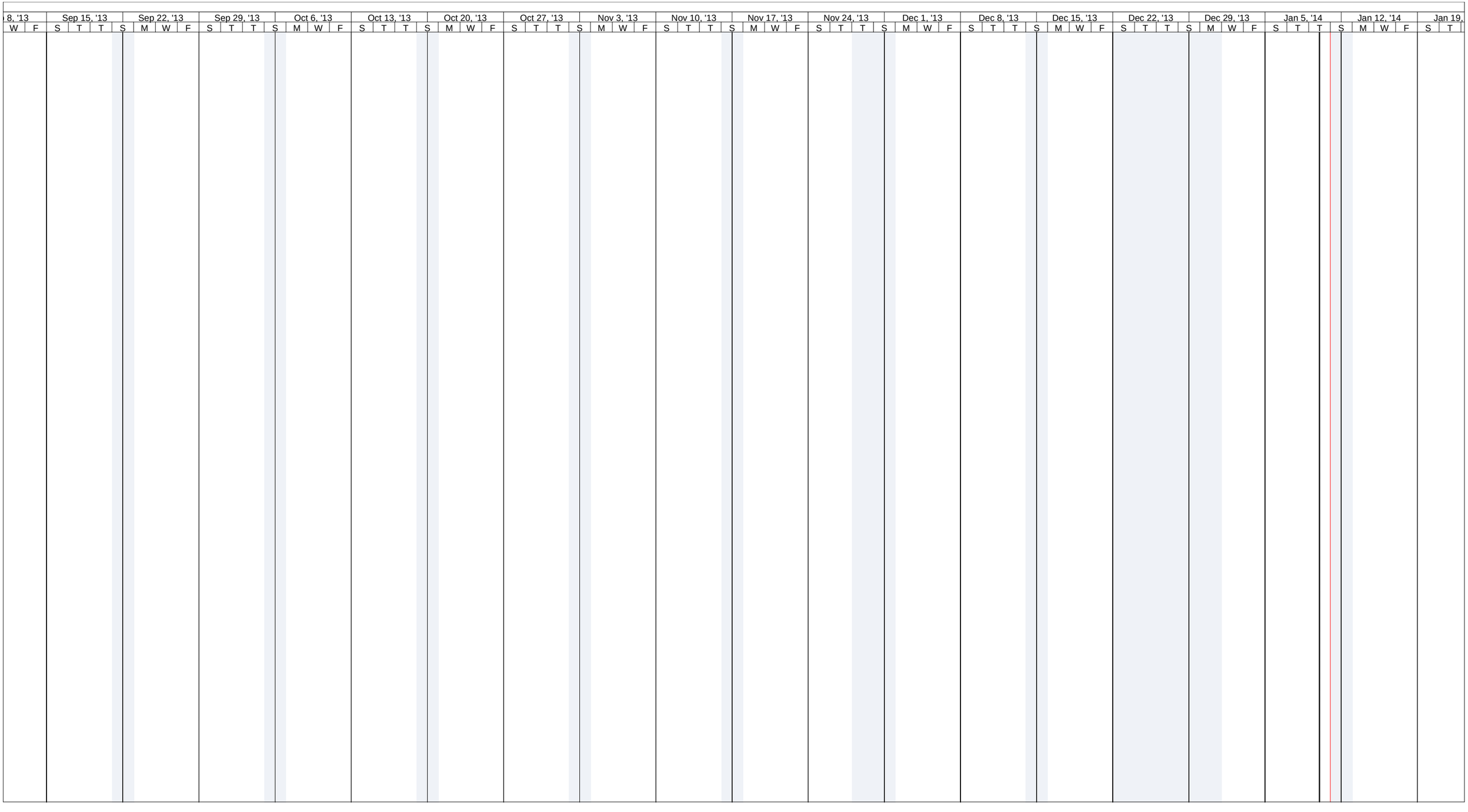
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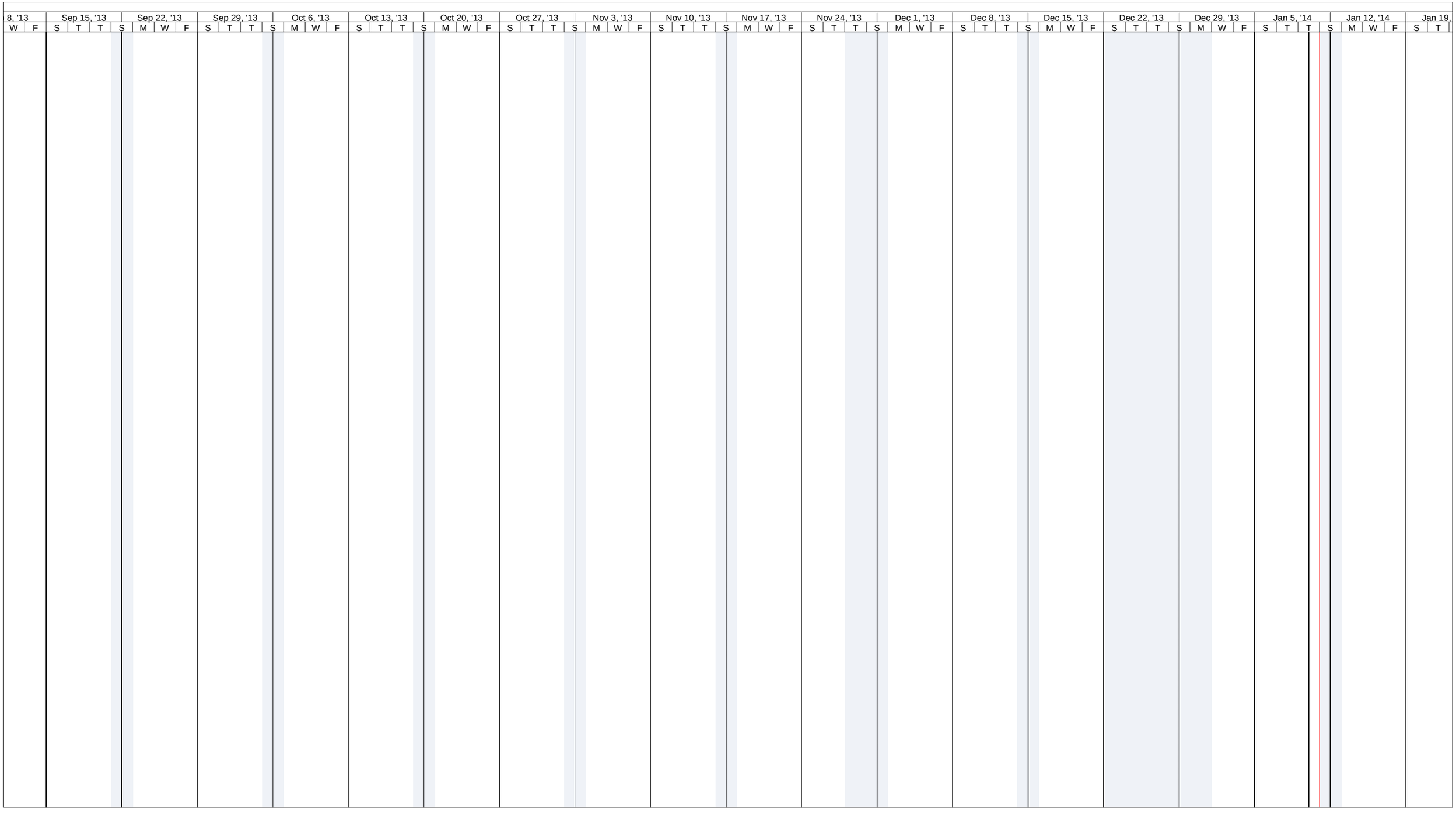
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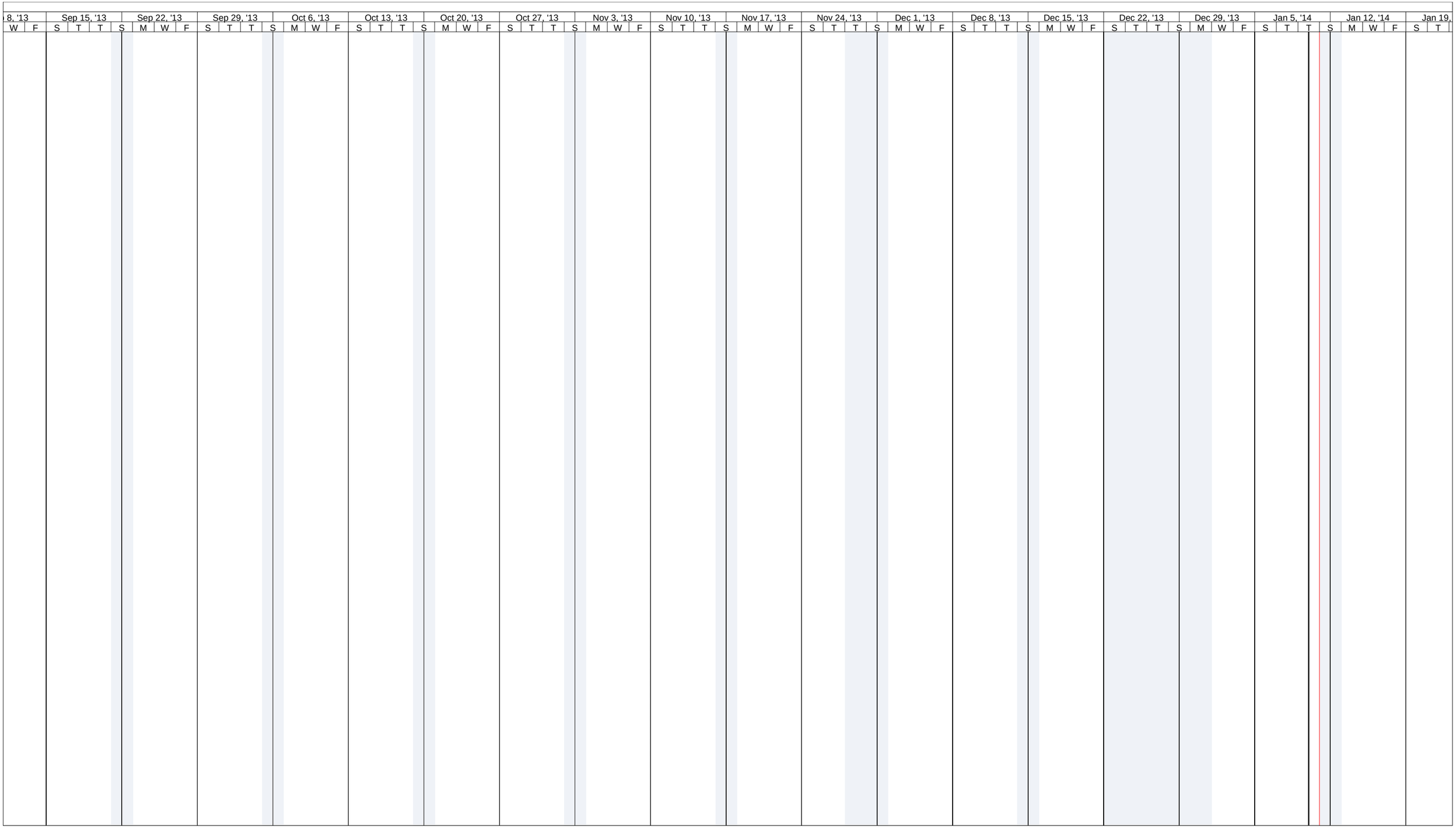
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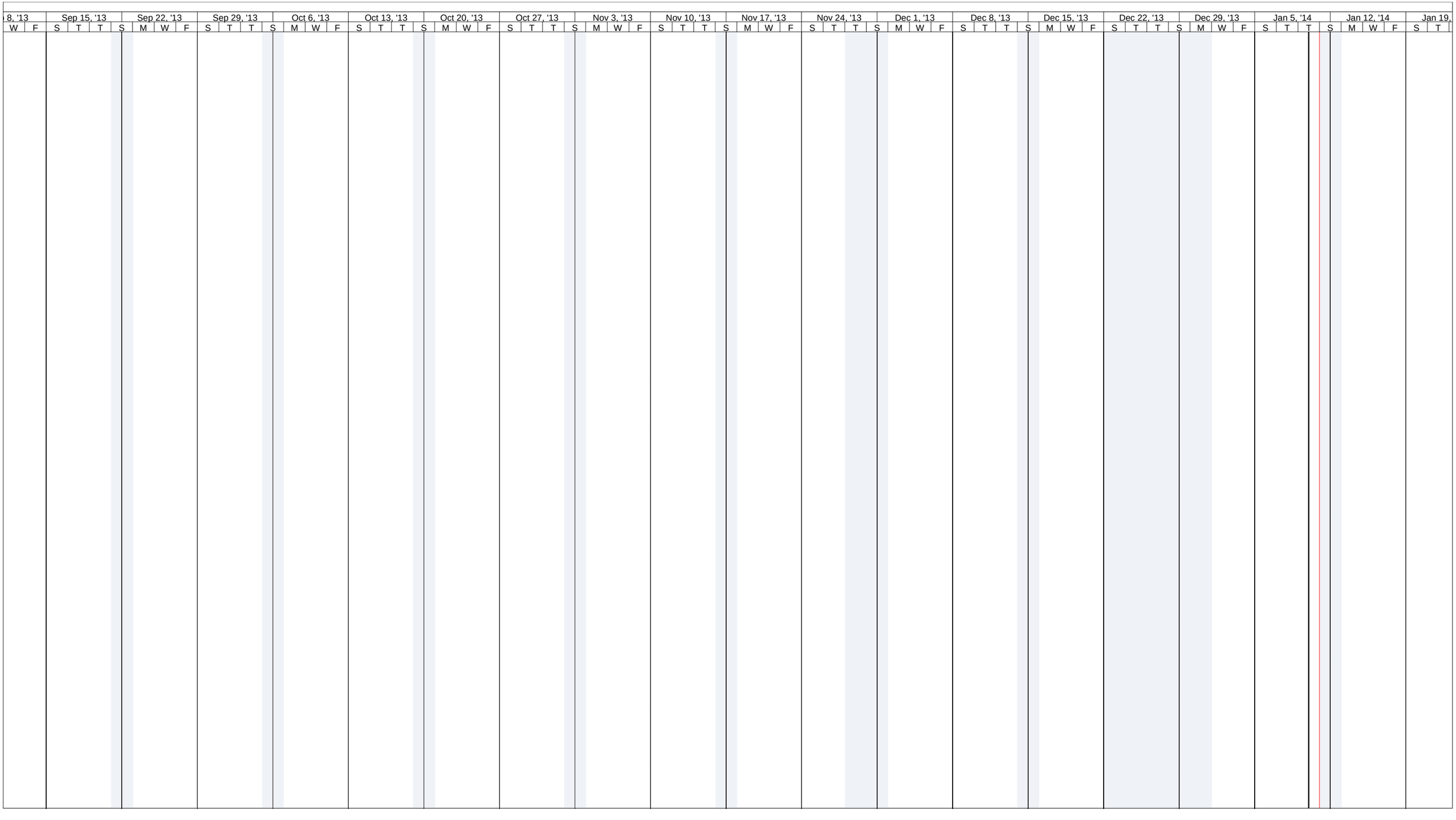
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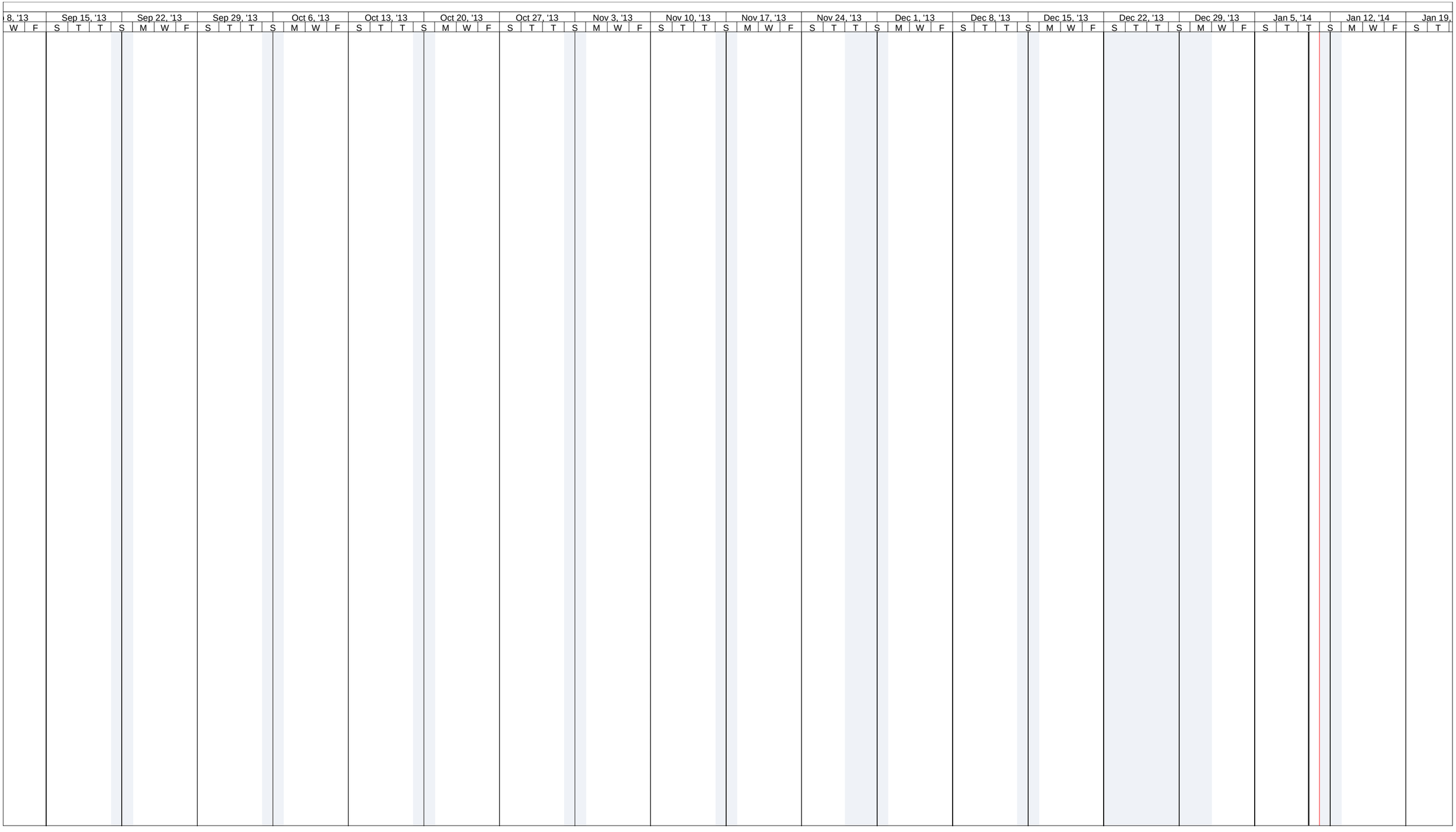
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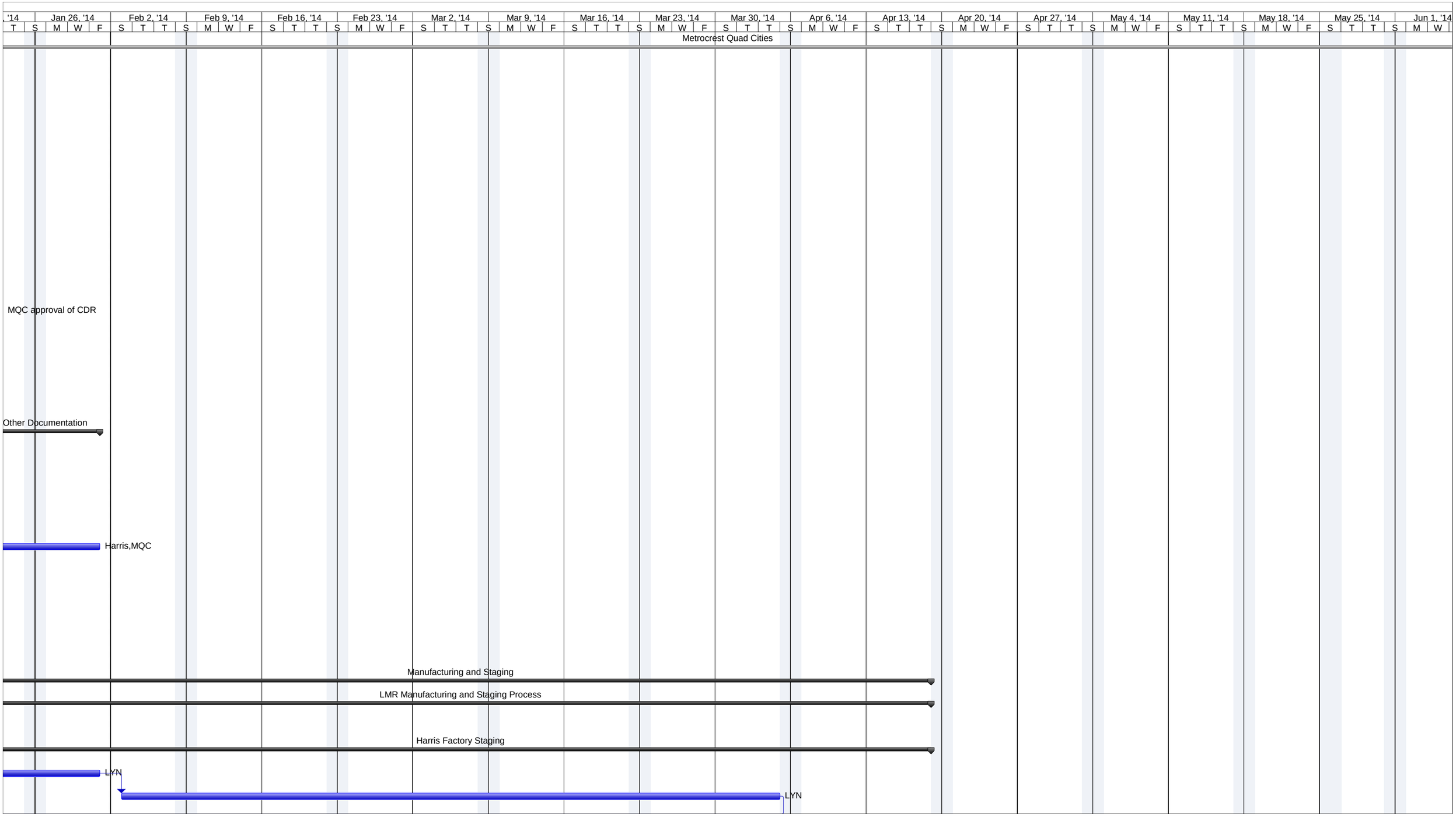
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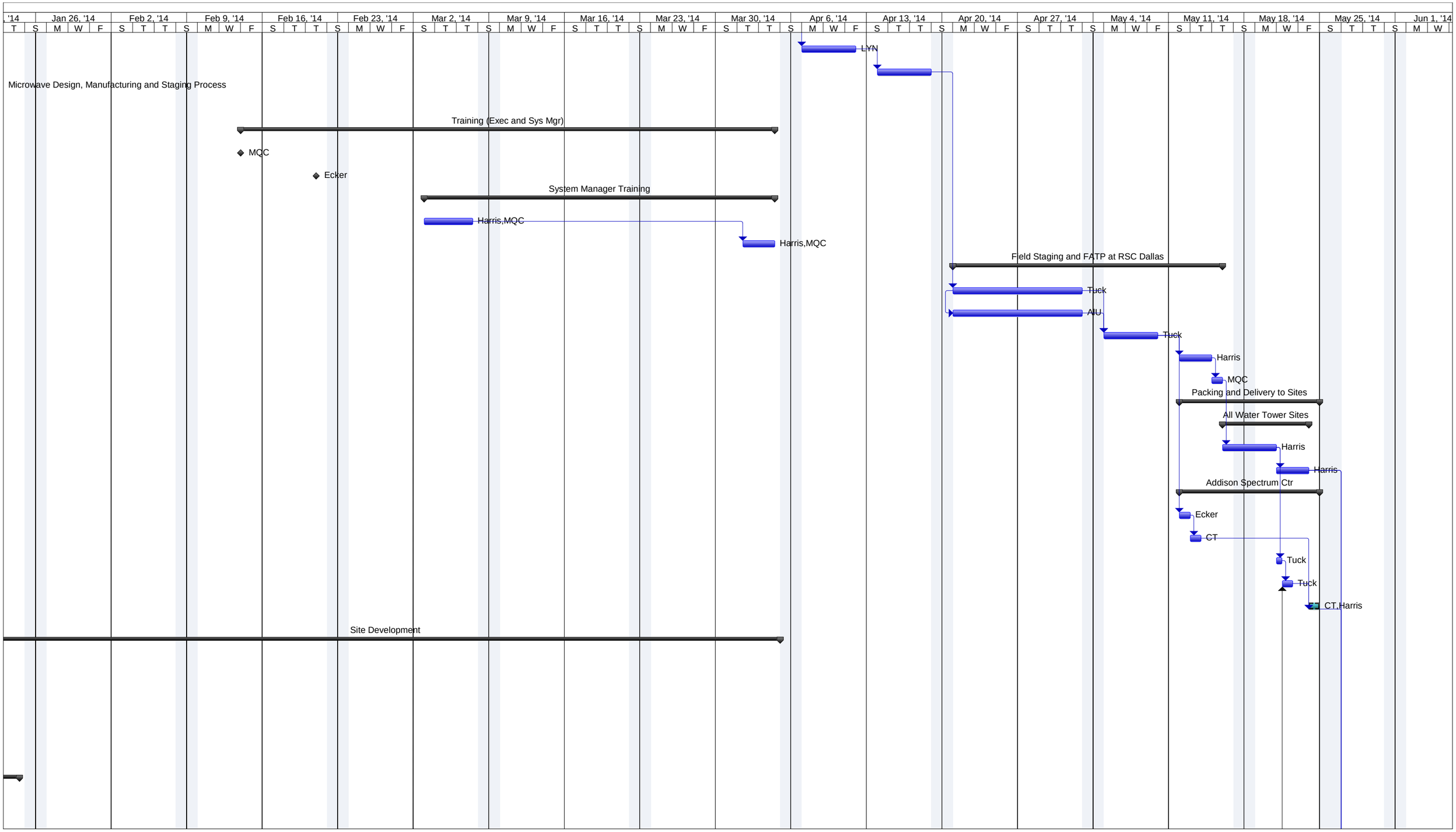
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Microwave Design, Manufacturing and Staging Process
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MQC
Ecker
System Manager Training
Harris,MQC
Harris,MQC
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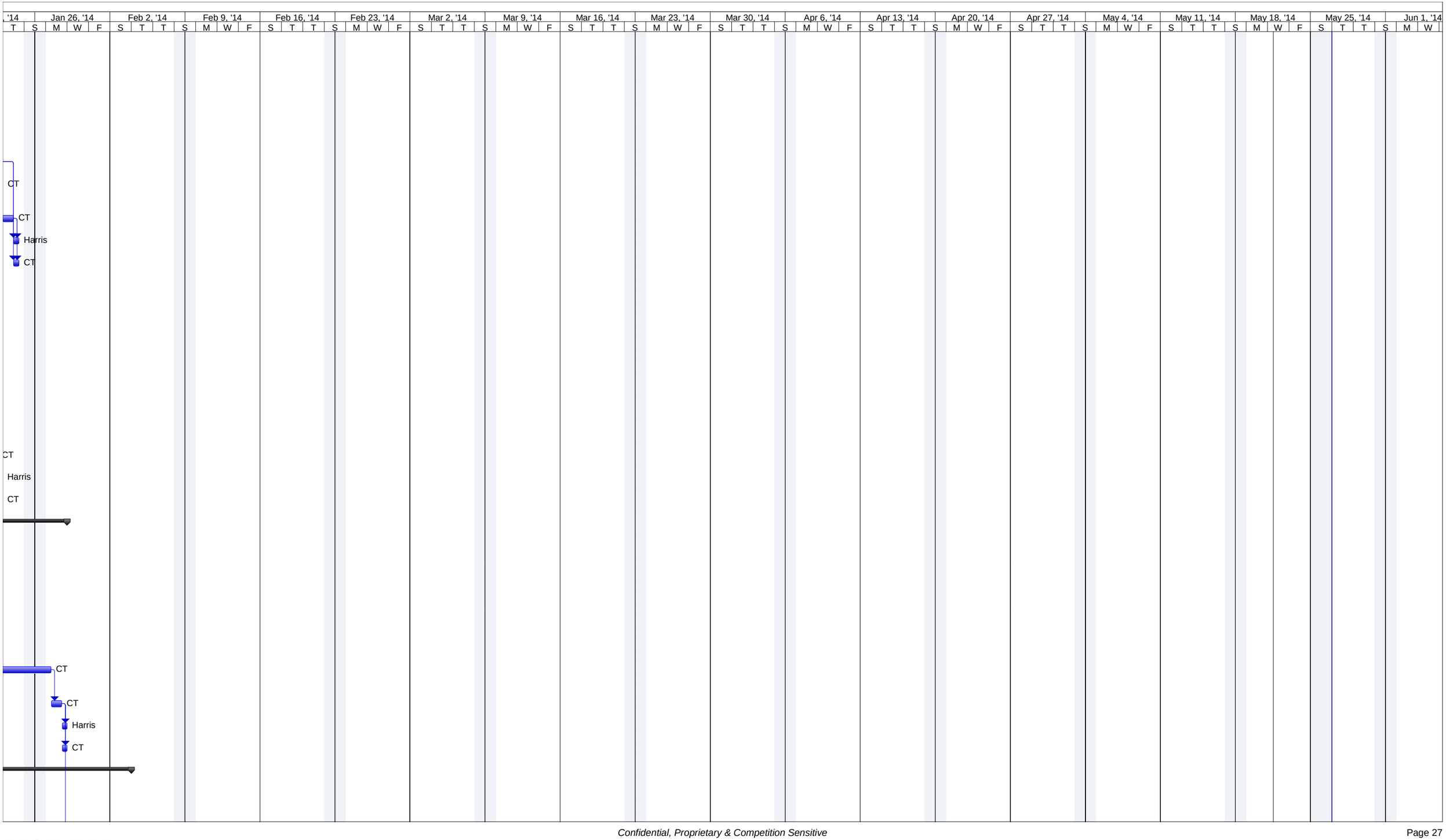
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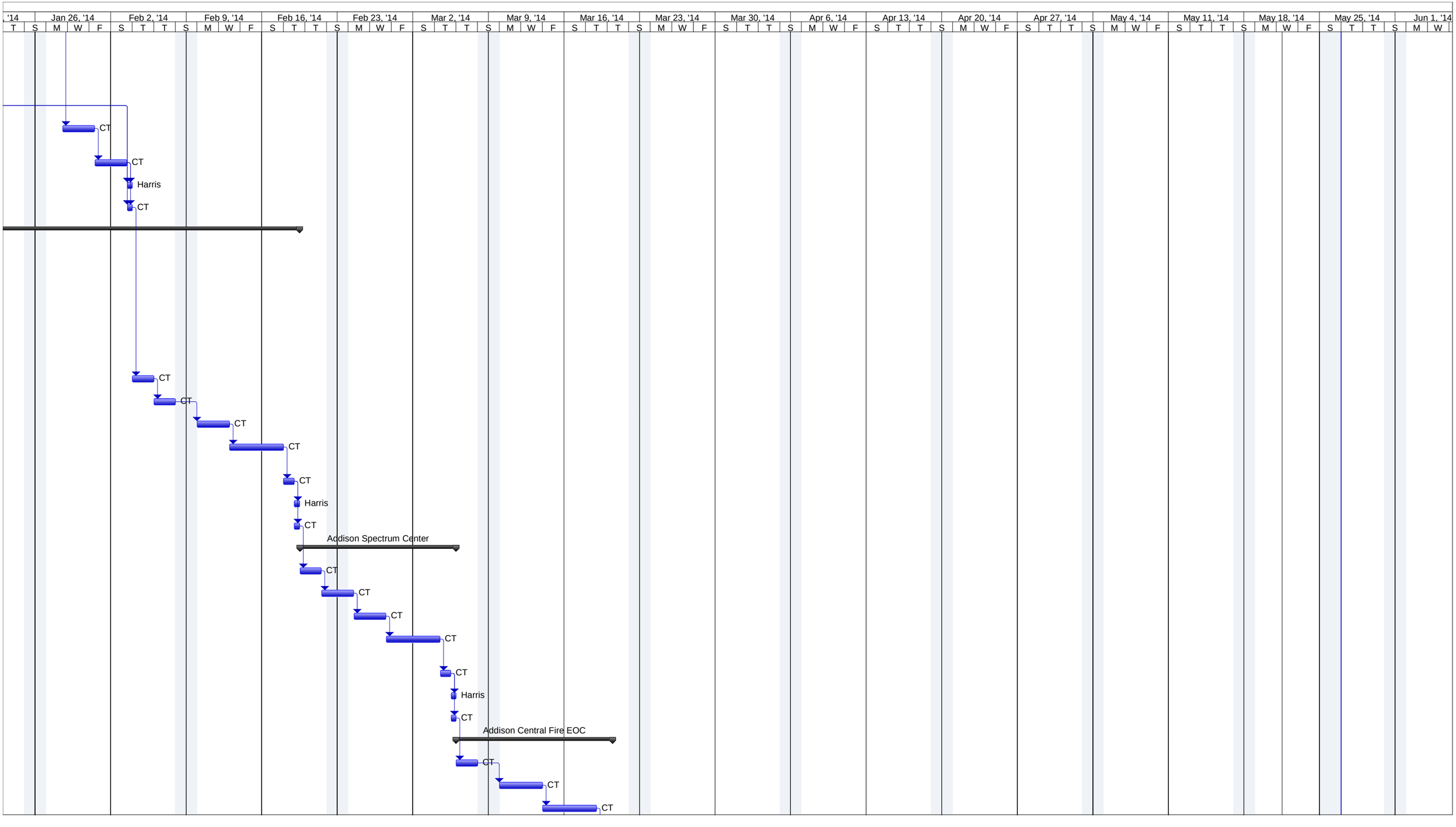
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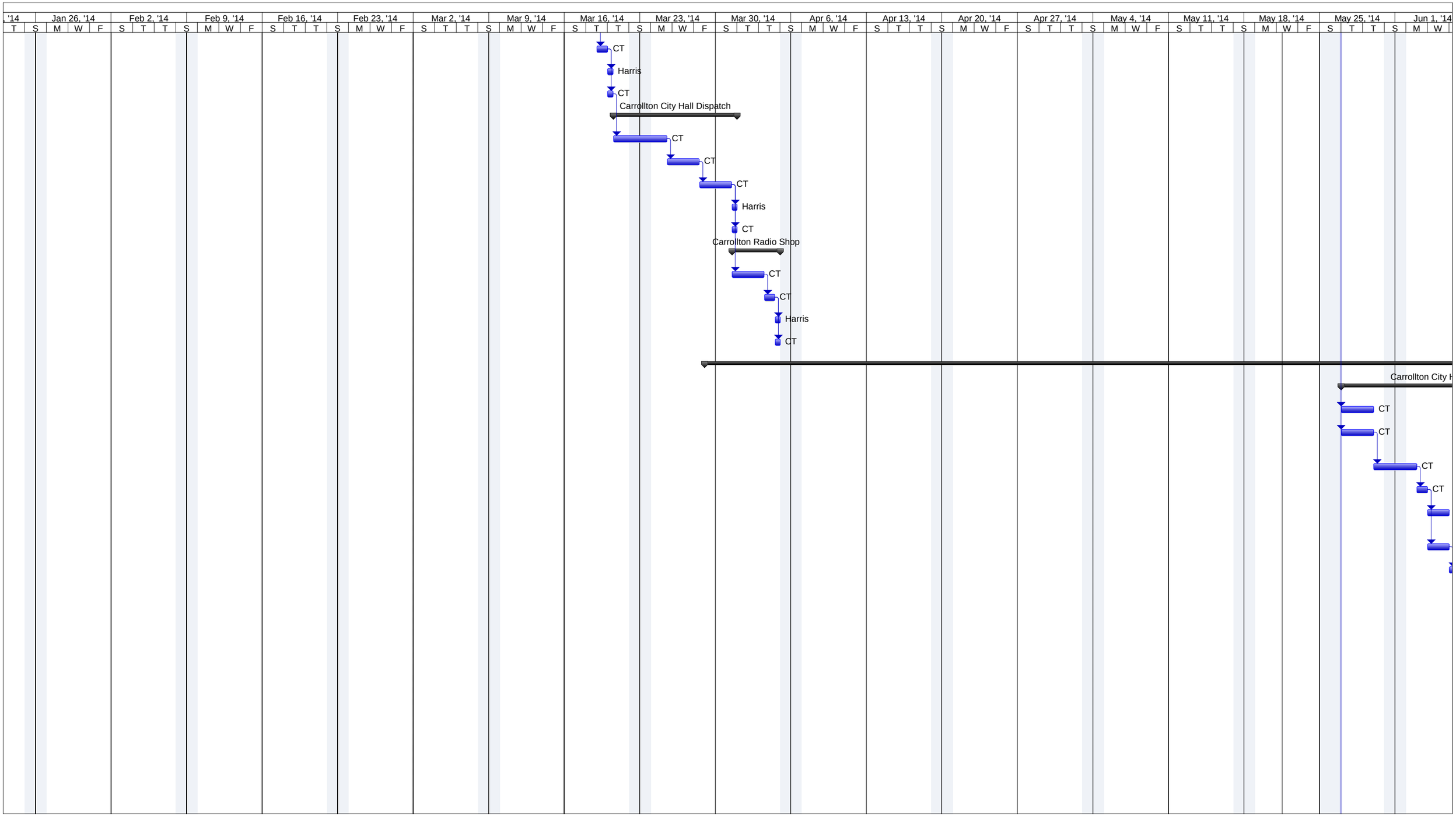
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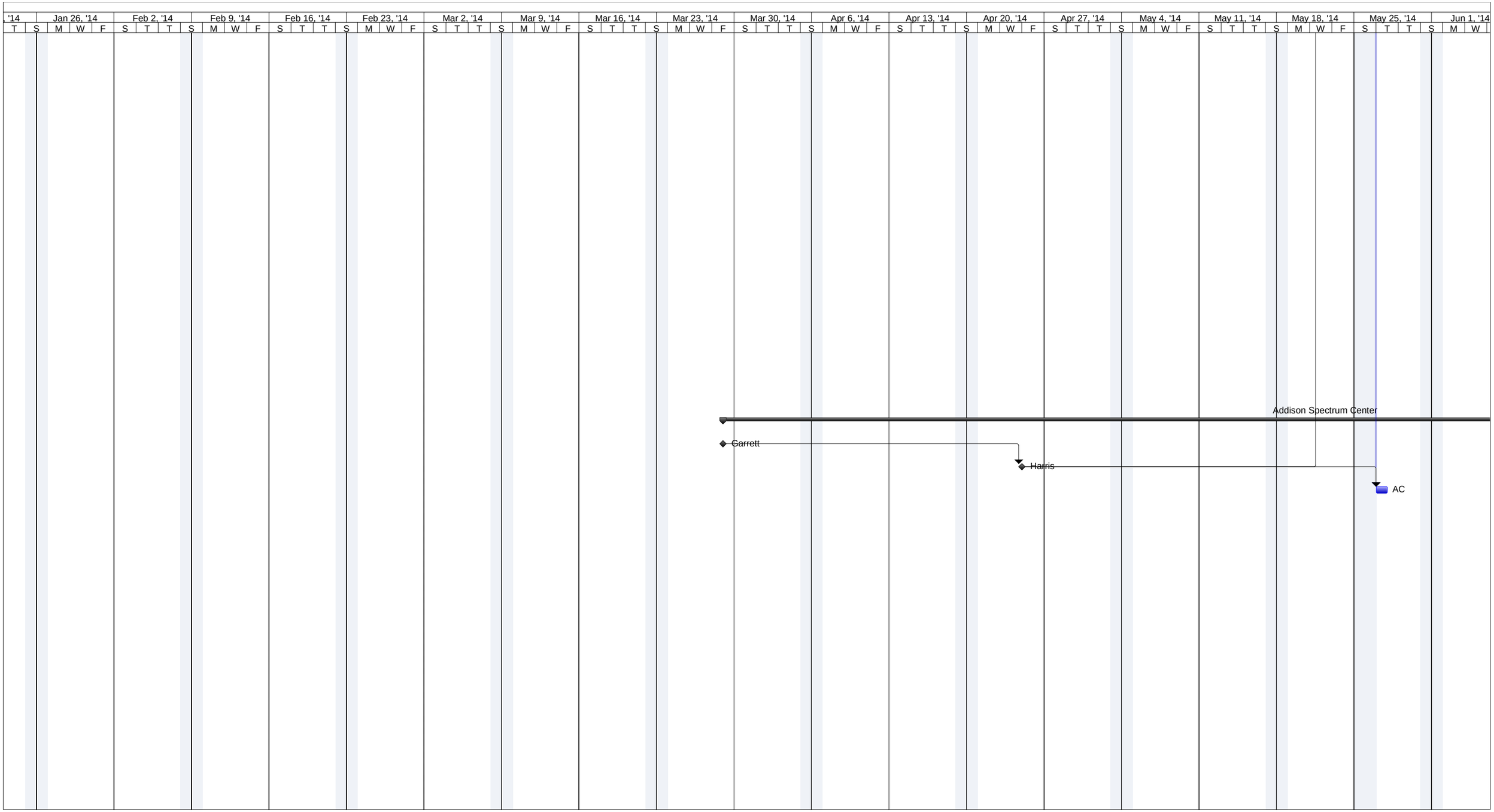
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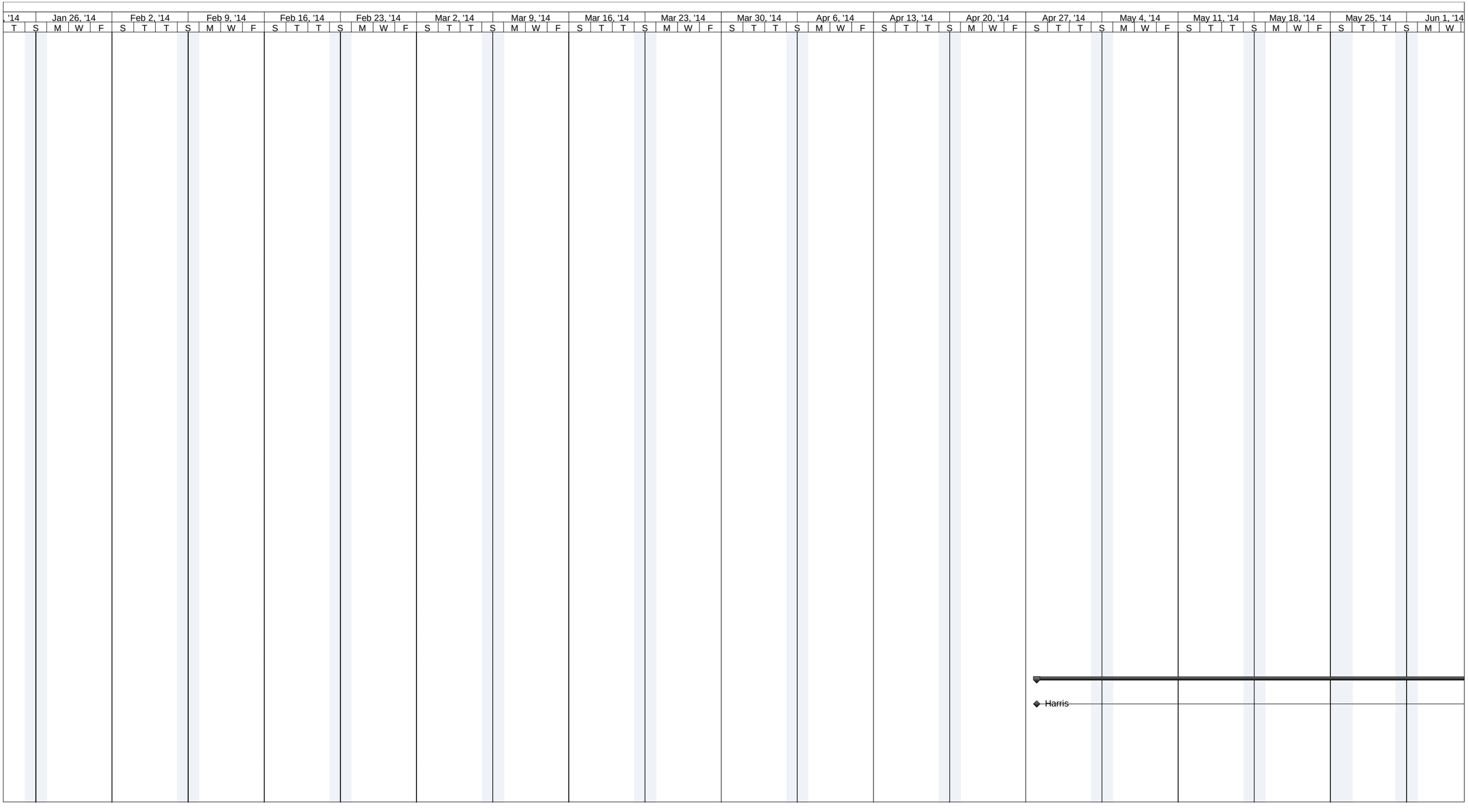
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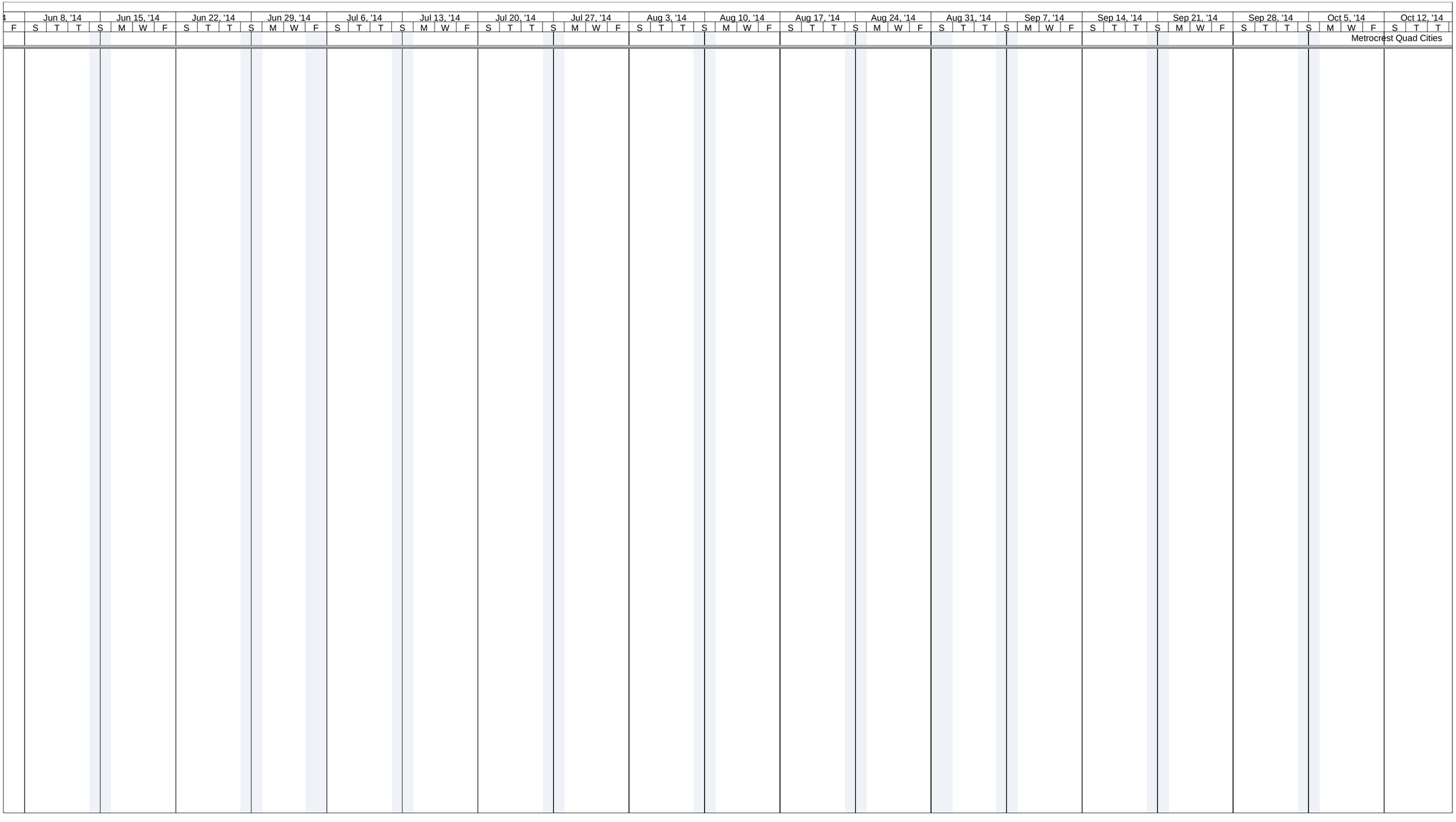
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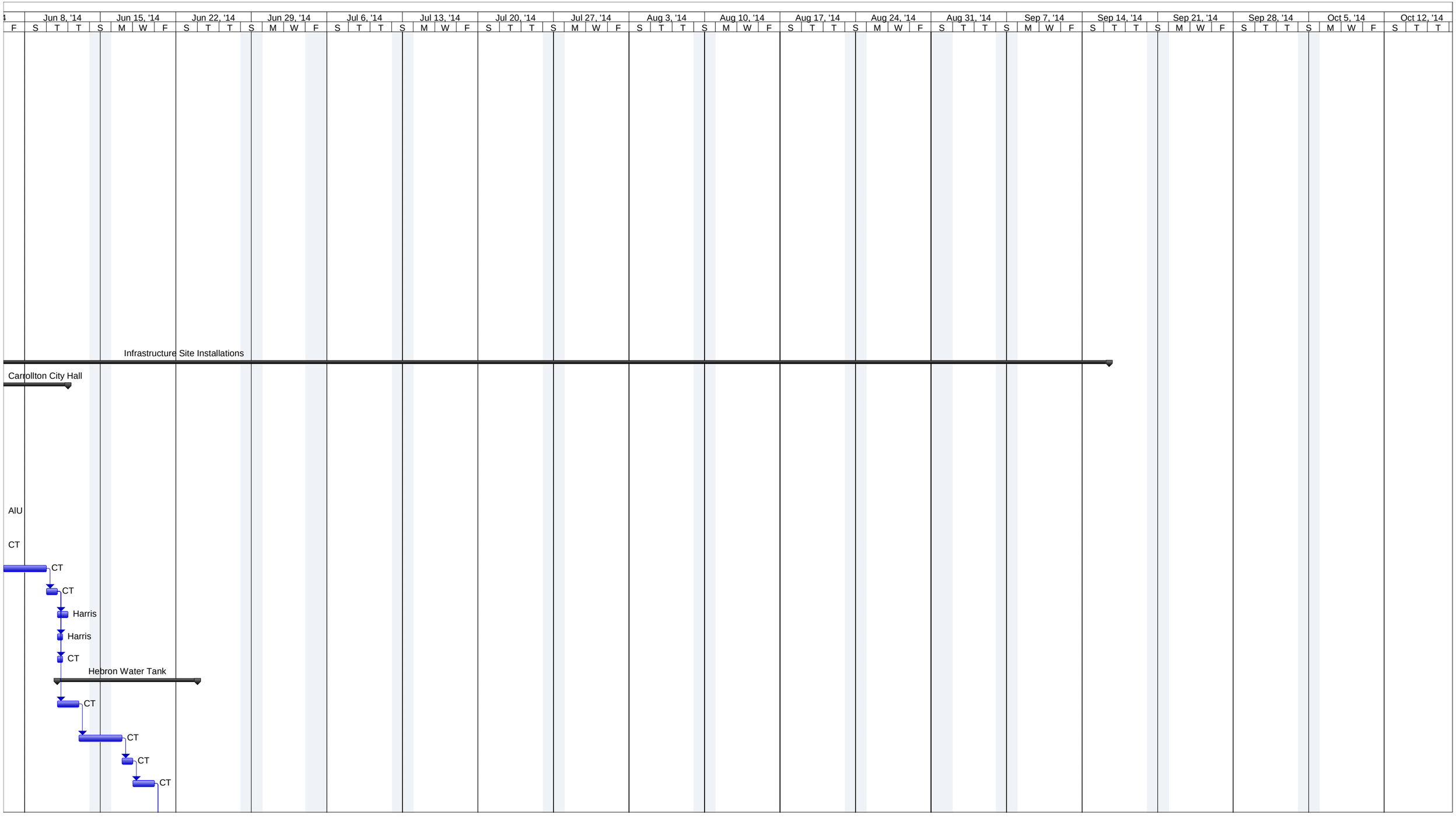
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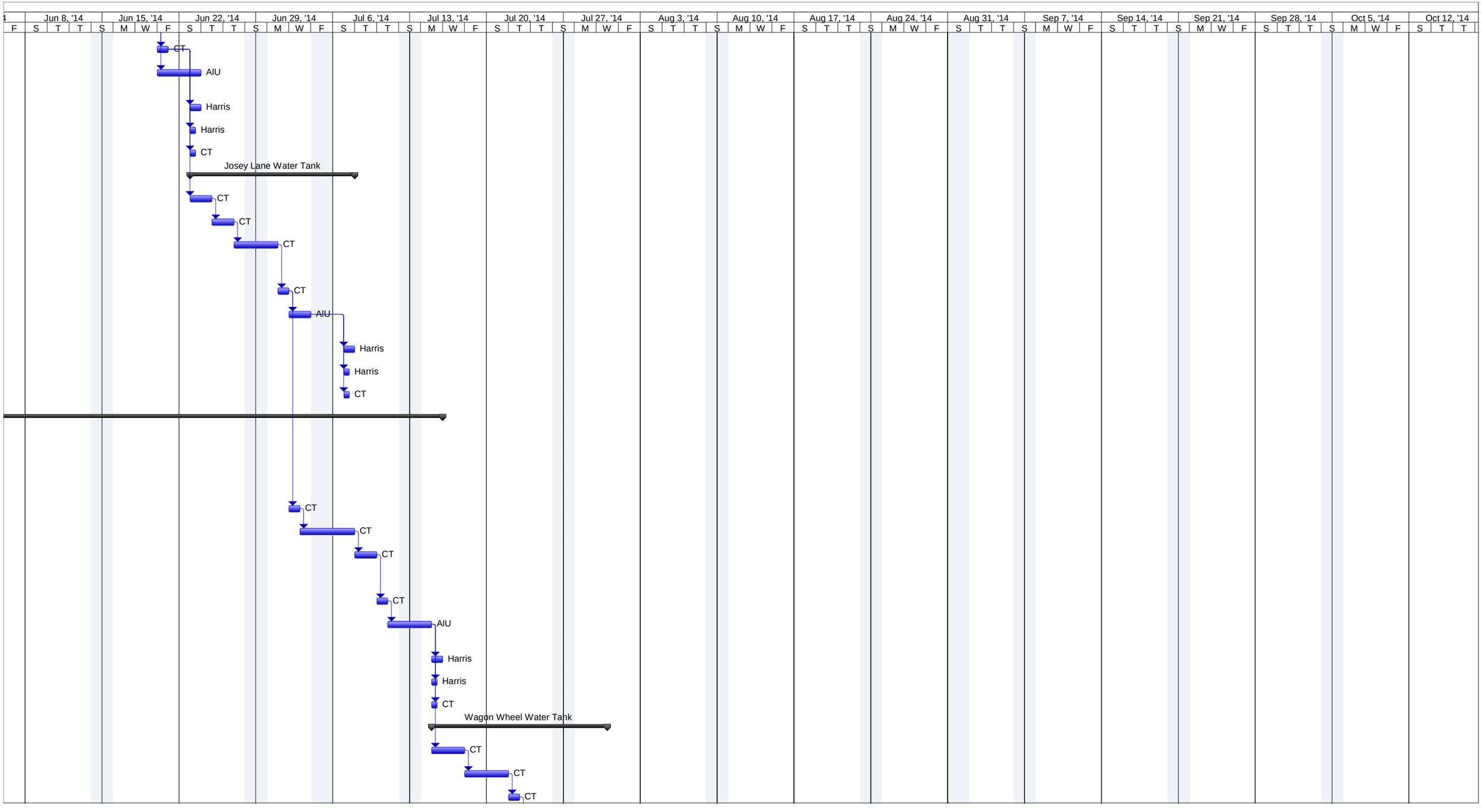
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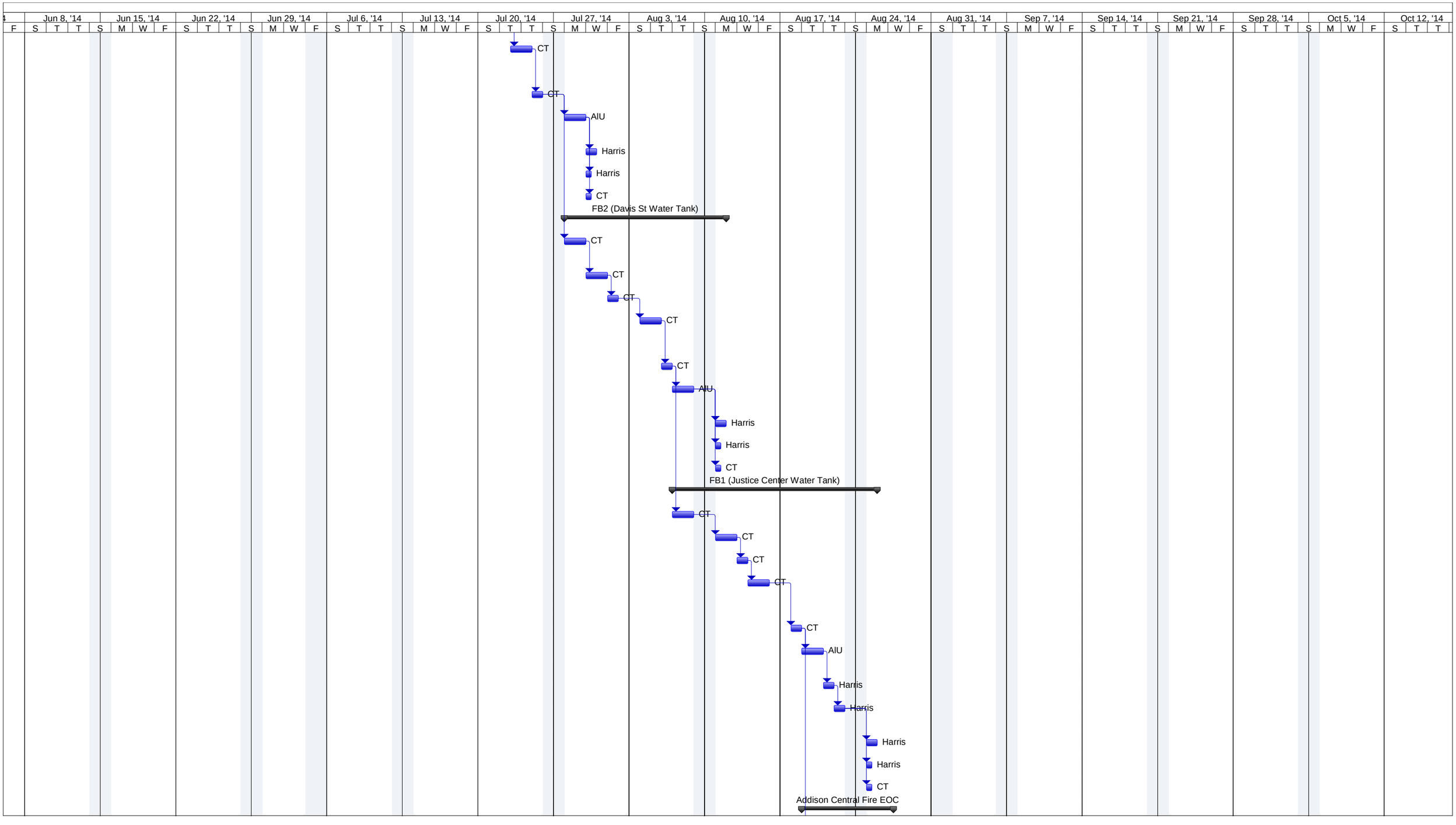
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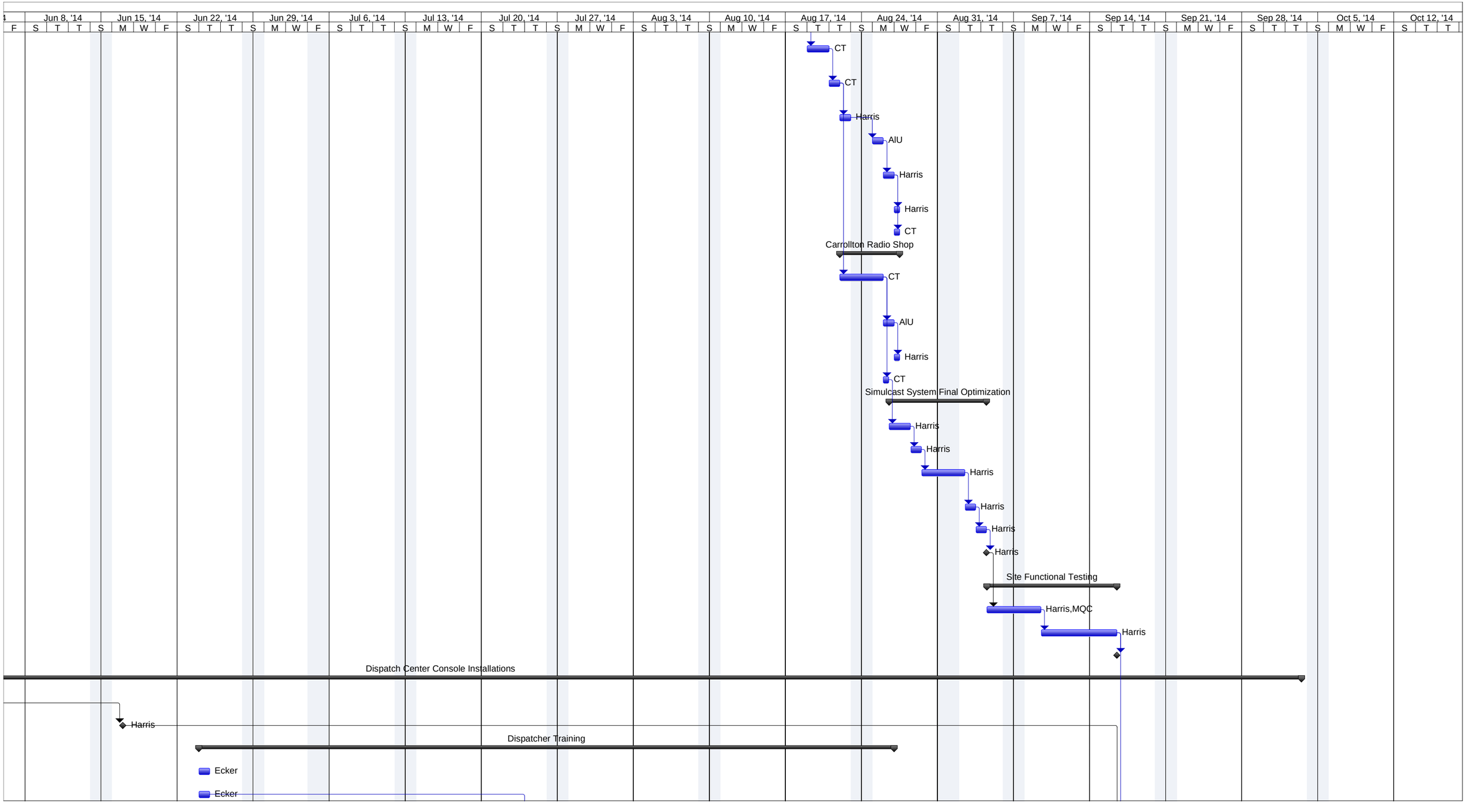
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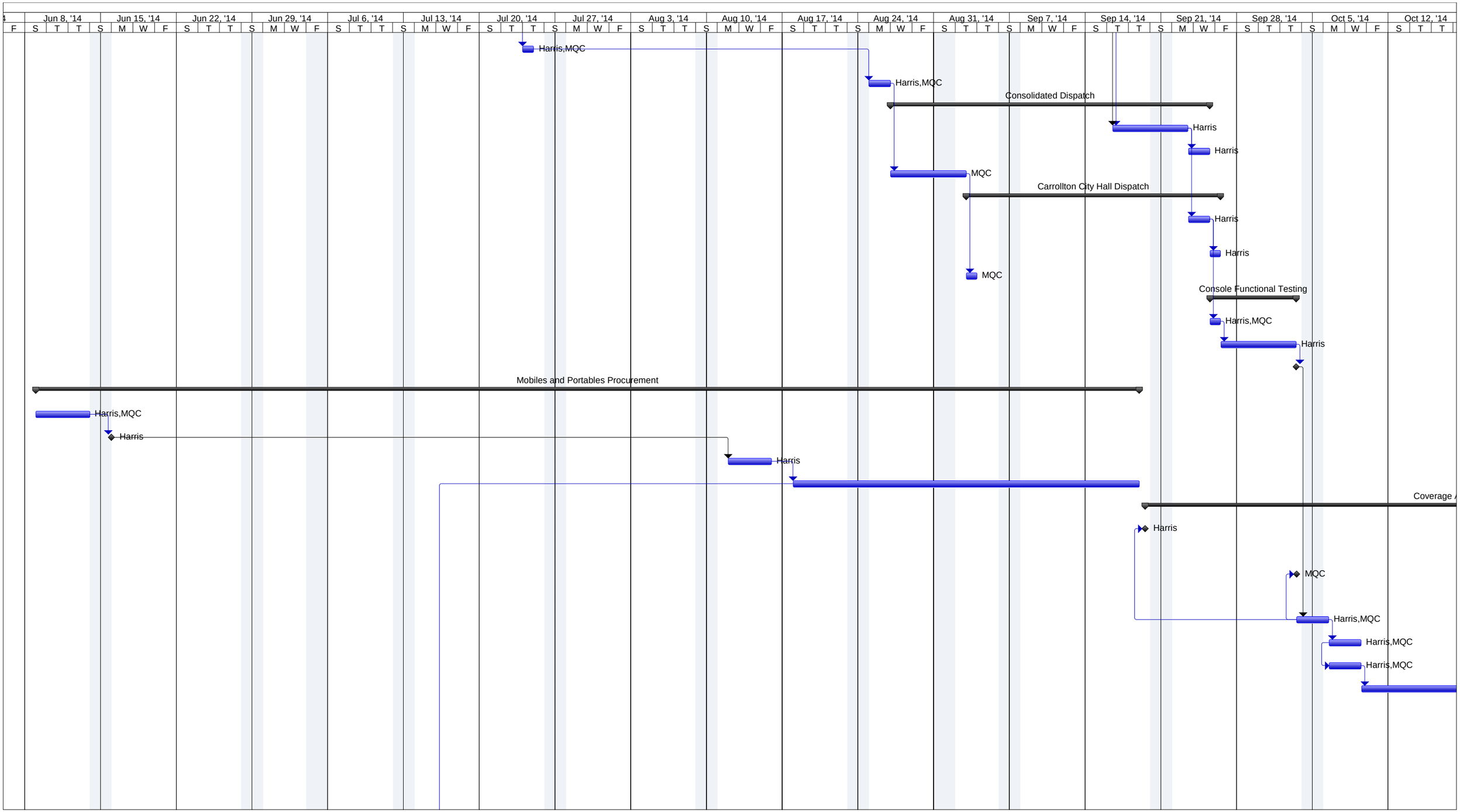
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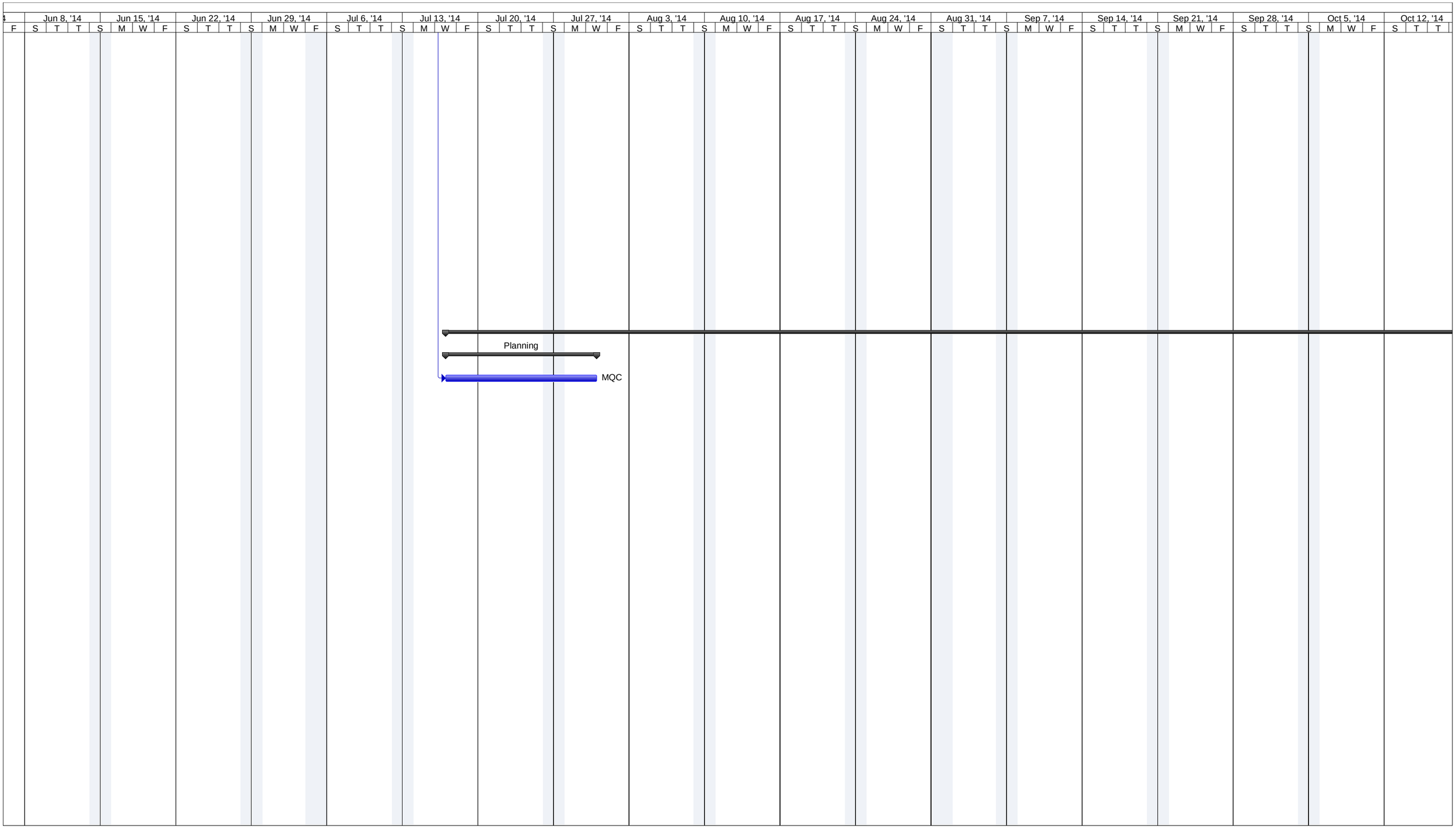
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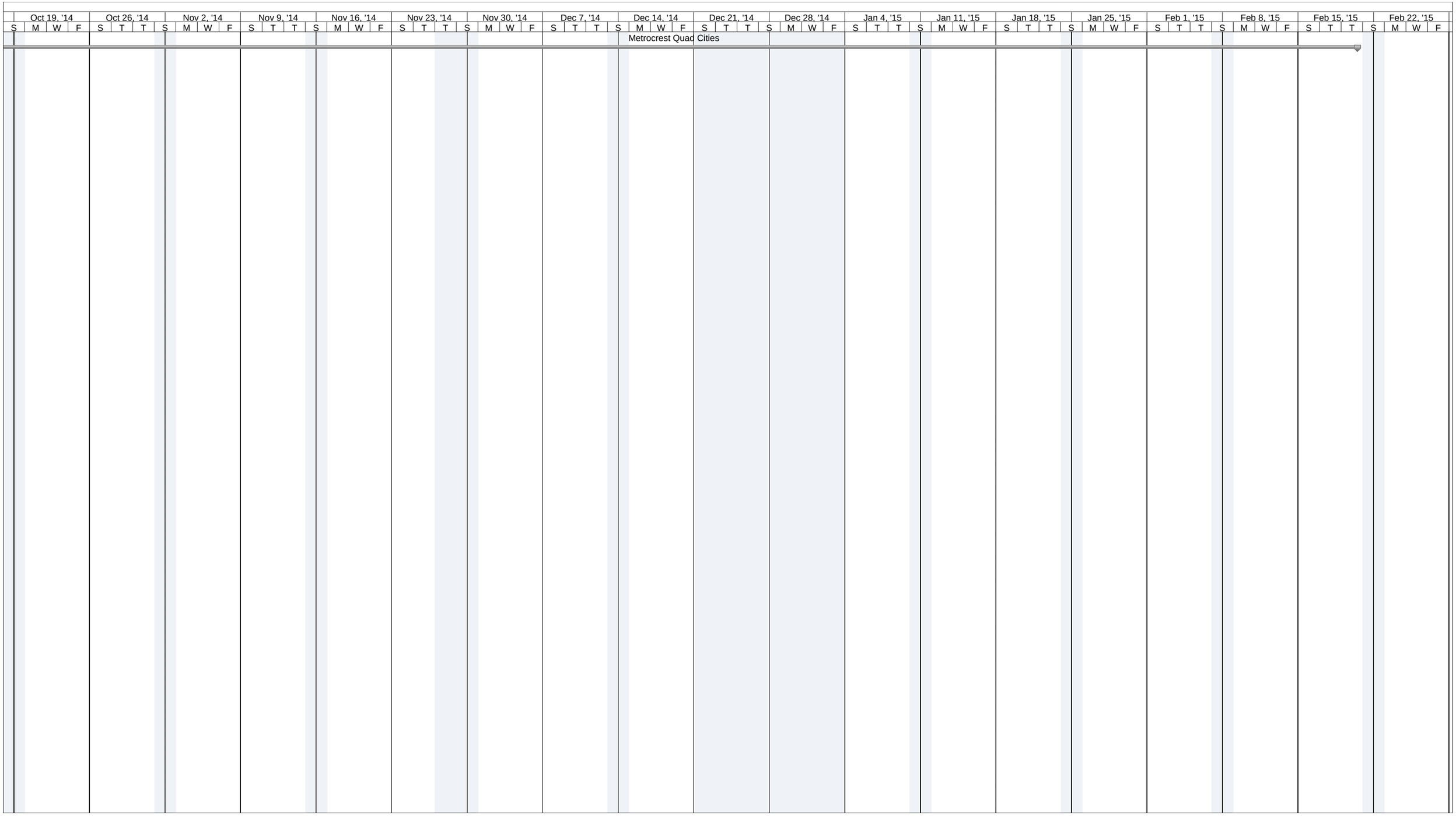
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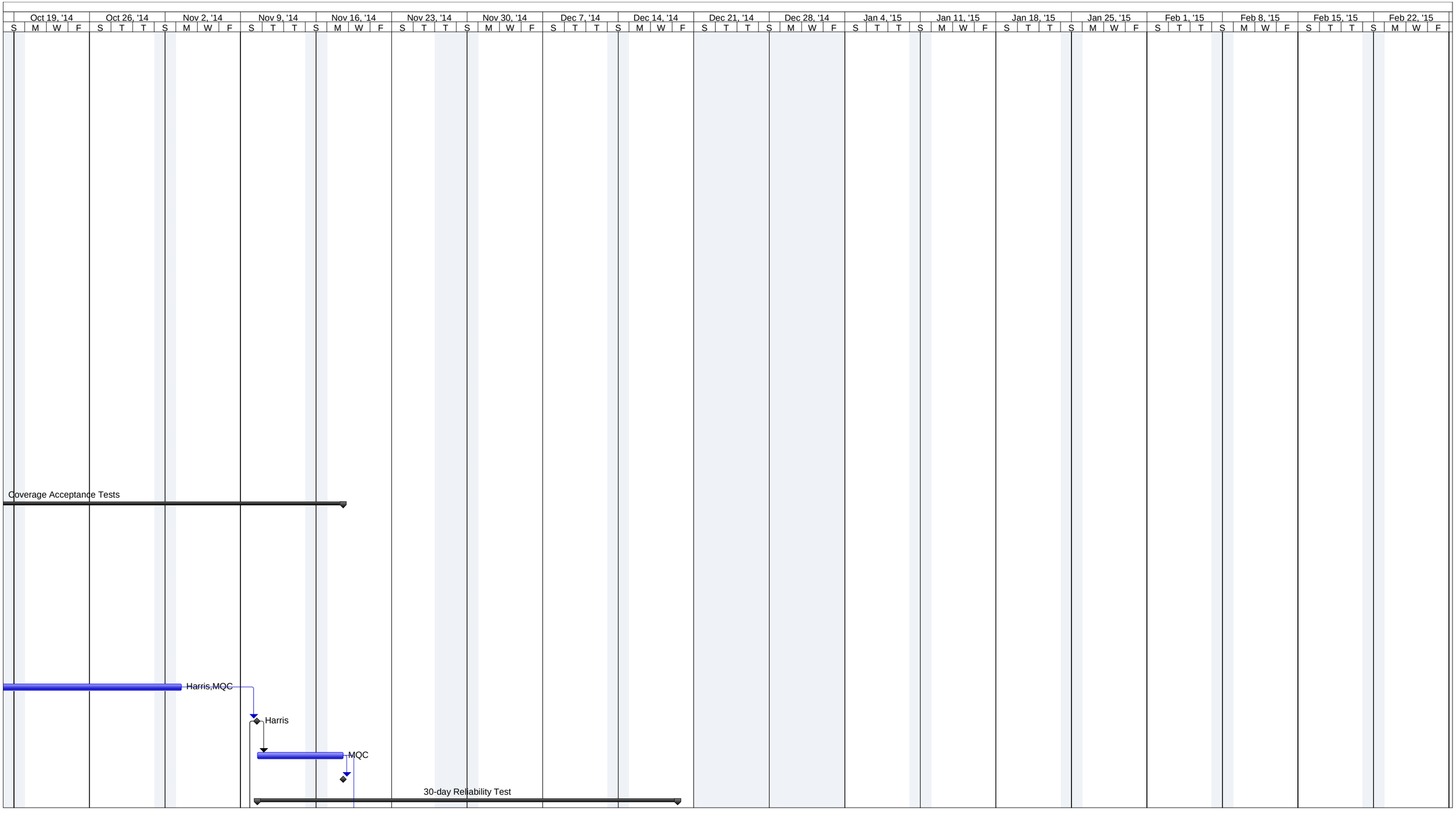
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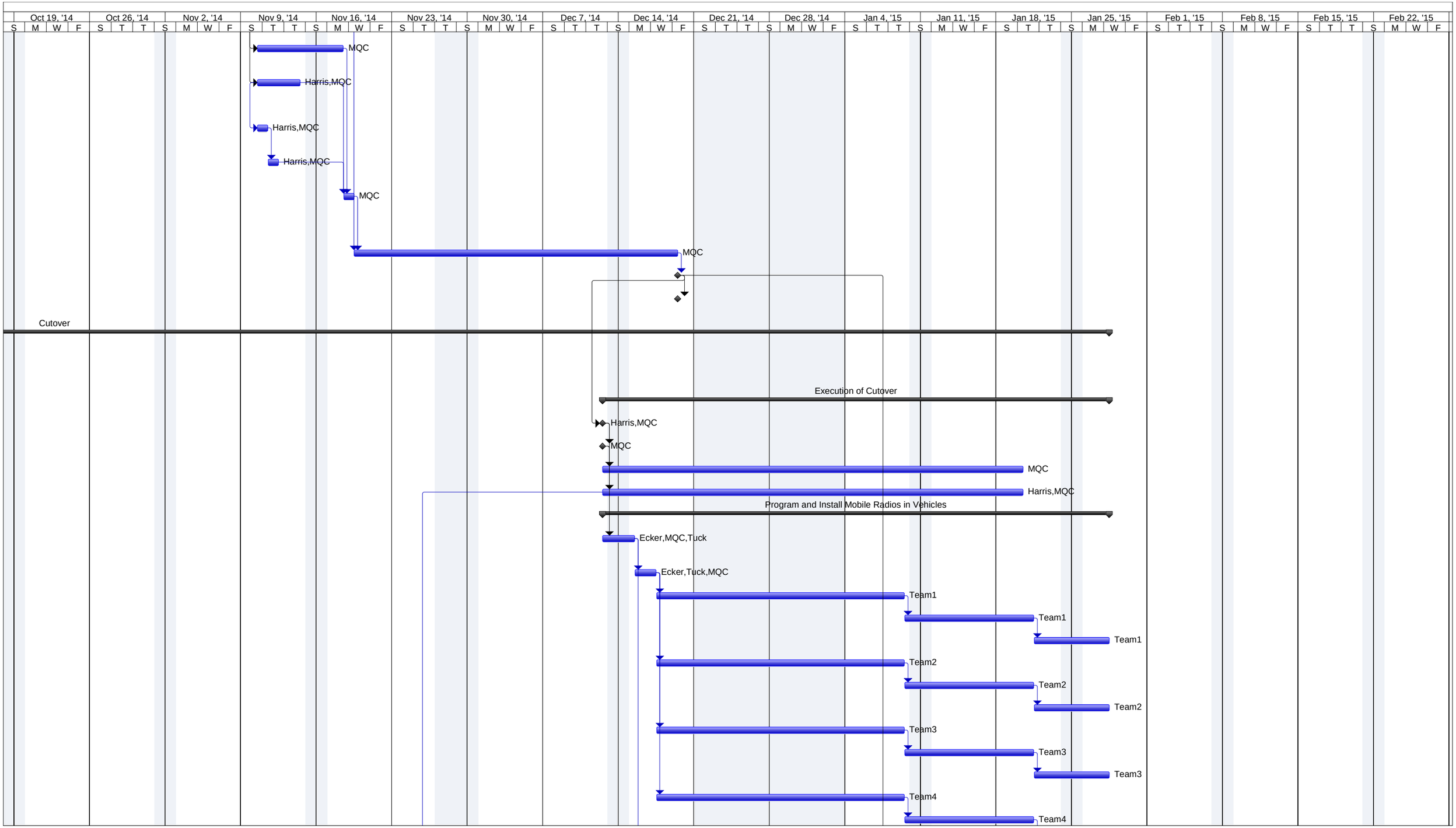
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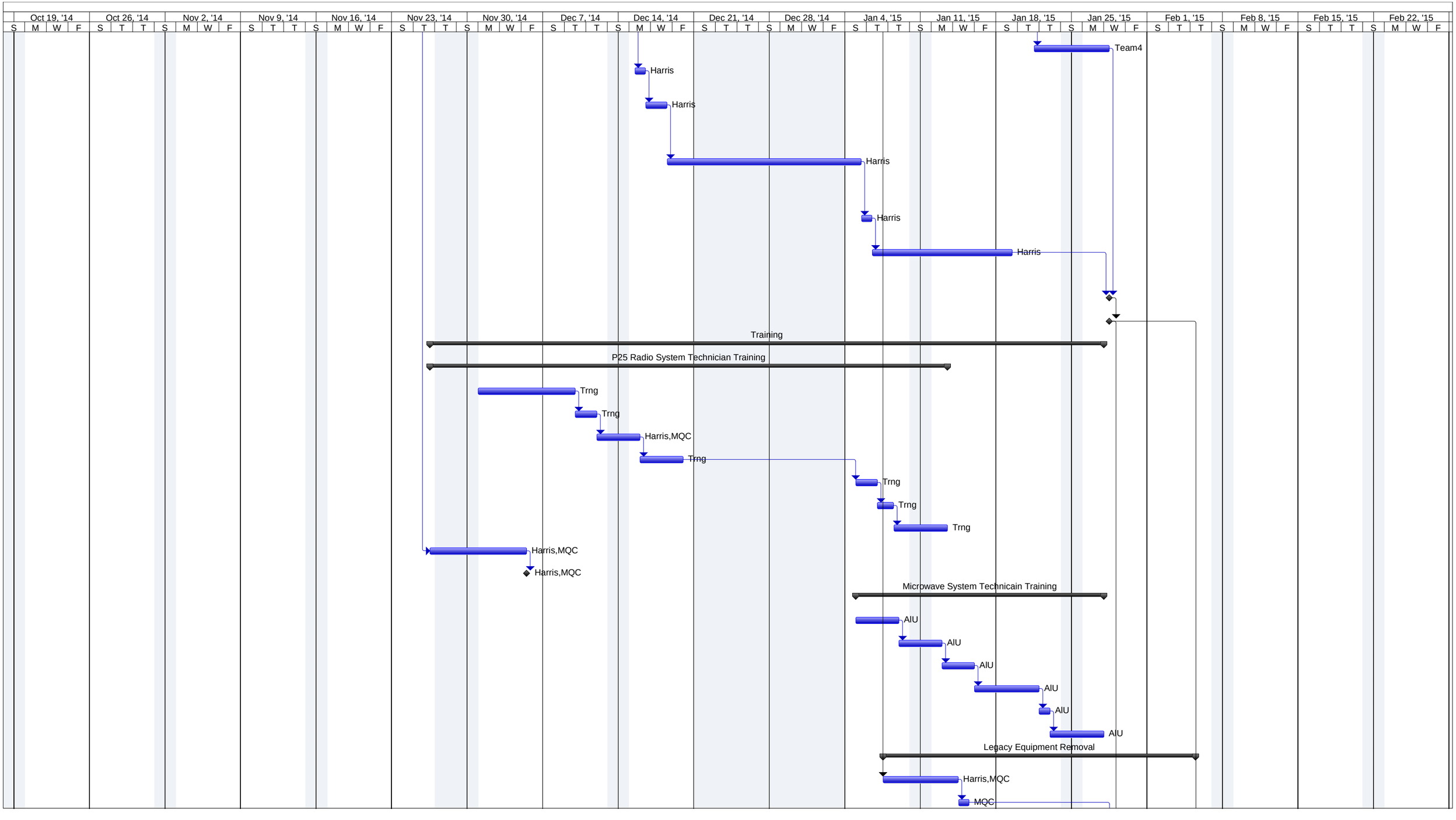
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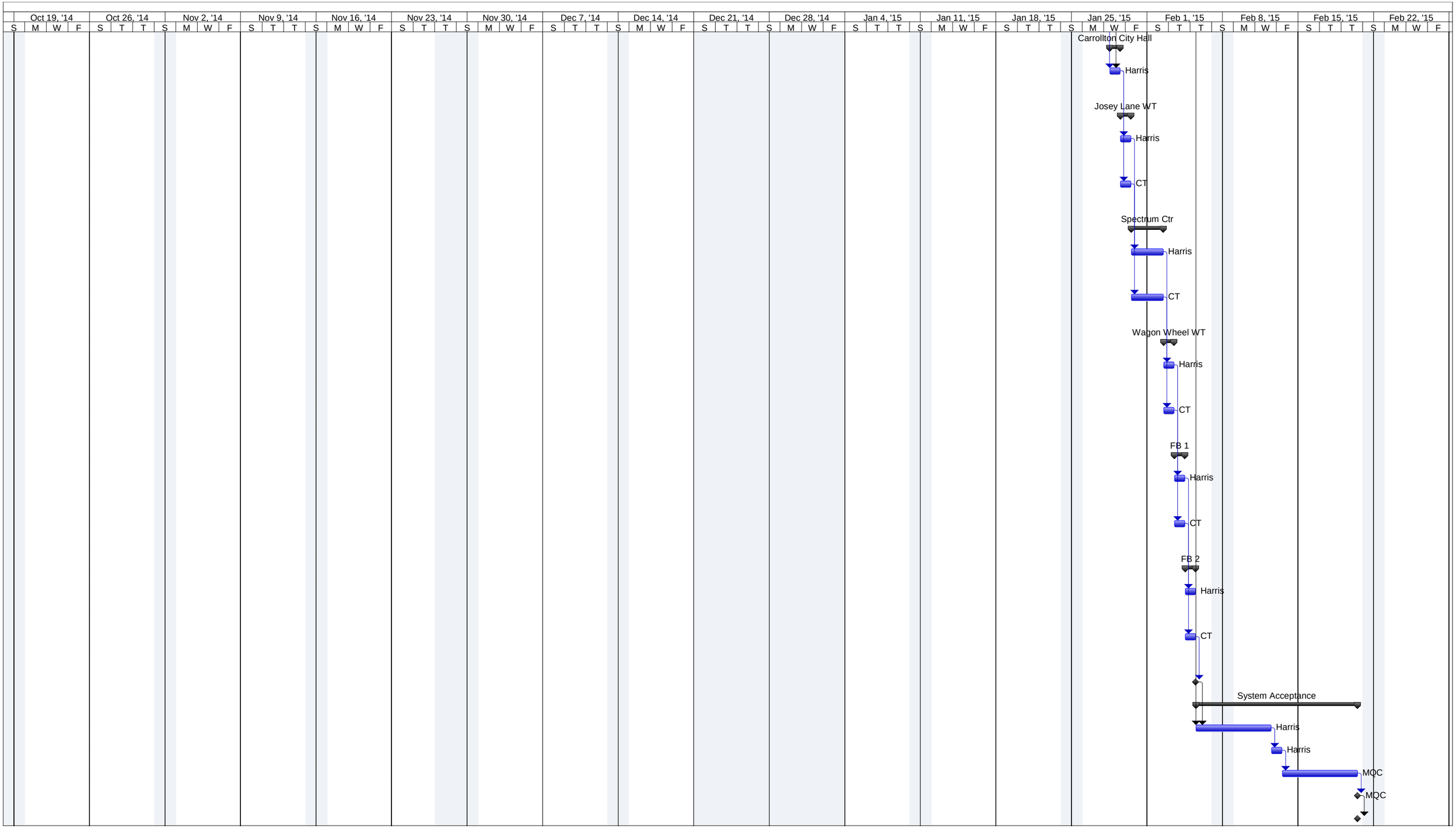
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E. Exhibit A – Statement of Work, Attachment 11 – Pricing, Revision 1

Attachment 11: Pricing, Rev 1

Master Pricing Summary – Metrocrest Quad Cities

This worksheet summarizes all of the previous pricing worksheets to derive a Total Project Cost.

ITEM	Scenario 1	Scenario 2
Total :Master Network Site Equipment and Services		$948,712.25
Total : Prime Simulcast Site Equipment and Services		$485,759.75
Total : Carrolton North Tower Remote Site Equipment and Services		$1,019,604.25
Total : Carrolton Josey Lane Remote Site Equipment and Services		$841,000.25
Total : Farmers Branch FB1 Remote Site Equipment and Services		$786,813.10
Total : Farmers Branch FB2 Remote Site Equipment and Services		$786,813.10
Total : Addison Spectrum Center Remote Site Equipment and Services		$725,252.00
Total : Coppell Wagon Wheel Tower Remote Site Equipment and Services		$772,539.50
Total: Microwave System		$1,572,633.16
Total: Consolidated Dispatch Center Equipment and Services		$0.00
Total : Dispatch Center Equipment and Services - Town of Addison		$516,700.83
Total : Dispatch Center Equipment and Services – City of City of Carrollton		$761,522.33
Total : Dispatch Center Equipment and Services – City of Coppell		$308,991.58
Total : Dispatch Center Equipment and Services – City of Farmers Branch		$350,715.08
Total: Recommended Spares for Infrastructure Equipment		$205,142.66
Total: All Upgrades For P25 **READY** Field Units – Town of Addison – All Units		$5,901.00
Total: All Upgrades For P25 **CAPABLE** Field Units – City of Addison – All Units		$0.00
Total: **New Radios**: Mobile, Portable, Control Stations and Related Services (all Tiers) – Town of Addison		$697,552.50
Total: All P25 Upgrades For P25 **CAPABLE** Field Units – City of Carrollton – All Units		$0.00
Total: **New Radios**: Mobile, Portable, Control Stations and Related Services (all Tiers) – City of Carrollton		$2,671,845.50
Total: All P25 Upgrades For P25 **READY** Field Units – City of Coppell – All Units		$1,967.00
Total: All P25 Upgrades For P25 **CAPABLE** Field Units – City of Coppell – All Units		$0.00
Total: **New Radios**: Mobile, Portable, Control Stations and Related Services (all Tiers) – City of Coppell		$1,235,956.25
Total: All Upgrades For P25 **CAPABLE** Field Units – City of Farmers Branch – All Units		$0.00
Total: **New Radios**: Mobile, Portable, Control Stations and Related Services (all Tiers) – City of Farmers Branch		$936,203.25
Total: Training		$304,227.50
Total: Radio Coverage Testing		$132,950.00
Total: Recommended Test Equipment		$142,955.02
Total: Total System Base Project Cost ***before Cost Adjustments***		$16,211,757.86
Total: Trade-In Allowance (Radios)		($537,600.00)
Other Cost Reduction Incentives – Complete the Table below		($4,827,439.86)
Total Base Project Cost (*after Cost Adjustments)*		**$10,846,718.00**
Total Infrastructure Maintenance - Years 2 through 5		$1,578,746.00
Software FX Agreement (Years 2 through 5)		$320,000.00
Total Base Project + Maintenance + Software FX (Total Agreement Price)		**$12,745,464.00**

Total Agreement Price Evolution

ITEM	ADD / DEDUCT	TOTALS
Total Base Project + Maintenance + Software FX (Total Agreement Price)		**$12,745,464.00**
CO 1: FB1 Generator	$78,750.00	
CO 2: Electrical work at Josey Lane	$14,785.00	
Subtotal Change Order(s)		**$93,535.00**
Amendment 1: Consolidated Dispatch		
Total: Consolidated Dispatch Center Equipment and Services	$1,727,573.75	
Total : Dispatch Center Equipment and Services - Town of Addison	($516,700.83)	
Total : Dispatch Center Equipment and Services - City of Carrollton	($761,522.33)	
Total : Dispatch Center Equipment and Services - City of Coppell	($308,991.58)	
Total : Dispatch Center Equipment and Services - City of Farmers Branch	($350,715.08)	
Subtotal Amendment(s)		**($210,356.07)**
Updated Total Agreement Price		**$12,628,642.93**

The following software and equipment was added to the original proposed scope of work along with the 6th site located in Farmer's Branch. These changes are included in the price on the previous page. Harris is able to include the increased scope of work at no increase in the original proposal price provided we have a fully exected contract by June 27, 2013.

Added	Site
KMF (software)	Master Network
ISSI (software)	Master Network
OTAR (software)	Control Stations
7 to 10 Channels Repeaters	Spectrum
7 to 10 Channels Repeaters	Josey
7 to 10 Channels Repeaters	Hebron
7 to 10 Channels Repeaters	Wagon Wheel
7 to 10 Channels Repeaters	FB2
7 to 10 Channels Antenna System	Spectrum
7 to 10 Channels Antenna System	Josey
7 to 10 Channels Antenna System	Hebron
7 to 10 Channels Antenna System	Wagon Wheel
7 to 10 Channels Antenna System	FB2
Redundant CP	Prime Sumulcast
Redundant Control Point Cabinet	Prime Sumulcast
Redundant NSC	Master Network
Redundant NSC Cabinet	Master Network
Larger UPS	Prime Sumulcast

Consolidated Dispatch Center

Description	Qty	Unit Cost	Extended Cost
Console LAN/WAN equipment & any central electronics equipment including all trunked and conventional channels	1	$ 10,874.66	$ 10,874.66
IP-Based dispatch console positions with 19" LCD monitors and all accessories for ten radio operator positions and 2 training positions	12	$ 47,062.50	$ 564,750.00
Equipment room facilities, racks, shelving, grounding equipment/hardware as needed	Lot	$ 5,312.50	$ 5,312.50
Digital VoIP Logging Recorder system	1	$ 48,075.95	$ 48,075.95
Master Time Source Interface.	1	included in LAN/WAN Price	
Control Stations for backup including antenna network and control station combiner(s)	12	$ 8,331.50	$ 99,978.00
Console System Main Master Site switching equipment as required (Interoperability Gateway)	3	$ 47,675.00	$ 143,025.00
Services: Installation, Project Management, Engineering, Optimization, Programming, and other Services Related to the Communications Console System implementation	Lot	$ 86,538.00	$ 86,538.00
Recommended spares (list)		$	$
Symphony Console Station	2	$ 44,212.50	$ 88,425.00
Monitor,19in Touch Capable	2	$ 622.50	$ 1,245.00
Speaker, Nano	4	$ 318.75	$ 1,275.00
Footswitch,Dual	2	$ 371.25	$ 742.50
Microphone,Gooseneck	2	$ 431.25	$ 862.50
Mobile,M7300,764-870MHz,Half Dplx	2	$ 3,315.00	$ 6,630.00
Desktop Station,CS-7000,Local Control	2	$ 1,496.25	$ 2,992.50
Control Unit,CH721,System,Front Mount	2	$ 592.50	$ 1,185.00
Microphone,Desktop	2	$ 146.25	$ 292.50
Total: Consolidated Dispatch Center Console System		**$**	**1,062,204.11**
Total for the Back-Up Dispatch Center Console System			***$ 665,369.64***
Grand Total			***$ 1,727,573.75***
New Credit reference			**$ 210,356.07**

X Fully Compliant Partially Compliant Non-Compliant

13.2.5Q **Worksheet: Communications Console System –Scenario 2 City of Carrollton**

Communications Console System	*Site Name:* **CCH Lower Level**		
Description	**Qty**	**Unit Cost**	**Extended Cost**
Console LAN/WAN equipment and any central electronics equipment including all trunked and conventional channel interfaces	1	$ 5,437.33	$ 5,437.33
IP-Based dispatch console positions with 19" LCD touch-screen monitors and all accessories for 7 operator positions	7	$ 47,062.50	$ 329,437.50
Equipment room facilities, racks, shelving, grounding equipment/hardware	Lot	$ 4,688.25	$ 4,688.25
Uninterruptable power supply (UPS) system (Combine with Master Site UPS if feasible)	1	$ 33,548.75	$ 33,548.75
Master Time Source Interface	1	included in LAN/WAN Price	
Digital Logging Recorder system, including playback terminal	1	$ 92,895.00	$ 92,895.00
VoIP Interfaces for Interoperability Stations - See Instructions for Pricing Radio Field Unit Equipment – City of Carrollton (Also includes VoIP requirements for Control Stations in 13.2.5AA)	Lot	$ 136,425.00	$ 136,425.00
Instant Replay Recorder per operator position (Call Check) per RFP	1	N/A	$
Control station combiner and antenna system – minimum 20 station combiner	1	$ 24,748.75	$ 24,748.75
Services: Installation, Project Management, Engineering, Optimization, Programming, and other Services Related to the Communications Console System implementation	Lot	$ 88,385.50	$ 88,385.50
Recommended spares (list)		$	$
MAESTROIP CONSOLE SYSTEM W/ENC - WIN7	1	$ 44,212.50	$ 44,212.50
Monitor,19in Touch Capable	1	$ 622.50	$ 622.50
Speaker, Nano	1	$ 318.75	$ 318.75
Footswitch,Dual	1	$ 371.25	$ 371.25
Microphone,Gooseneck	1	$ 431.25	$ 431.25
Other Items (list)		$	$
Total: City of Carrollton Communications Console System		**$**	**761,522.33**

X Fully Compliant Partially Compliant Non-Compliant

13.2.5R **Worksheet: Communications Console System – Scenario 2 - City of Coppell**

Communications Console System	*Site Name:* **Coppell Justice Center**		
Description	**Qty**	**Unit Cost**	**Extended Cost**
Console LAN/WAN equipment and any central electronics equipment including all trunked and conventional channel interfaces	1	$ 5,437.33	$ 5,437.33
IP-Based dispatch console positions with 19" LCD touch-screen monitors and all accessories for 3 operator positions	3	$ 47,062.50	$ 141,187.50
Equipment room facilities, racks, shelving, grounding equipment/hardware	Lot	N/A	$
Uninterruptable power supply (UPS) system	1	N/A	$
Master Time Source Interface	1	included in LAN/WAN Price	
Playback Terminal for digital logging recorder	2	$ 5,587.50	$ 11,175.00
Instant Replay Recorder per operator position (Call Check) per RFP	1	N/A	$
VoIP Interfaces for Interoperability Stations - See Instructions for Pricing Radio Field Unit Equipment – City of Coppell (Also includes VoIP requirements for Control Stations in 13.2.5KKi)	Lot	$ 90,887.00	$ 90,887.00
Control station combiner and antenna system – minimum 12 station combiner	1	$ 16,556.50	$ 16,556.50
Services: Installation, Project Management, Engineering, Optimization, Programming, and other Services Related to the Communications Console System implementation	Lot	$ 37,879.50	$ 37,879.50
Recommended spares (list)		$	$
Speaker, Nano	1	$ 318.75	$ 318.75
Mobile,M7300,764-870MHz,Half Dplx	1	$ 3,315.00	$ 3,315.00
Desktop Station,CS-7000,Local Control	1	$ 1,496.25	$ 1,496.25
Control Unit,CH721,System,Front Mount	1	$ 592.50	$ 592.50
Microphone,Desktop	1	$ 146.25	$ 146.25
Other Items (list)		$	$
Total: City of Coppell Communications Console System		**$**	**308,991.58**

X Fully Compliant Partially Compliant Non-Compliant

13.2.5S **Worksheet: Communications Console System–Scenario 2 City of Farmers Branch**

Communications Console System		*Site Name:* **FB Justice Center**	
Description	**Qty**	**Unit Cost**	**Extended Cost**
Console LAN/WAN equipment and any central electronics equipment including all trunked and conventional channel interfaces	1	$ 5,437.33	$ 5,437.33
IP-Based dispatch console positions with 19" LCD touch-screen monitors and all accessories for four (4) operator positions	4	$ 47,062.50	$ 188,250.00
Equipment room facilities, racks, shelving, grounding equipment/hardware	Lot	$ 2,500.00	$ 2,500.00
Uninterruptable power supply (UPS) system	NA		
Master Time Source Interface	1	included in LAN/WAN Price	
Playback Terminal for digital logging recorder	2	$ 5,587.50	$ 11,175.00
VoIP Interfaces for Interoperability Stations - See Instructions for Pricing Radio Field Unit Equipment – City of Farmers Branch (Also includes VoIP requirements for Control Stations in 13.2.5TT)	Lot	$ 86,978.00	$ 86,978.00
Instant Replay Recorder per operator position (Call Check) per RFP	1	N/A	$
Services: Installation, Project Management, Engineering, Optimization, Programming, and other Services Related to the Communications Console System implementation	Lot	$ 50,506.00	$ 50,506.00
Recommended spares (list)		$	$
Speaker, Nano	1	$ 318.75	$ 318.75
Mobile,M7300,764-870MHz,Half Dplx	1	$ 3,315.00	$ 3,315.00
Desktop Station,CS-7000,Local Control	1	$ 1,496.25	$ 1,496.25
Control Unit,CH721,System,Front Mount	1	$ 592.50	$ 592.50
Microphone,Desktop	1	$ 146.25	$ 146.25
Other Items (list)		$	$
Total: City of Farmers Branch Communications Console System		**$**	**350,715.08**

X Fully Compliant Partially Compliant Non-Compliant

Back-up Dispatch at City of Carrollton

Description	Qty	Unit Cost	Extended Cost
Console LAN/WAN equipment and any central electronics equipment including all trunked and conventional channel interfaces	1	$ 5,437.33	$ 5,437.33
IP-Based dispatch console positions with 19" LCD touch-screen monitors and all accessories for 8 operator positions	8	$ 47,062.50	$ 376,500.00
Uninterruptable power supply (UPS) system	1	$ 15,662.36	$ 15,662.36
Master Time Source Interface	1	included in LAN/WAN Price	
Digital Logging Recorder system, including playback terminal	1	$ 48,075.95	$ 48,075.95
Console System Back-Up Master Site switching equipment as required (Interoperability Gateway)	2	$ 47,675.00	$ 95,350.00
Control station combiner and antenna system	8	$ 8,331.50	$ 66,652.00
Services: Installation, Project Management, Engineering, Optimization, Programming, and other Services Related to the Communications Console System implementation	Lot	$ 57,692.00	$ 57,692.00
Total: Back-Up Dispatch Console System		**$**	**665,369.64**