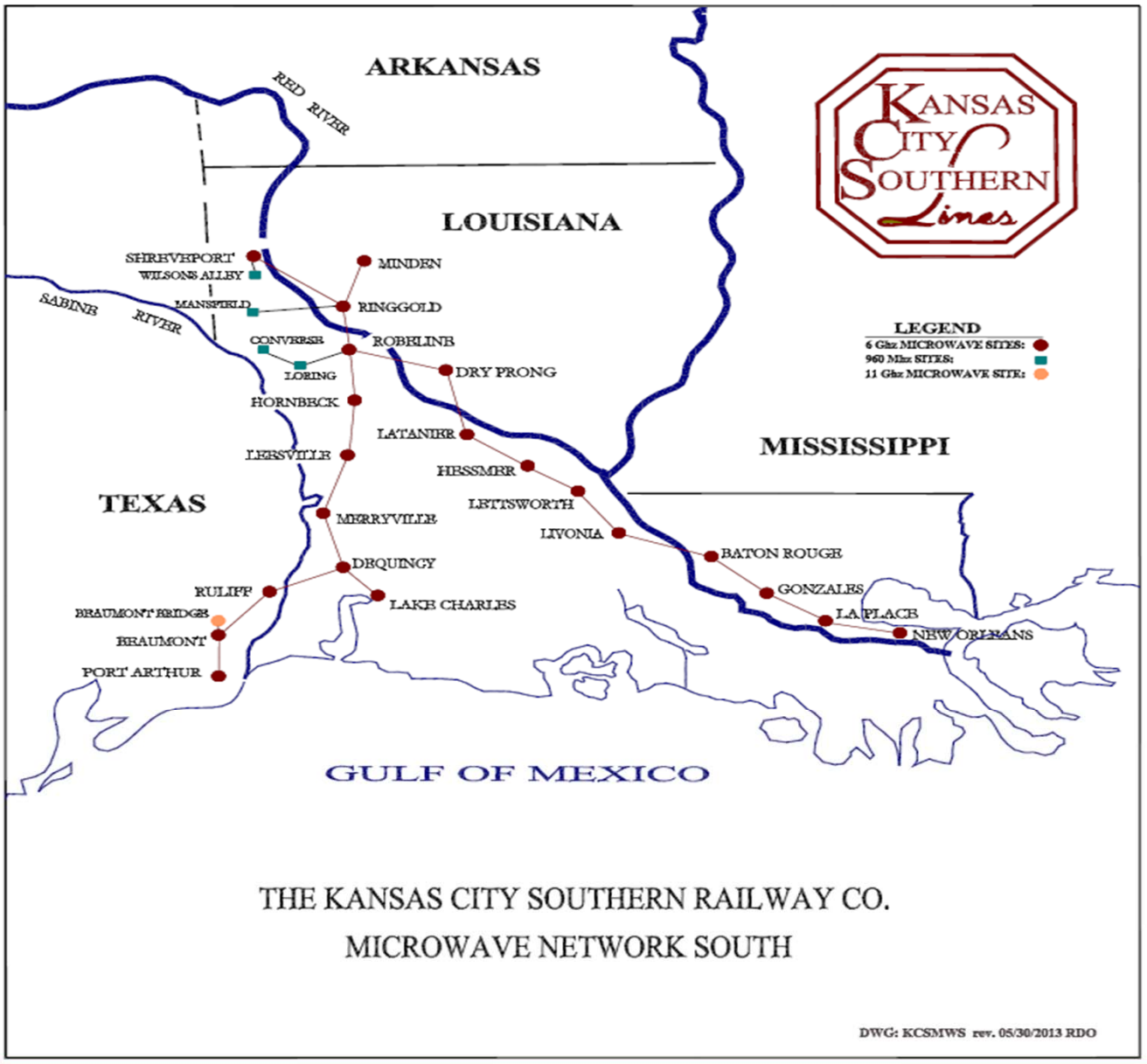
Legacy Microwave to IP Microwave Conversion

6/11/13

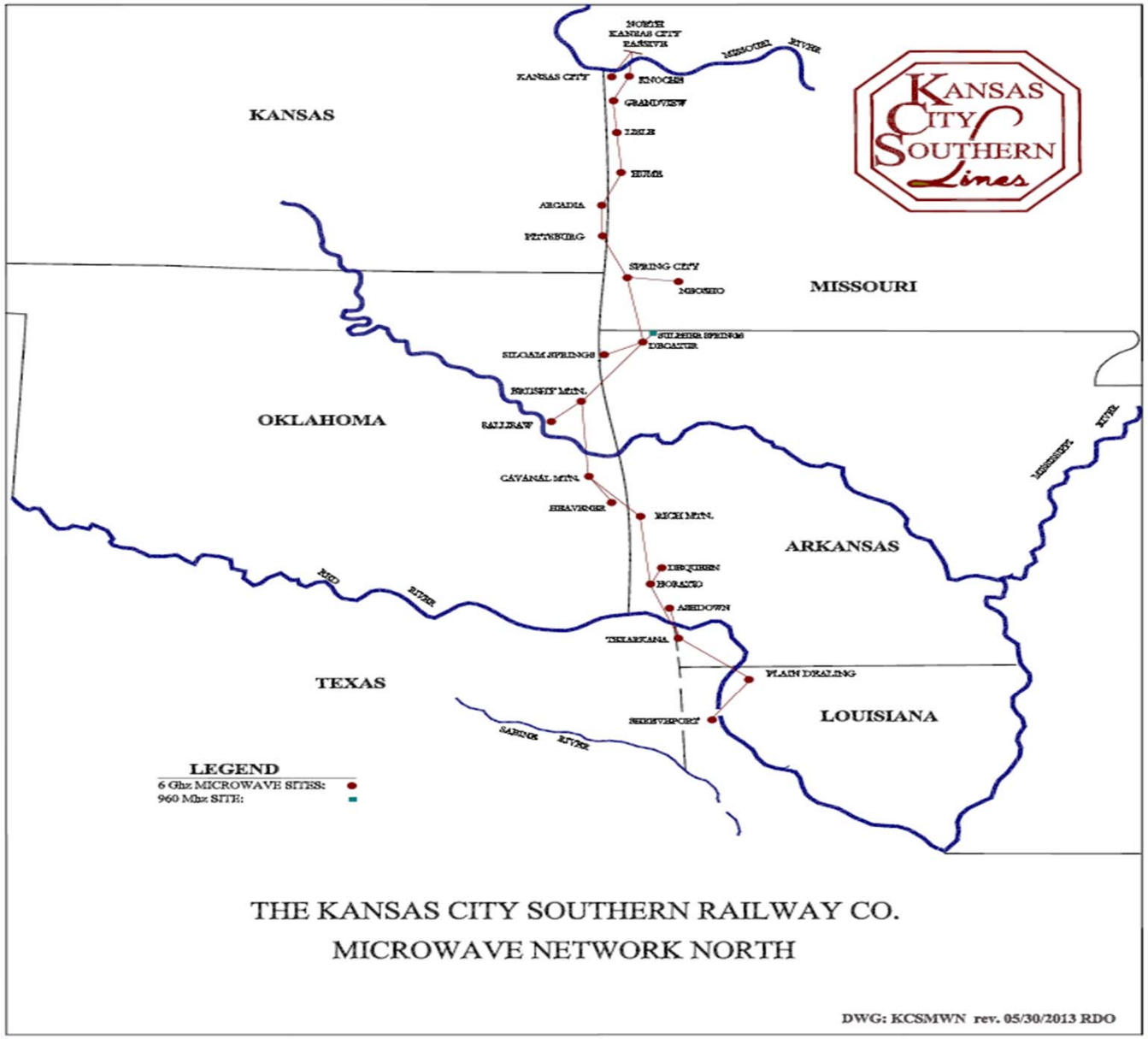
Legacy to IP Microwave Conversion

- The Kansas City Southern Railway (KCSR) had a need to modernize an outdated microwave system in preparation for a PTC deployment
- Microwave system is made up of 48 sites than runs through 5 states
- Primarily paths run North/South from Kansas City to Beaumont and New Orleans
- Multi year project
- Phase I included sites South of Shreveport
- Phase II included sites North of Shreveport

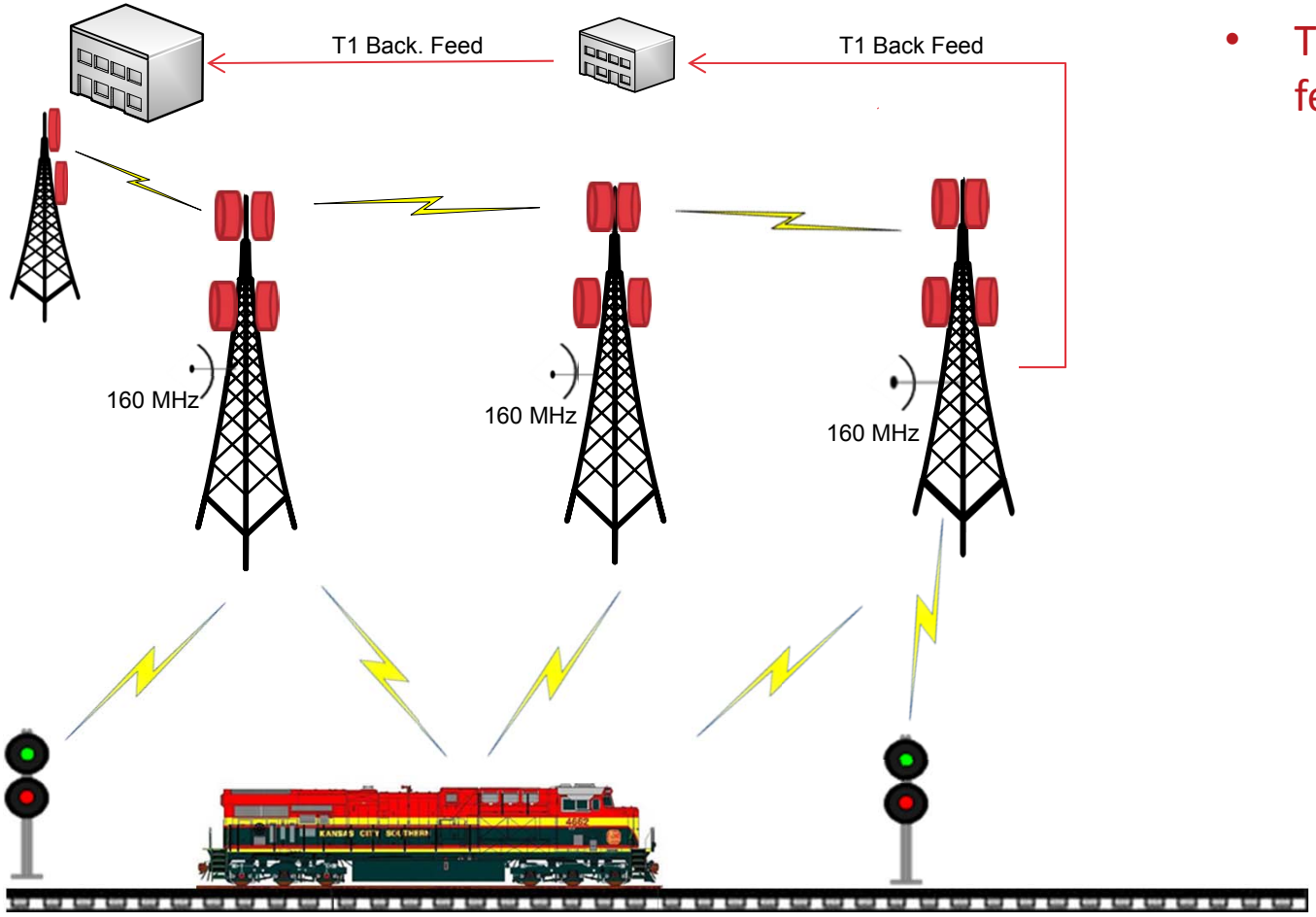
Phase I Tower Locations



Phase II Tower Locations



Legacy Microwave Backbone



- T1's were used for back feed on the legacy system

Key Objectives

- New system needed to be capable of handling PTC data transfer requirements
- New microwave radios needed to be implemented with failover capability in mind
- Tower infrastructure needed upgrading where for enhanced reliability
- Needed to be deployed with a minimal impact to the business

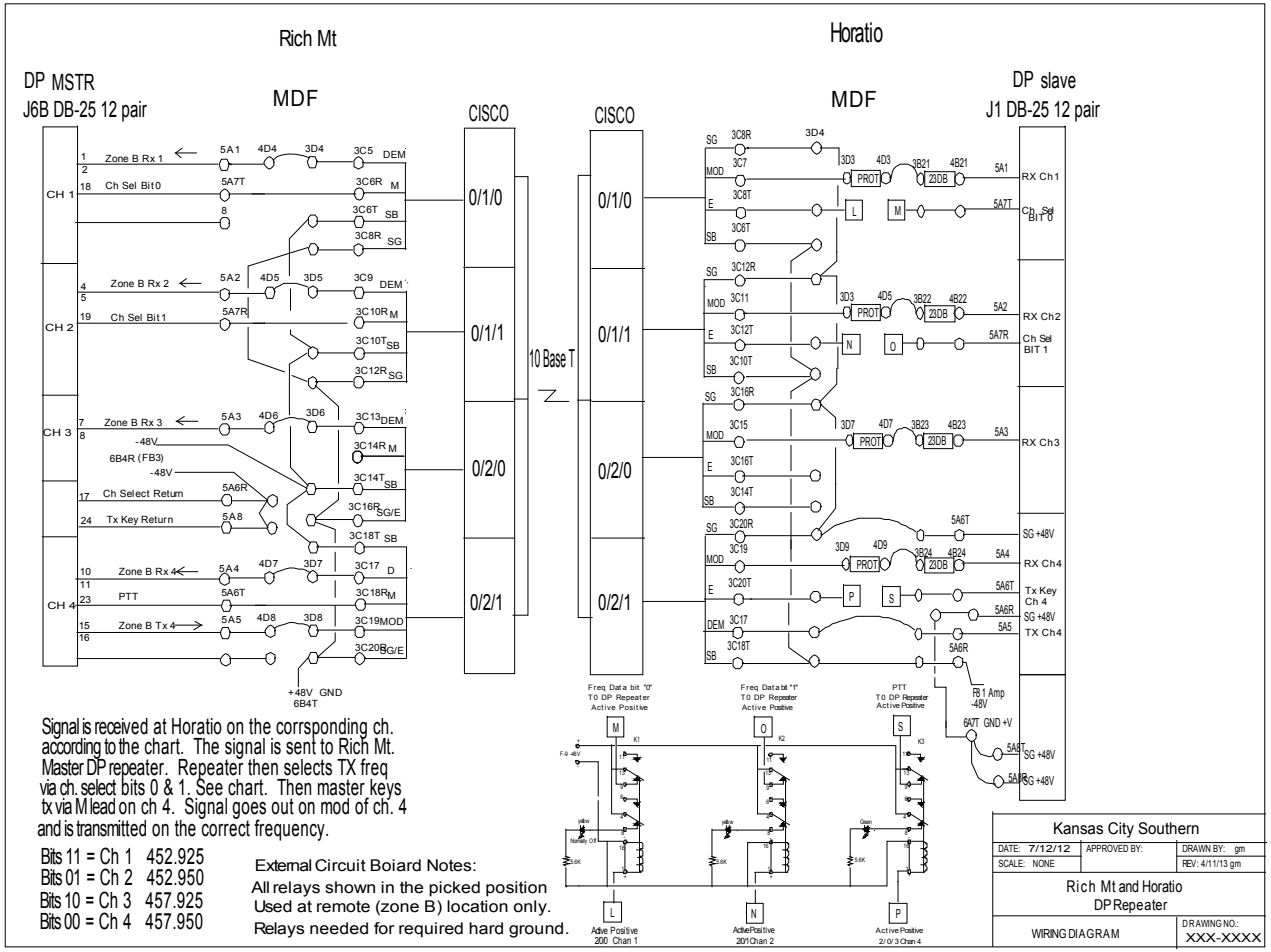
Interface considerations

- Sites needed to be surveyed
- Had to determine what equipment would stay after the upgrade
- A one for one comparison, existing endpoint/channel interface to IP interface, was performed on the entire network
- Will the remaining legacy equipment work with the new equipment being installed

Non IP Equipment

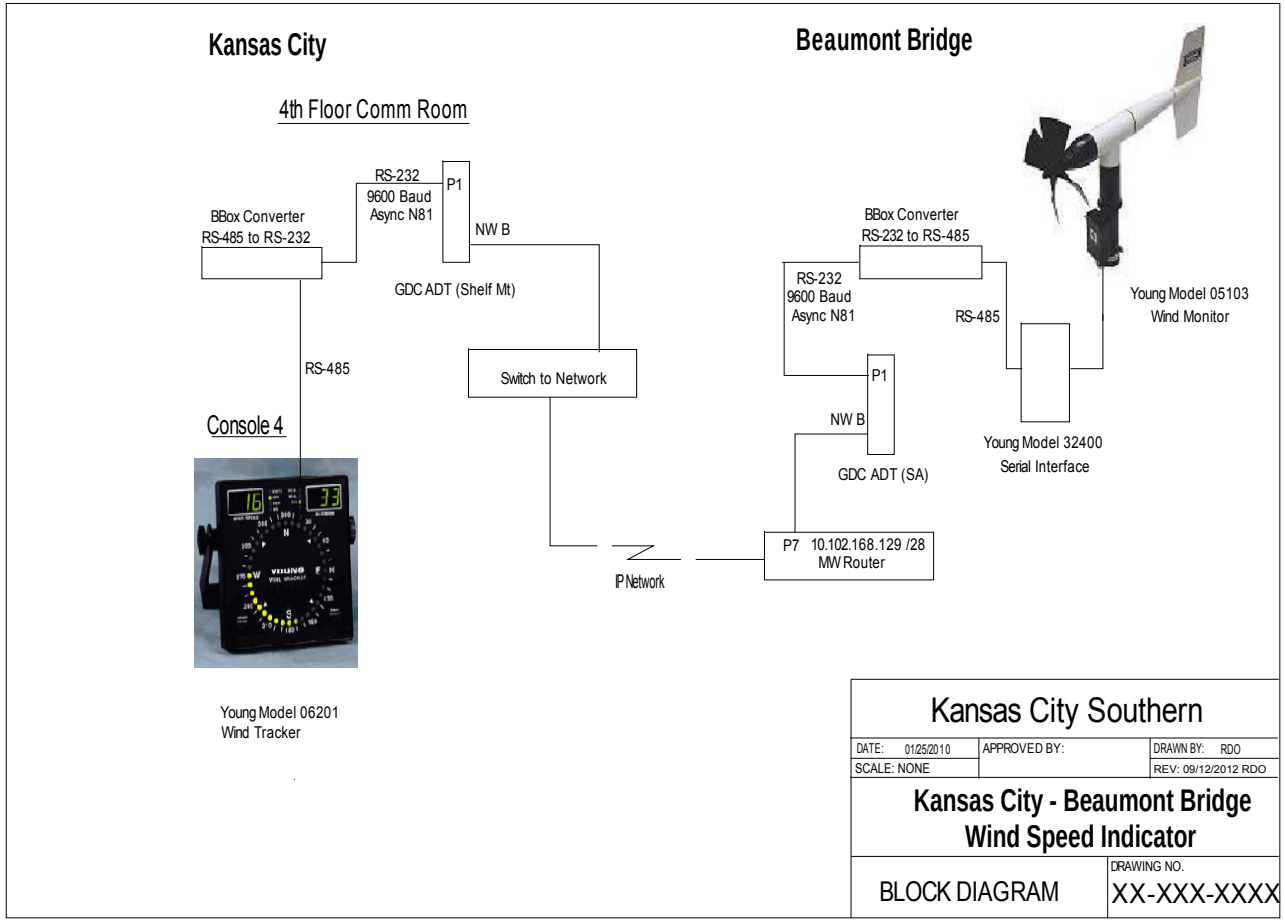
- There was legacy equipment that needed to remain post cutover not capable of communicating over IP
- Had to find an interface solution
  - Distributed Power (DP) repeaters
  - Wind speed indicators
  - Cameras
  - Base Communication Package (BCP) communication to backoffice.
  - Dispatch radios

DP Repeaters



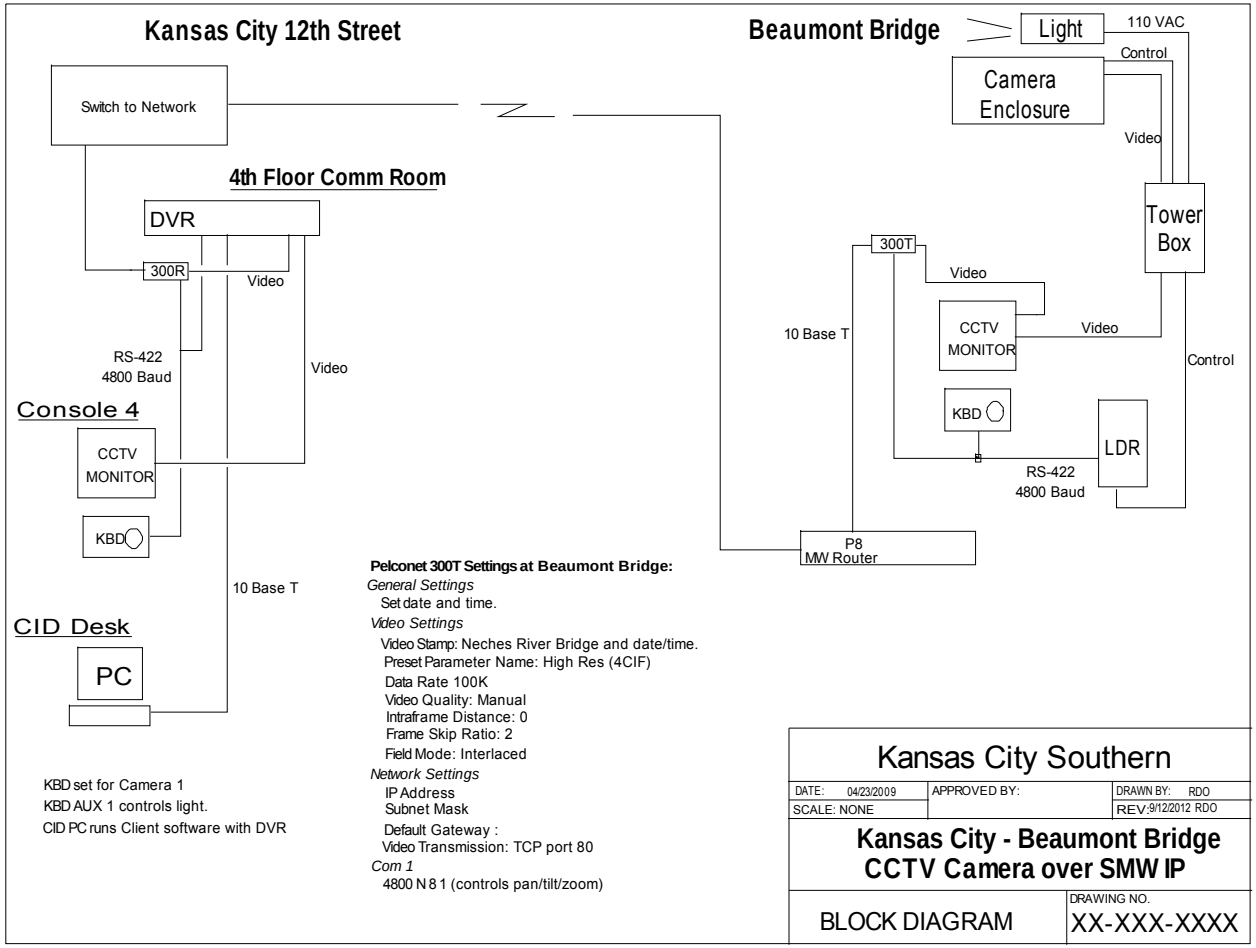
- Relays communication between locomotives in a train consist
- CPU for two zones located at master end, limited equipment located at remote end, each end equipped with one multichannel transmitter and four independent receivers at 450 Mhz
- OLD – Used E&M channels via mux equipment. Mod/Dem for data transmission, E&M for PTT and Channel Selection
- NEW – Duplicated configuration using E&M interfaces on routers.

Wind Speed Monitor



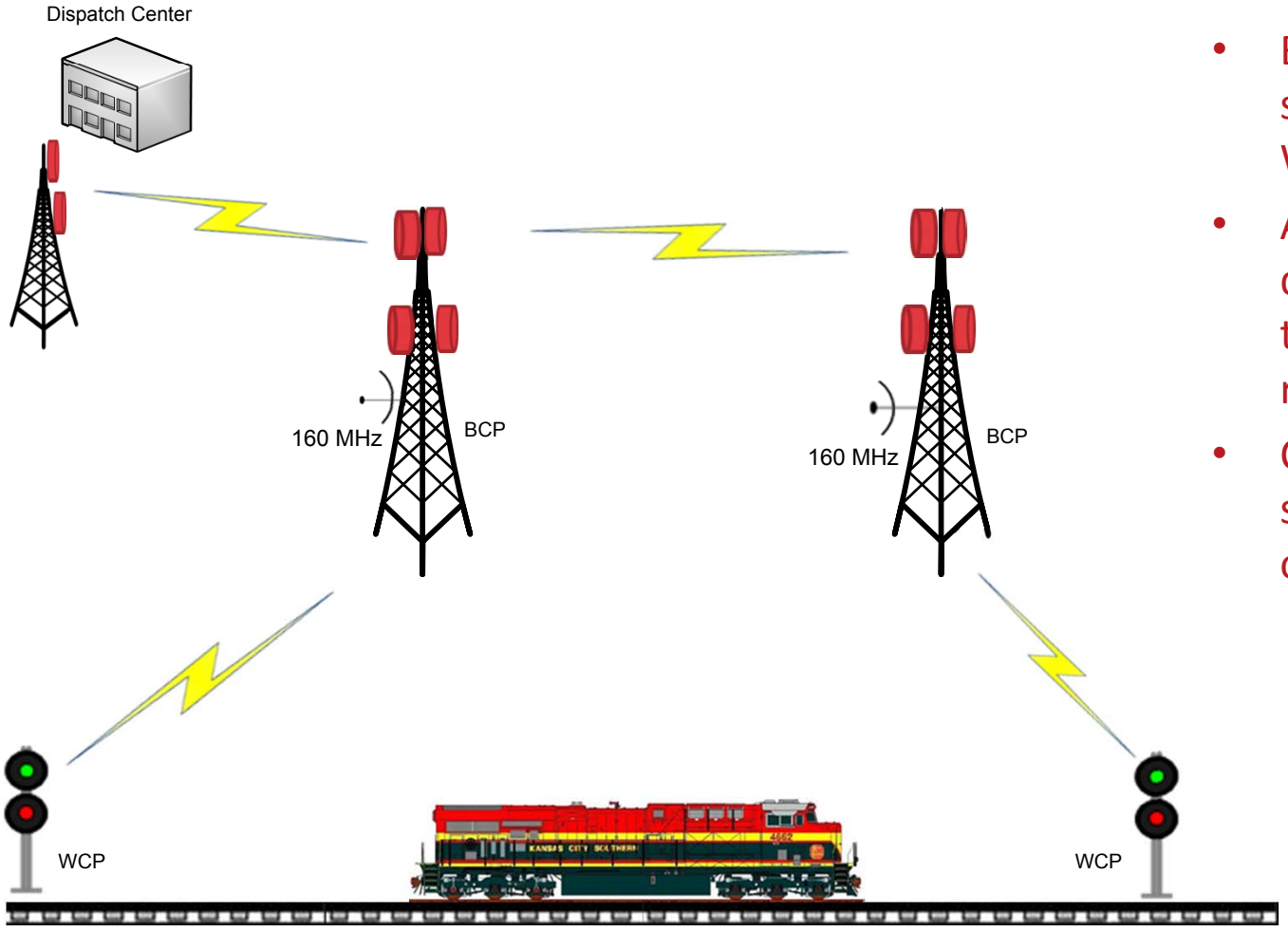
- OLD – Used a GDC MUX channel on each end to transmit Asynchronous Data
- NEW – Now use a GDC ADT (Asynchronous Data Transport) module to convert to IP, bookend solution

Video Camera



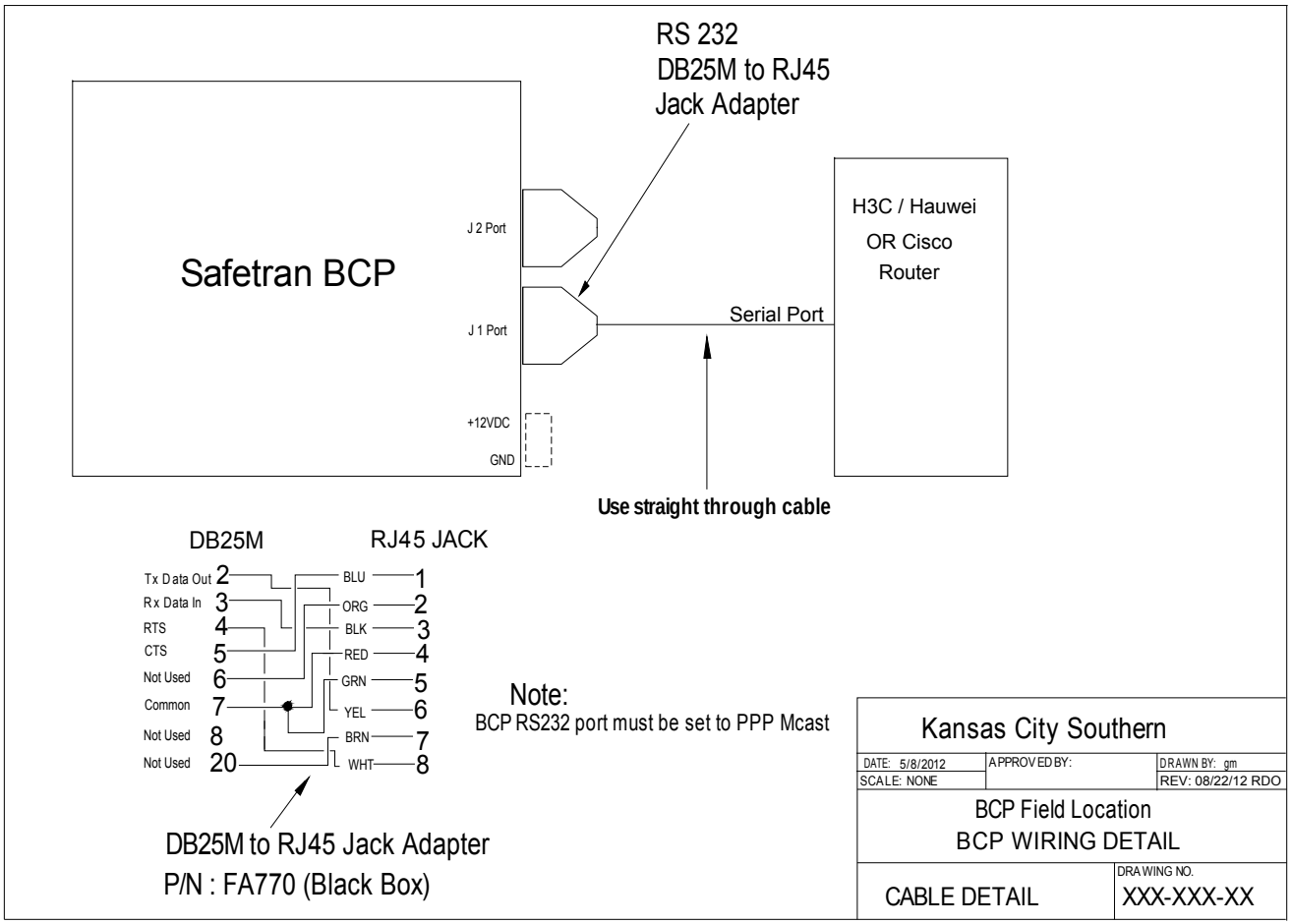
- OLD – Used an Enerdyne Codex and a GDC MUX channel on each end to carry video and control signals
- NEW – Now use a Pelco 300T video transmitter and a Pelco 300R video receiver to transport video and control signals via IP, bookend solution

Centralized Traffic Control (CTC)



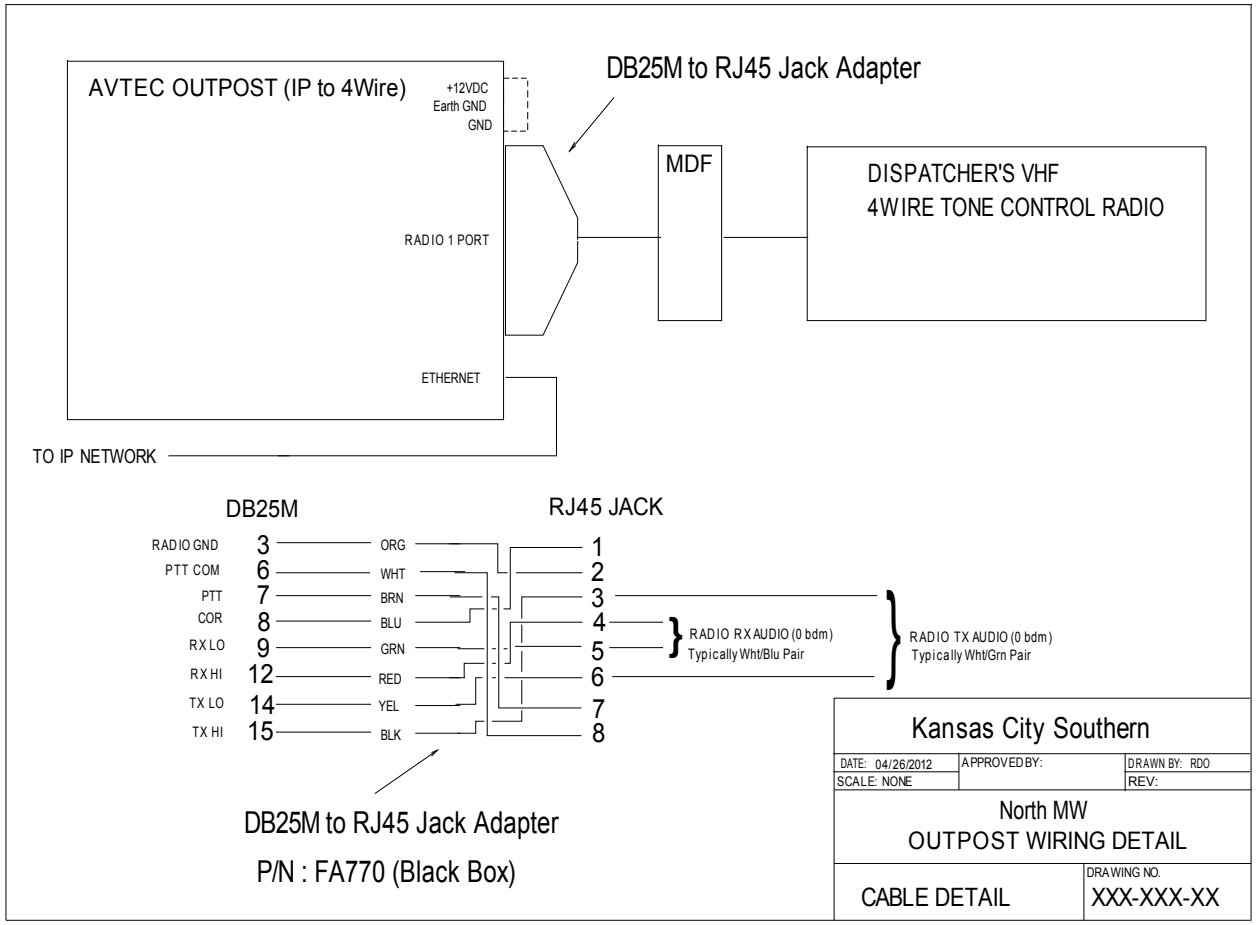
- BCP located at the tower sites communicate with WCP at signal locations
- Allows the centralized dispatch office the ability to control traffic flow remotely using signals
- Critical system that supports safe fluid train operations

Centralized Traffic Control (CTC)



- OLD – Used a channel on the GDC MUX to a synchronous serial port on the BCP
- NEW – Now use a router serial interface to a PPP (point to point protocol) serial interface on the BCP

Dispatch radios



- Use Motorola Quantar analog dispatch radios at tower locations
- OLD - Communicated over E&M channel to Avtec outposts located in central office
- NEW - Avtec outposts were moved to tower locations to support Scout deployment and allow for disaster recovery

Frequency Coordination

Microwave Path Data Sheet Page 23 of 23

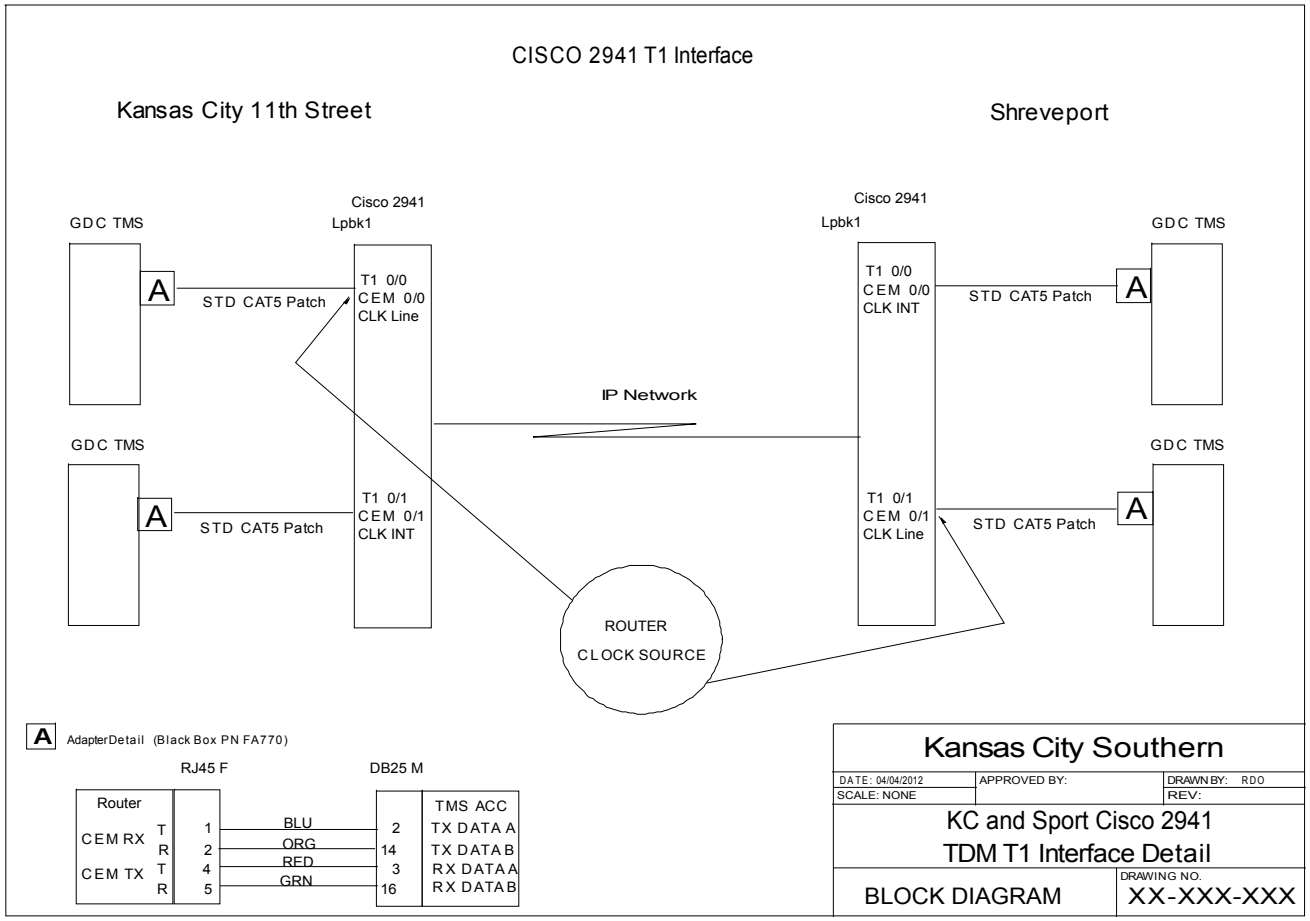
COMSEARCH
19700 Janelia Farm Boulevard, Ashburn, VA, 20147
(703)726−5651 www.comsearch.com

PCN Date: 08/19/2011 Prev Job Num:
Job Number 110819COMSTH02 RCN Number: 11081917

Administrative Information	**PLAIN DEALI LA**	**SHREVEPORT LA**
City/County	/Bossier	Shreveport/Caddo
Status / License Basis	Engineering Proposal / PRIMARY OPERATION	Engineering Proposal / PRIMARY OPERATION
Call Sign	KJN89	KJN88
Licensee Code	S0047P	S0047P
Licensee Name	Kansas City Southern Railway Compan	Kansas City Southern Railway Compan
Radio Service / Station Class	MG −− Microwave Industrial/Business Pool	FXO −− Fixed
Site Information		
Latitude (NAD 83)	32 °56' 16.0 " N	32 °32' 27.0" N
Longitude (NAD 83)	93 °43' 55.0 " W	93 °50' 10.0" W
Ground Elevation (m/ft−AMSL)	142.30 / 466.9	62.20 / 204.1
Antenna Structure Registration #	1054953	1054958
Path Azimuth (°)	192.533	12.477
Path Length (km / miles)	45.091 / 28.018	
Transmit Antenna	A64130	A64130
Manufacturer	ANDREW CORPORATION	ANDREW CORPORATION
Model	P8−65D	P8−65D
Gain(dBi) / Beamwidth(°) / Tilt(°)	42.3 / 1.30 / −0.28	42.3 / 1.30 / −0.02
Centerline (m / ft − AGL)	89.92 / 295.0	68.58 / 225.0
Receive Antenna	Same As Transmit	
Manufacturer		
Model		
Gain (dBi) / Beamwidth (°)		
Centerline (m / ft − AGL)		
Diversity Receive Antenna	A64130	A64130
Manufacturer	ANDREW CORPORATION	ANDREW CORPORATION
Model	P8−65D	P8−65D
Gain (dBi) / Beamwidth (°)	42.3 / 1.30	42.3 / 1.30
Centerline (m / ft − AGL)	76.20 / 250.0	59.44 / 195.0
Radio Information	TEMZ47	TEMZ47
Manufacturer	CERAGON NETWORKS	CERAGON NETWORKS
Model	IP10−6−T10−64QAM−4	IP10−6−T10−64QAM−4
Model Description	IDU T 64QAM	IDU T 64QAM
Emission Designator / Modulation	10M0D7W 64 QAM	10M0D7W 64 QAM
Loading	1 CH DIG 44730.000	1 CH DIG 44730.000
Stability (%)	0.001	0.001
	Nominal Coordinated Maximum	Nominal Coordinated Maximum
Power (dBm)	32.0	32.0
Received Level (dBm)	−38.3	−38.3
EIRP (dBm)	67.4	68.4
Fixed Loss: Tx / Common (dB)	0.0 / 6.9	0.0 / 5.9
Free Space Loss (dB)	142.1	
Transmit Frequencies (MHz)	6785.0000H(5)	6625.0000H(5)

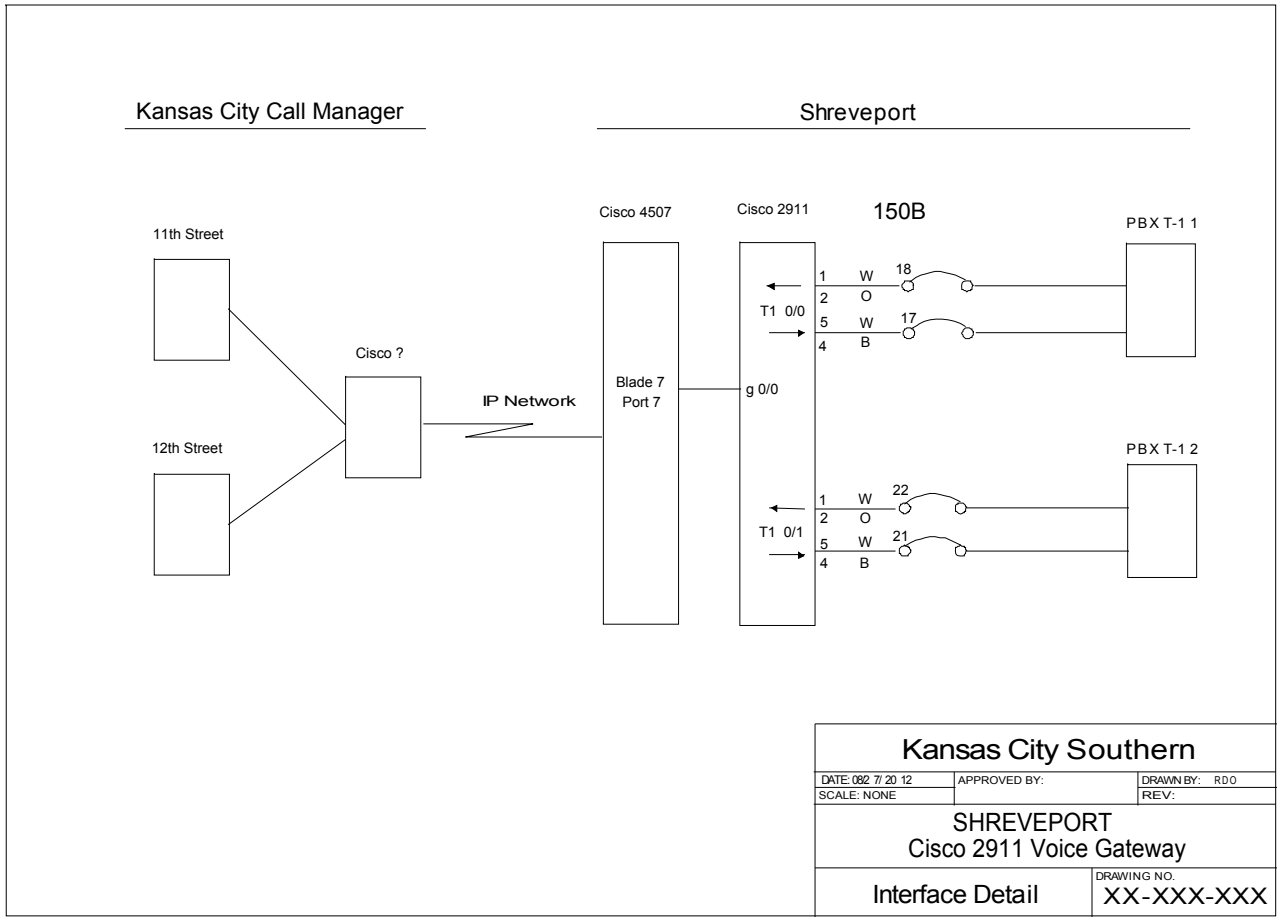
- ComSearch performed frequency coordination
- All links were analyzed
- This is an example data sheet from Plain Dealing, LA to Shreveport, LA
- Helps determine possible interference issues with outside entities and legacy paths
- Found interference issues with some legacy paths, temporarily decreased new transmitter power until cutover was complete

T1 Interfaces



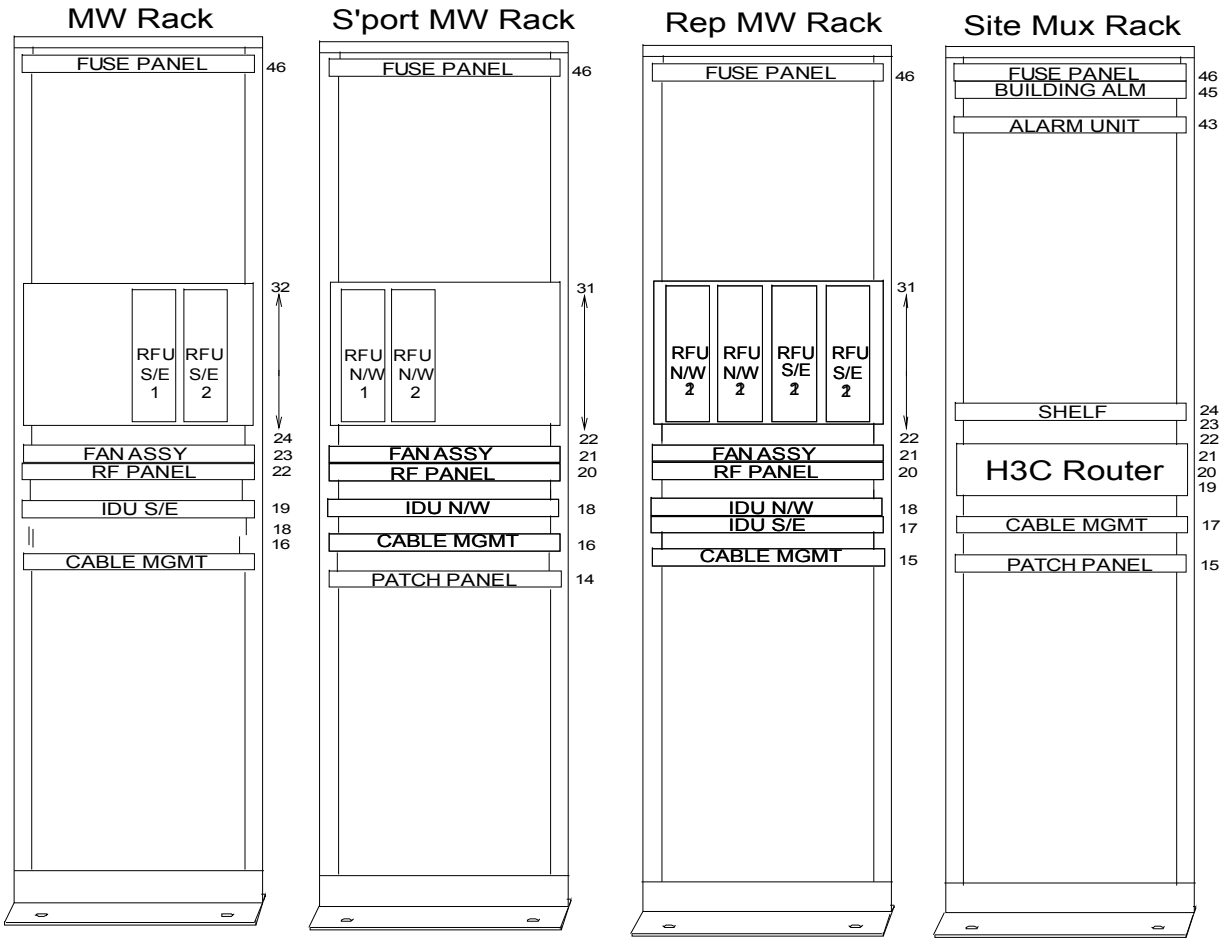
- It was determined during 1 for 1 evaluation that legacy wireless T-1 circuits needed to be maintained after cutover, supporting backup for leased T-1 circuits
- The solution was to emulate T-1 circuits across the ethernet network
- This was accomplished using Cisco routers with T-1 interfaces
- Main issue to overcome was determining the correct clocking environment for the T-1s over multiple router hops

PBX Tie Trunks



- Legacy tie trunks using T-1 had to be supported with the Ethernet solution
- We used a Cisco call manager with T-1 interfaces to convert the legacy T-1 trunks to IP
- Analog sections of the MW network already had MPLS circuits and VOIP phones, now supported via IP microwave

Equipment Racks



- Rack layout drawings were made before any physical work
- Different layouts required based on building type and equipment requirements
- Height to top of rack kept consistent for measurement of flex waveguide needed
- Provided for uniform installation

IP Radios

- Researched radio manufactures to understand their interface options
- Technical considerations such as path reliability projections or bandwidth limitations and frequency limitations eliminated some vendors
- Selected Ceragon IP-10 all indoor, 32 dbm TX, native Ethernet, 64QAM

Network Routers

- Phase I
  - General DataComm (“GDC”) multi-plex units were being used for re-routing and T1 interfaces on the legacy microwave system
  - Chose to use Huawei AR 4549 routers recommended by GDC for the IP routing

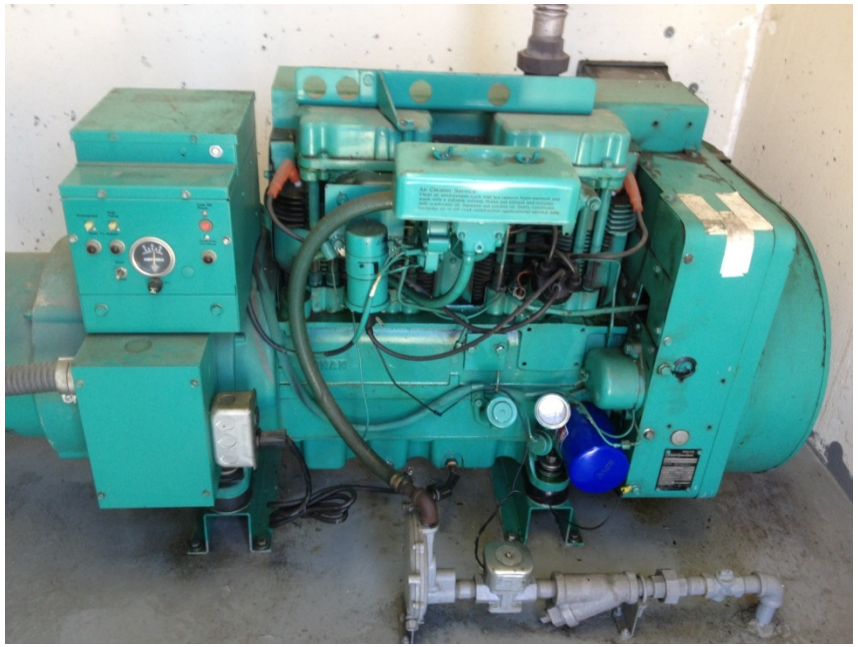
- Phase II
  - KCSR converted to Cisco core network devices before this phase began
  - Implemented Cisco 3925 routers instead of the Huawei routers in the first phase
  - Utilize Cisco certified network engineers on staff

Generators

- Advertised in industry magazine to solicit vendors
- Generators needed to work with current transfer switches where possible
- Sized for 25% capacity growth
- Needed a minimum of 3 alarm contacts (generator run, loss of AC power, fail to start)
- Outdoor model (current indoor units overheated and were starved for oxygen if building ventilation failed)
- We had used Generac back up power systems in the past and were happy with the units

Generators

Generators replaced



New Generac QT025A 25kW

Installation

- A site package, containing all necessary equipment, hardware, and drawings was created and delivered to each location to assist technicians during the install and cutover
- All cabling, power connections, and grounding terminations were completed before equipment was put in service
- Racks were staged at field locations to minimize down time
- Utilized diversity antennas during cutover
  - One set of antennas used for the legacy radios, second set used for new radios
  - Kept the legacy microwave in service until cutover complete

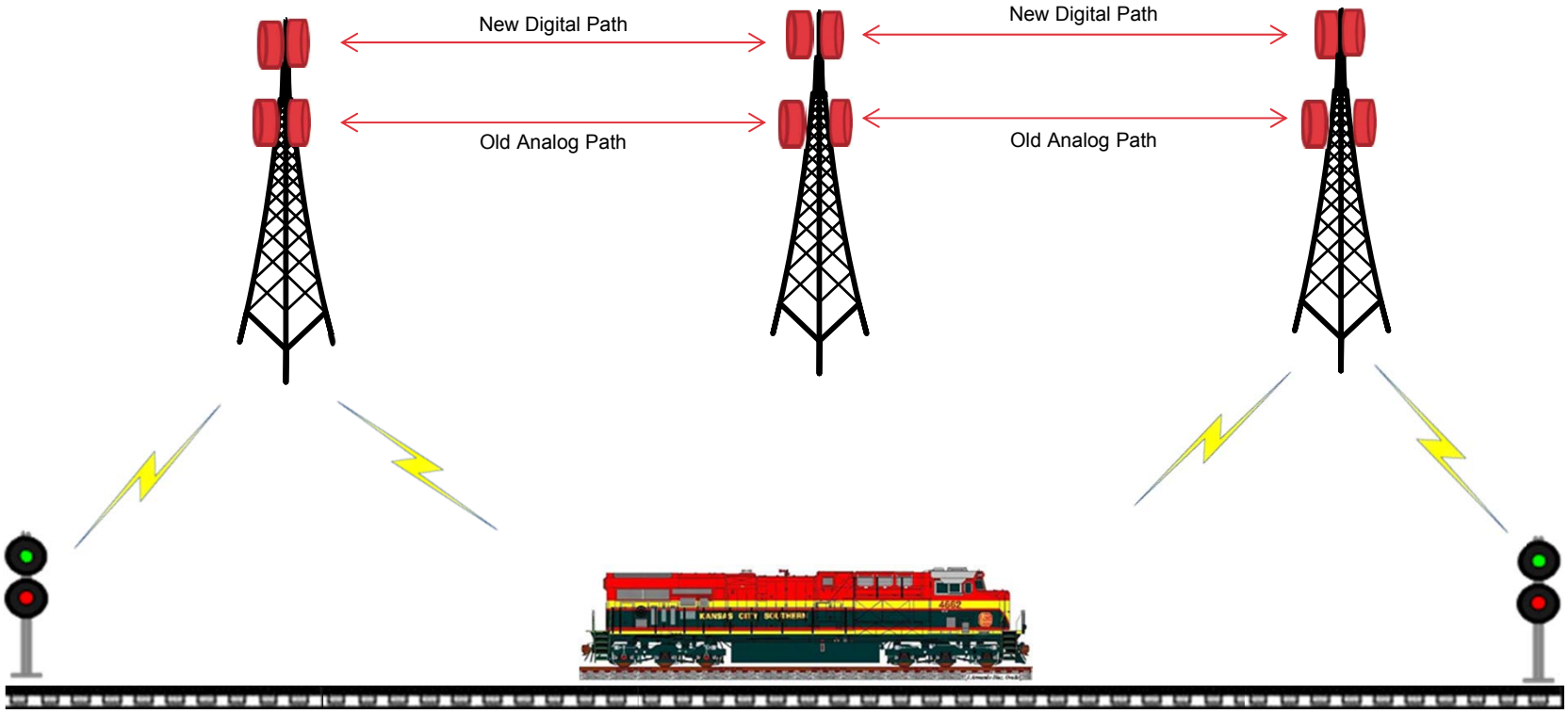
Installation

- Equipment configured and tested in lab environment
- Equipment racks were built in central office

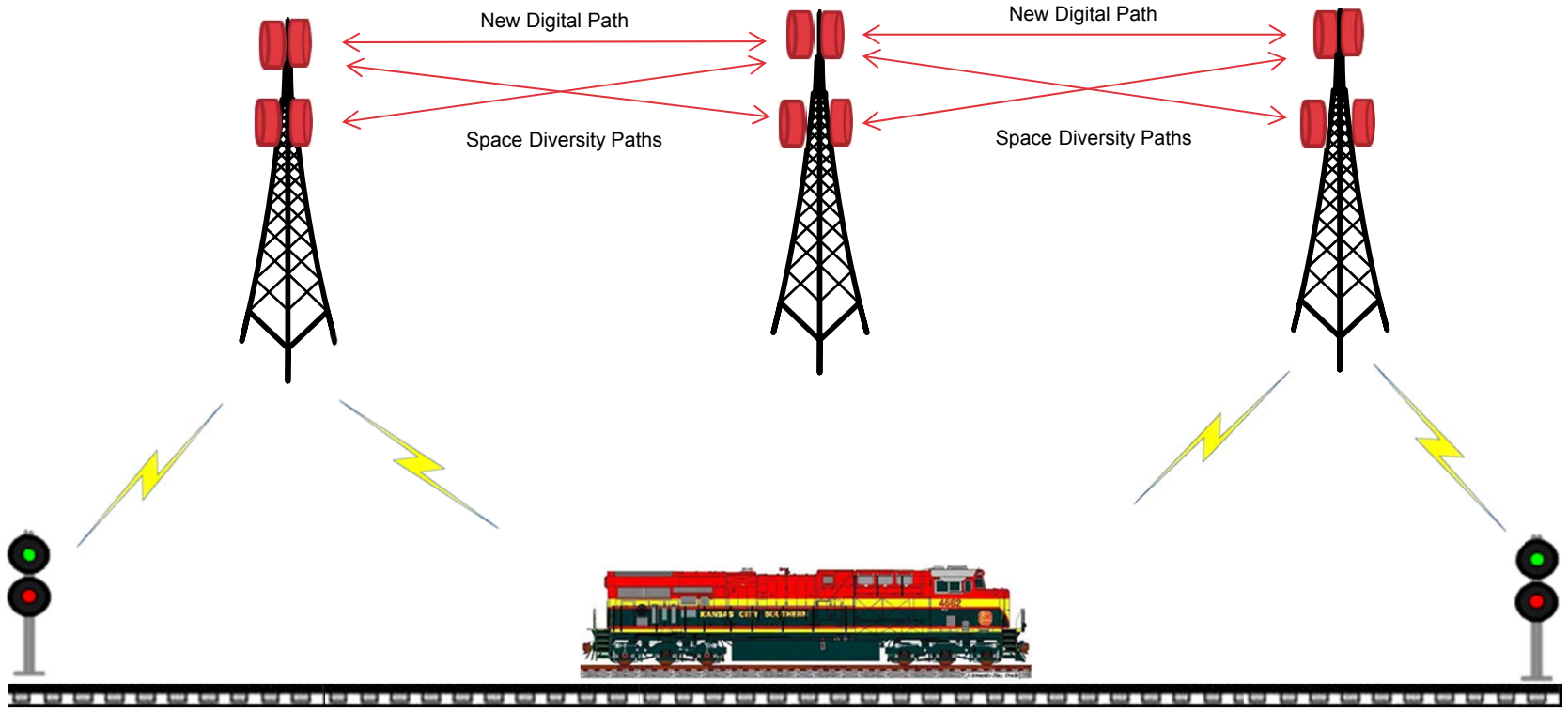
Site Deployment

- Ceragon IP-10 radios
- 1 + 1 HSB configuration

Antenna Configuration During Cutover

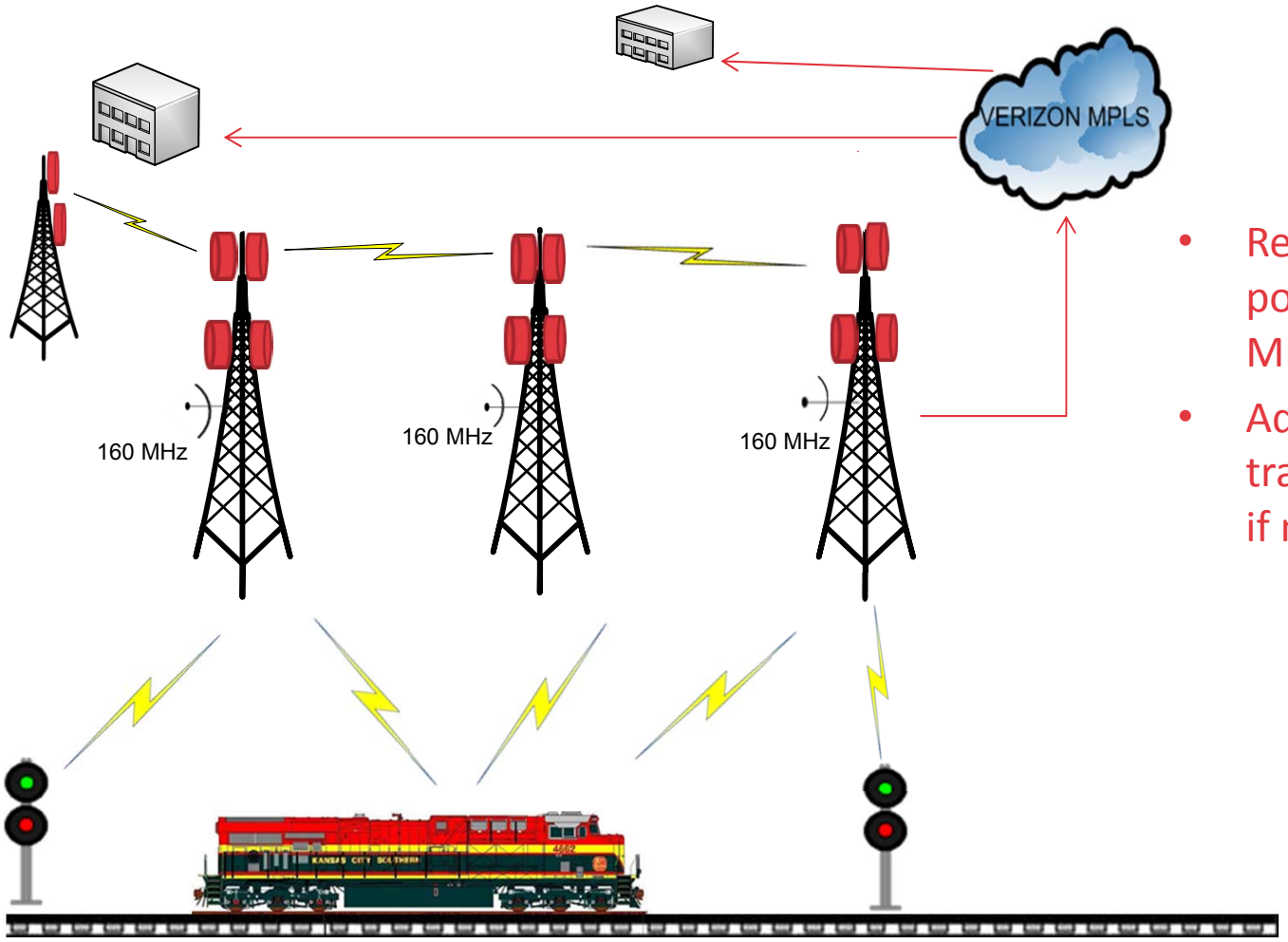


Space Diverse Configuration Post Cutover



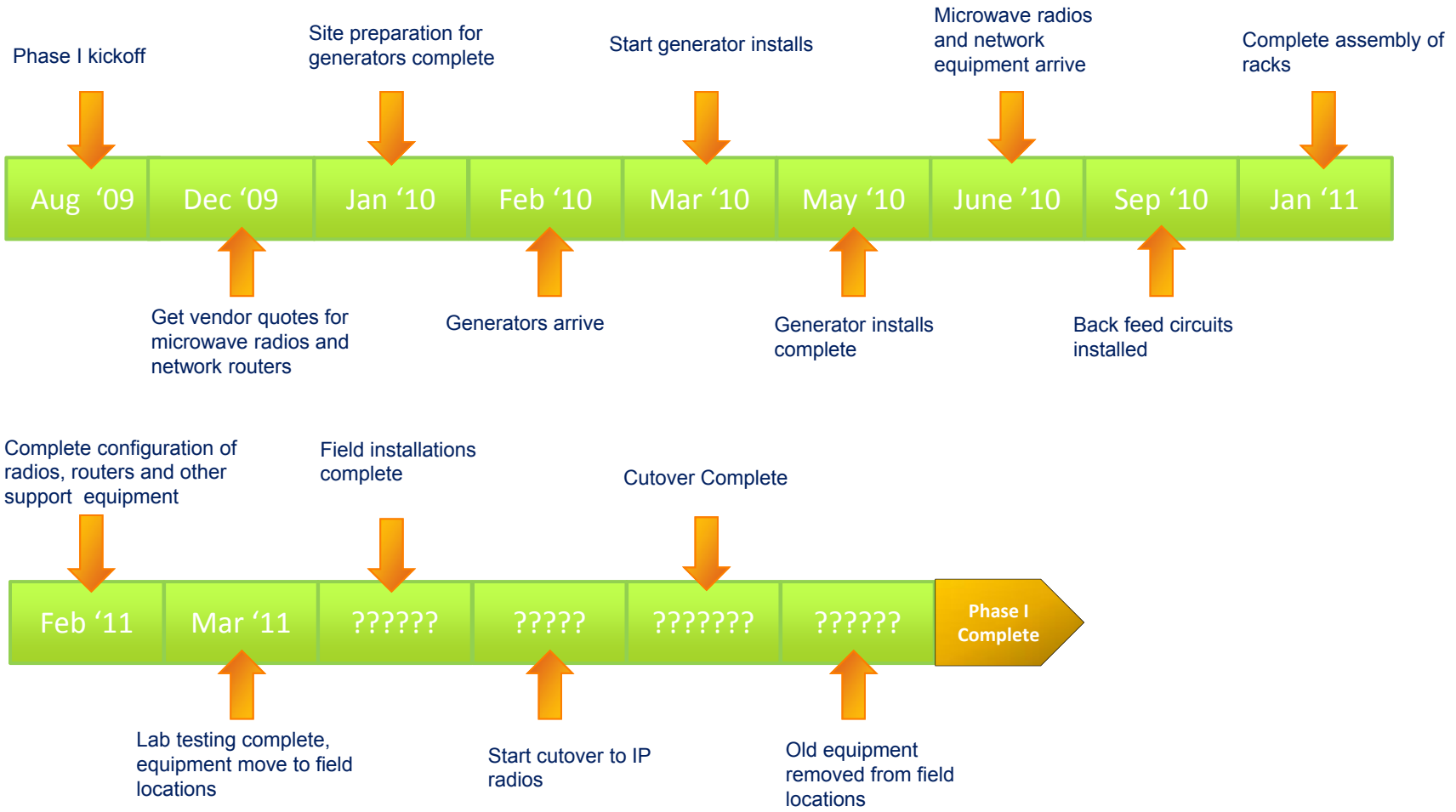
Tower with space diverse antennas

IP Communications backbone - Microwave

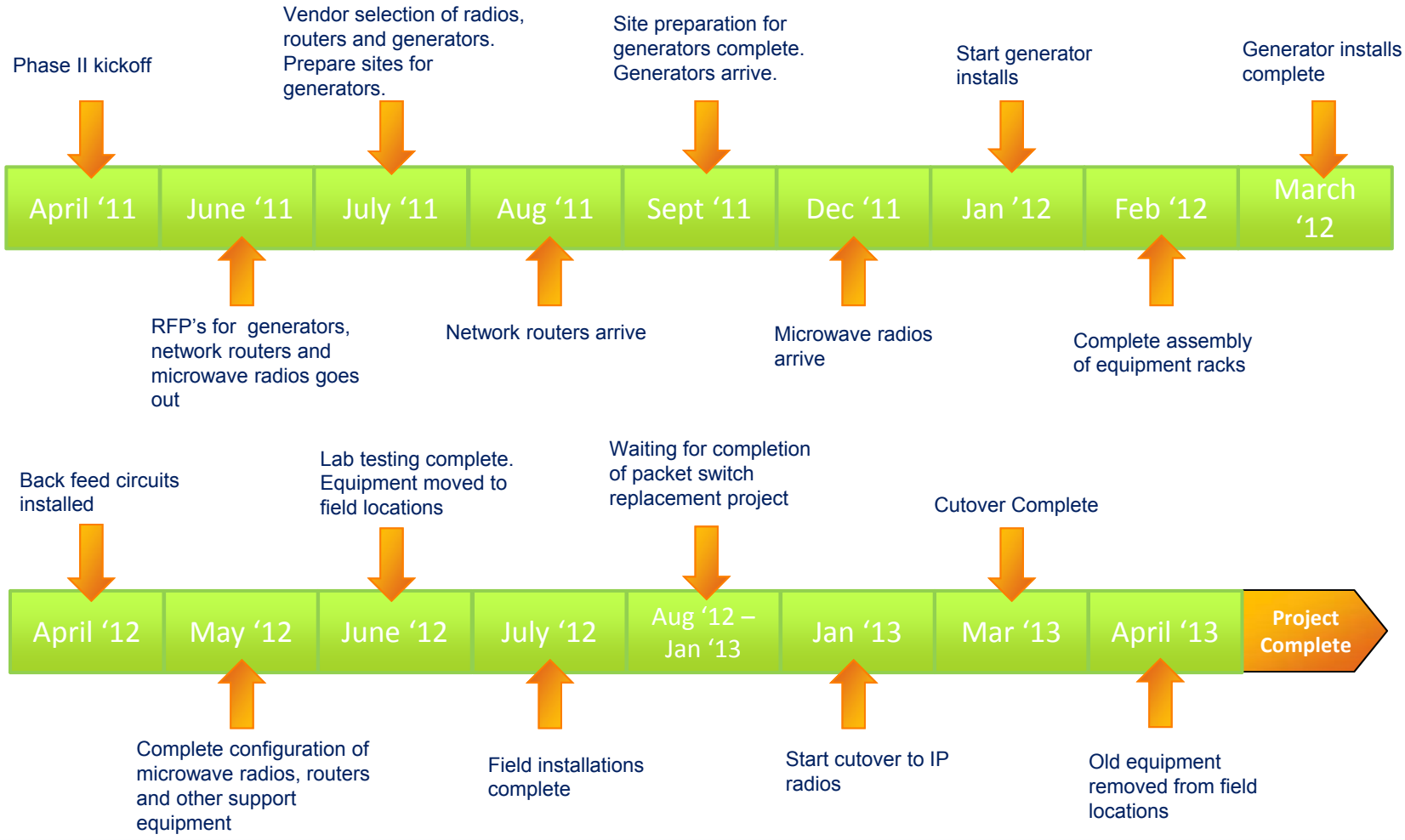


- Replaced the T1 point to point back feed circuit with MPLS
- Added flexibility for routing traffic to multiple locations if needed

Phase I Timeline



Phase II Timeline



Lessons Learned

- Gained an understanding of Ethernet microwave radios
  - Reduced latency
  - Better bandwidth utilization
  - Scalable
- Realized that the data network had to be prepared so it could handle “communications” traffic
- Gained an understanding of dynamic routing (OSPF). Before this project we only used static routing in the network.
- Realized the importance of getting design help from data network engineers. Didn’t have adequate network engineering support on the first phase.

Lessons Learned

- Not all legacy equipment that had to say on-site was IP capable and not all vendors offer IP solutions
- Had to design interfaces between some legacy equipment and new IP radios
- Had to learn new diagnostic and trouble shooting techniques
- Network Engineering and Communication Engineering teams have to work more closely together
- New radios are IP devices on the network, have to become more security aware