COMMUTERLINK

DIXIE REGIONAL COMMUNICATIONS STUDY
(DRAFT)

Prepared for:

State of Utah
Department of Transportation

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EXHIBITS

LIST OF ACRONYMS

AP	Access Point
ATMS	Advanced Traffic Management System
BLM	Bureau of Land Management
CCTV	Closed Circuit Television
DPS	Department of Public Safety
IP	Internet Protocol
ITS	Intelligent Transportation System
MPO	Metropolitan Planning Organization
PM	Project Manager
PMP	Point to Multipoint
POE	Port of Entry
POTS	Plain Old Telephone Service
PSTN	Public Switched Telephone Network
PTP	Point to Point
QMOE	Qwest Metro Optical Ethernet
SR	State Road
TCC	Traffic Control Center
TCS	Traffic Control System
TOC	Traffic Operations Center
UDOT	Utah Department of Transportation
UHP	Utah Highway Patrol
VCS	Video Control System
VMS	Variable Message Sign
WAN	Wide Area Network

1. INTRODUCTION & PURPOSE

The primary purpose of this document is to present the overall architecture and high-level design of the telecommunication system that will be used to expand the CommuterLink Advanced Traffic Management System (ATMS) into the Dixie / Saint George metro area. This includes a connection to the roadside equipment such as traffic signals, Closed Circuit Television (CCTV) cameras, and Variable Message Signs (VMS). It also includes connectivity to key transportation and public safety partners that provide service to the region.

The high-level design included in the document is based on the cumulative requirements of all agencies in the region and should be viewed as a regional system. This document should be used as a guide by those responsible for the planning, design, installation, and operation of the system.

Where possible, agency Project Managers (PM) will use this document as a reference to make sure the requirements of the regional communication system are prioritized and incorporated into all road construction projects. The remaining sections of the regional communication system will be broken into smaller projects and prioritized for consideration and funding as a standalone project.

It is important to emphasize that this is not a detailed design document, but will be used as a guide for future projects and will require the input and participation of all the agencies in the region.

2. BACKGROUND

Agencies in the Dixie region have already made a significant amount of progress on the implementation of the regional ATMS and the communication system that is required to support it. A Motorola Canopy wireless network was put in place several years ago to connect traffic signals and was later expanded to include a limited number of CCTV cameras. Fiber optic cable was later installed along Saint George Blvd (SR-34), and is being expanded to include Bluff Street (SR-18), and a large section along the east side of I-15. An overview of the fiber optic cable that is complete or under construction is included in Exhibit 1.

3. MAPS

Several maps are included in the body of this document for easy reference, but the large area covered in this report and the amount of detail makes it impractical to provide static maps for all situations. A detailed electronic map is provided as a companion document. The map is in Adobe Acrobat format (PDF) and supports layers. This allows the end user to turn layers on as needed and off to declutter the map and focus on the specific areas of interest.

4. EXISTING SYSTEM

This section provides more detail about the existing system and will provide a reference point as the system is expanded.

4.1 Field Devices

This section includes more detail about the existing roadside field devices.

4.1.1 Traffic Signal Controllers

There were 60 traffic signal controllers on the system today. That includes 17 connected by fiber optic cable and 43 connected by wireless. The existing signals are shown in green on Exhibit 1.

4.1.2 CCTV Cameras

There are 40 CCTV cameras that are on the system or under construction. This includes 35 locations that are or will be on fiber and 5 others that are connected by wireless. This includes 22 CCTV cameras located along I-15 as shown in Exhibit 2 and the remaining 18 on surface streets. All existing CCTV cameras are shown in green on Exhibit 1 and can be viewed on the layered map.

Exhibit 1 – Overview of Existing Fiber Network and Field Devices

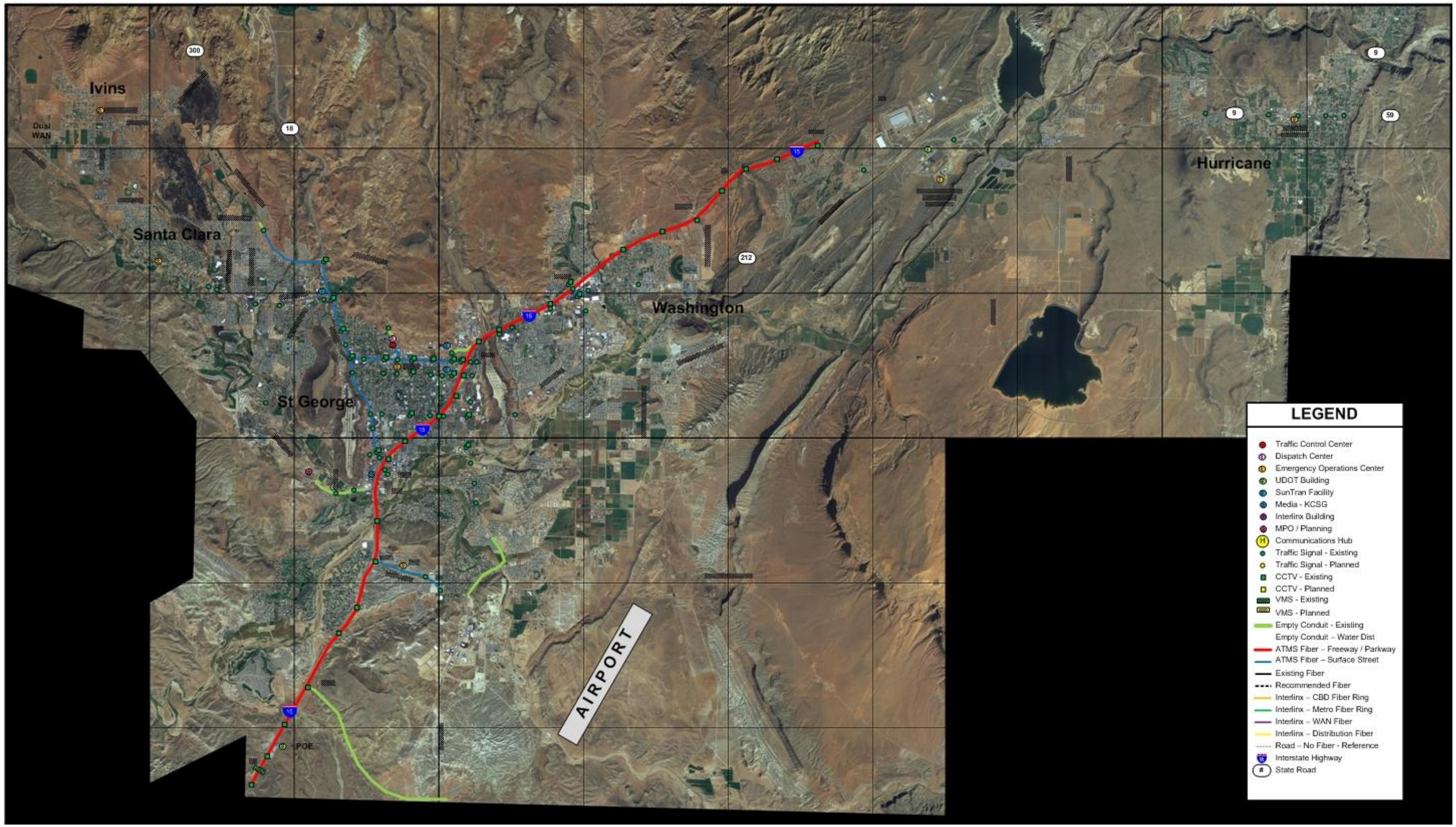


Exhibit 2 – Existing CCTV Camera on I-15 at Virgin River Bridge

4.1.3 Variable Message Signs

There are only three (3) Variable Message Signs installed or planned to be part of the system. This includes one (1) existing North Bound (NB) VMS on I-15 near the UDOT Port of Entry as shown in Exhibit 3.

Exhibit 3 – Variable Message Sign on North Bound I-15

Two (2) VMS are planned as part of future projects for I-15 near Exit 16 at SR-9. A South Bound (SB) VMS will be located just north of the I-15/SR-9 interchange and a NB VMS will be located just south of the I-15/SR-9 interchange.

4.2 Existing Traffic Control Center

The Saint George City Offices shown in Exhibit 4 is the center of the CommuterLink system in the Dixie / Saint George metro area.

Exhibit 4 – Saint George City Offices

The Traffic Control Center (TCC) shown in Exhibit 5 is located in the basement of the Saint George City Offices. The TCC is primarily used by staff at the City of Saint George, but is used to control all traffic signals, regardless of the owning agency and location within the region.

Exhibit 5 – Saint George Traffic Control Center

4.3 Existing Computer Center

In addition to the role as a Traffic Control Center, the Saint George City Offices are also used as a computer center to house the servers used for the Video Control System (VCS) and the i2TMS Traffic signal Control System (TCS). While this equipment is in the same building as the TCC, this is an independent function and could be located anywhere on the system.

4.4 Existing Communication System

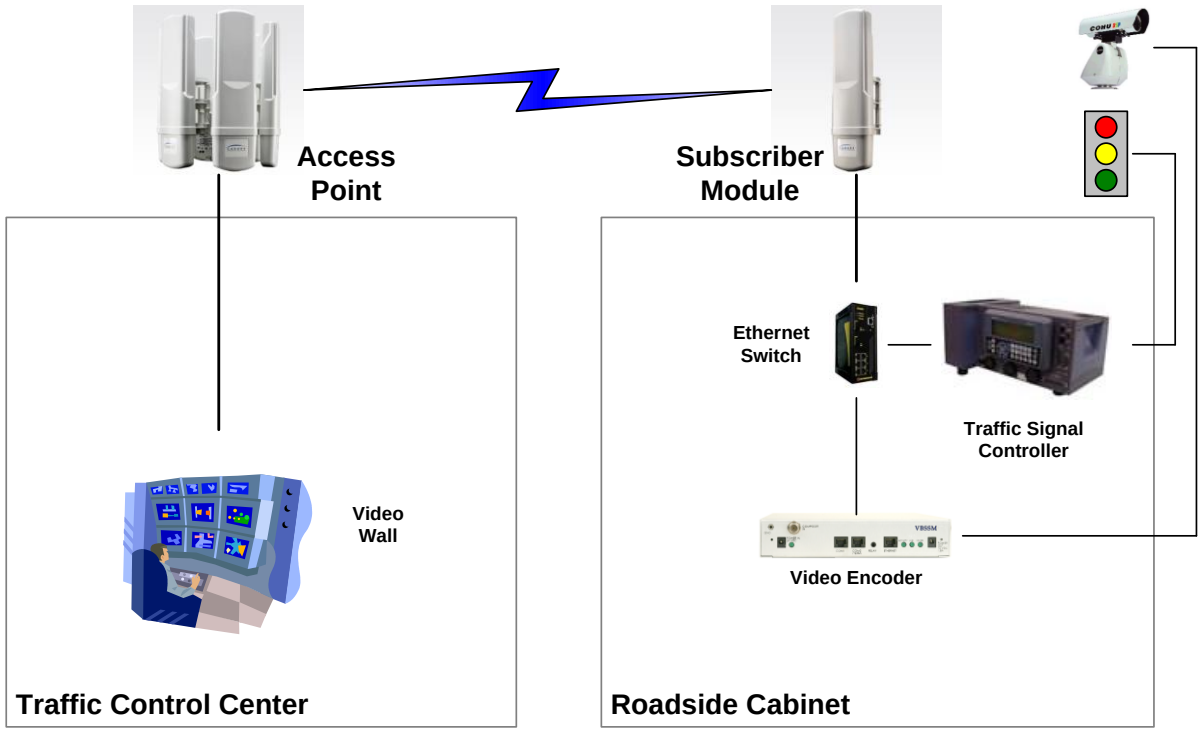
This section provides more detail about the existing communication system.

4.4.1 Motorola Canopy Wireless Network

As mentioned in previous sections, a radio system was put in place several years ago to provide connectivity to the traffic signals in the region and was later expanded to include a limited number of CCTV cameras. This system was setup in a Point-to-Multipoint (PMP) configuration with the primary radios, also know as Access Points (AP), located on the radio tower at the Saint George City

Hall. A small Subscriber Module (SM) is located at each device. The tower is shown in Exhibit 4. Where more than one device is located within the same cabinet, an Ethernet switch is installed as shown in Exhibit 5. While not shown, repeaters have been setup in some areas to expand and improve coverage.

Exhibit 6 – Radio System Overview



The current system is based on Motorola Canopy radios operating in the 5.2 GHz and 5.7 GHz unlicensed bands. While the wireless system has provided basic connectivity for several years, agencies have complained about interference as other operators have installed new systems in the area. The wireless network has required a significant amount of work to keep it operational.

4.4.2 Fiber Optic Network

Agencies have moved ahead with plans to install fiber optic cable where possible and when budget was available. This includes a 16 miles section along I-15 as shown during construction in Exhibit 7.

Exhibit 7 – Trench for Fiber Optical Cable along I-15

The fiber optic cable on I-15 was done in two (2) parts. The first section from milepost 0-10 included eight (8) conduits. In the past, this arrangement of conduit was designated as "2D" on the plan sets. The second section of conduit from milepost 10-16 only included four (4) conduits or "1D" as shown in the Exhibit 8 below.

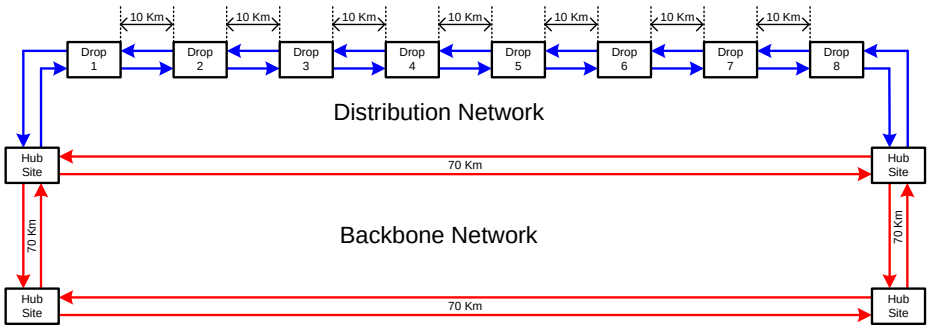
Exhibit 8 – "1D" Conduit on I-15

In addition to the conduit, boxes, and fiber optic cable, a field hardened Ethernet, such as the Ruggedcom RS900 shown in Exhibit 9, is installed at each cabinet location. This equipment provides six (6) Unshielded Twisted Pair (UTP) interfaces for devices such as traffic signal controllers, video encoders, or a laptop computer for troubleshooting in the field.

Exhibit 9 – Field Hardened Ethernet Switch

Two (2) Single Mode Fiber (SMF) interfaces provide connectivity between cabinets or to the nearest communication hub as shown in Exhibit 10.

Exhibit 10 – SMF Ports to Hub or Other Cabinet



4.5 Existing Communications Hub (Fiber)

In addition to the other roles described in this document, the Saint George City Office Building is also used as the only fiber communications hub in the Dixie area. Fiber along Saint George Blvd (SR-34) is not only used to connect local traffic signals, but is also used to extend service to devices along Bluff Street (SR-18) and the devices on the sixteen-mile section of I-15.

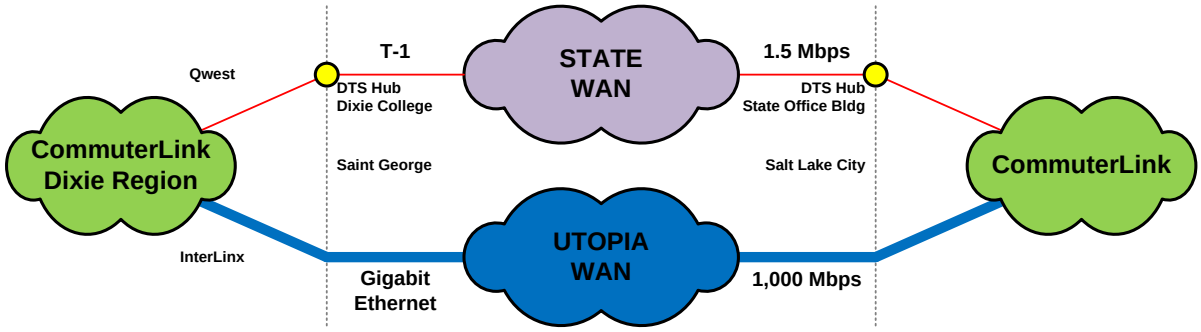
4.6 Existing Communications Hub (Wireless)

As described in earlier sections, the radio tower on the Saint George City Office Building is used the primary communication hub for the wireless network.

4.7 Wide Area Network

A Wide Area Network (WAN) has been setup to provide connectivity between the Saint George City Offices and the TOC in Salt Lake City as shown in Exhibit 11.

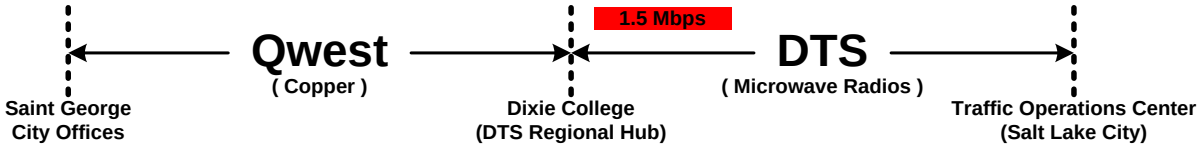
Exhibit 11 – Existing Wide Area Network



4.7.1 State Microwave Network (T-1)

A low-speed T-1 (1.5 Mbps) circuit was added between the Saint George City Offices and the Traffic Operations Center in Salt Lake City. The circuit is provided thru UDOT's agreement with State DTS and indirectly thru their contract with Qwest. The local T-1 circuit is provided by Qwest and is used to connect to the Region Hub at Dixie College operated by State DTS. The T-1 is then extended across the State microwave network to the TOC as shown in Exhibits 11 & 12.

Exhibit 12 – State Microwave Network (T-1)

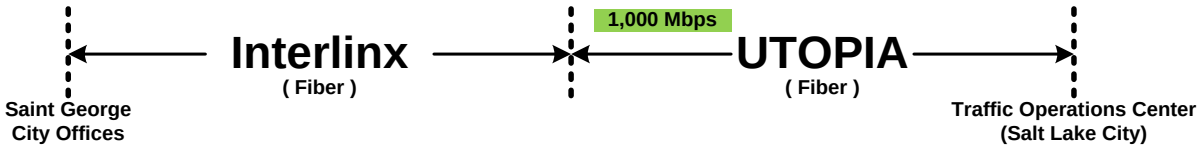


The T-1 circuit is limited to 1.5 Mbps of bandwidth which is barely enough capacity to support a few low bit rate MPEG-4 video streams and limited access to the TCS.

4.7.2 UTOPIA / Interlinx (Gigabit Ethernet)

A high-speed Gigabit Ethernet (1,000 Mbps) circuit was recently added between the Saint George City Offices and the Traffic Operations Center in Salt Lake City as shown in Exhibit 13. The circuit is provided thru UDOT's agreement with UTOPIA and indirectly thru their agreement with Interlinx.

Exhibit 13 – UTOPIA / Interlinx (Gigabit Ethernet)



The Gigabit Ethernet circuit supports 1,000 Mbps of bandwidth and is enough capacity to support all the cameras in the Dixie area and provide real-time access to the i2TMS traffic signal control system.

5. COMMUNICATION REQUIREMENTS

In summary, the communication system should connect each element that is part of the system. That includes the roadside devices and each facility that is part of the system as shown later in Exhibit 14. The requirements for the communication system are described in more detail in the following sections.

5.1 Support for Existing Communications Architecture

All requirements for the Dixie Region are based on the current architecture for the CommuterLink system. This includes standards such as the Internet Protocol (IP) and Ethernet. This document does not include all the detail that would be part of a procurement specification.

5.2 Roadside Devices

The communication system should support all the current and planned roadside devices that are part of the system. That includes traffic signal controllers, CCTV cameras, and VMS signs. These devices are shown in Exhibit 14. The specific device requirements for the Southern Parkway and the Western Corridor have not been finalize at this time. CCTV cameras are shown along the Southern Parkway but are subject to change. At a minimum, it is expected that the system should support traffic signals and CCTV cameras at each of the interchanges. The spacing and placement will be finalized later. The unique requirements for each type of device are included in the following sections. Again, the following requirements focus on the type of device, not the specific location.

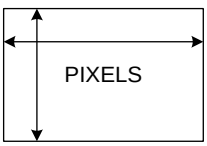
5.2.1 Traffic Signal Controllers

The communication system should be capable of supporting the once per second polling of the traffic signal controllers. In most cases, the connection to the controller is thru a serial cable or Ethernet port. In order to support the requirement to upload and download information in a timely manner, it is recommended that a connection be setup for data rates higher than 56 Kbps.

5.2.2 CCTV Cameras

This section provides more detail about the communication requirements for a CCTV camera. This includes details about the resolution, frame rate, latency limitations, and supporting requirements such as IP multicast. These requirements apply to the entire communication path from the roadside camera to the video display that will be located in each facility such as a public safety dispatch center.

5.2.2.1 Resolution



The communication system should be capable of supporting high-resolution (4SIF or D1) NTSC video. It is important to note some older equipment such as the VBrick MPEG-4 encoders are not able to support this resolution. However, the newer Teleste encoders meet this requirement.

5.2.2.2 Frame Rate

Where possible, the communication system should be cable of supporting 30 Frames Per Second (FPS) in an urban area and at least 1 FPS in a rural area.

5.2.2.3 Latency

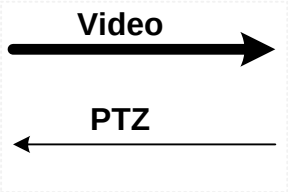
In order to maintain accurate PTZ control, the end-to-end latency should not exceed 500 ms. This includes the time for compression at the encoder, transport across the IP/Ethernet network, and decompression at the decoder. For remote areas that may require the use of a lower performance network, it may be necessary to use camera presets to compensate for the higher latency.

5.2.2.4 Data Rate

The data rate will change based on the resolution, frame rate, and compression used. Previous experience has shown the system should support a minimum of 256 Kbps in the upload direction from the camera. However, the system should be designed to support higher quality video when possible with support for 1-2 Mbps.

5.2.2.5 Duplex Mode

Video from the roadside cameras is compressed and transported over the IP/Ethernet network in a continuous stream of small packets. While the majority of the traffic is in the upload direction from the camera into the network, it is still necessary to support the bidirectional flow of IP packets for PTZ control and other utility functions such as software upgrades. Streaming video works best in a network that support full-duplex communications so that video can flow without any interruption.



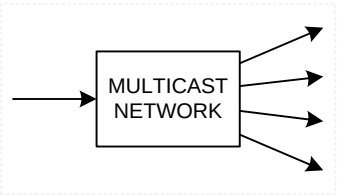
It is possible to use a half-duplex communication system and still support streaming video and PTZ functions without packet loss. Video can be buffered by the encoders and decoders to better handle the continuous interruption of packet flow on the network. The buffering adds latency and lowers the responsiveness of the PTZ control, but if done properly, can still support streaming video.

The use of streaming video in a Point-to-Multipoint (PMP) wireless network only exaggerates the problems since transmit time is not only divided between upload and download, but is divided again as time is allocated between all the sites. Point-to-Multipoint networks should be used as a method of last resort for all streaming video applications. The use of JPEG still images would be a more appropriate way to get road conditions when a full-duplex network is not available.

When possible, the communication system should support a full-duplex connection from all CCTV sites. When this is not possible, half-duplex networks should be limited to a Point-to-Point configuration.

5.2.2.6 Multicast

Video from a roadside camera can be viewed at multiple locations by using IP multicast. The replication of the stream is actually handled inside network equipment such as Ethernet switches and IP routers instead of using a PC or server.



Multicast is considered by most to be one of the most efficient and cost effective ways to replicate and distribute video on an IP/Ethernet network and is the standard used on the CommuterLink system today. The communication system implemented in the Dixie Region should support IP multicast from the roadside cameras to the video displays.

5.2.2.7 MPEG-4

The video from the camera should be digitized and compressed using MPEG-4 in order to maintain compatibility with the existing system and facilitate the exchange of video with other agencies. Older MPEG-2 encoders should not be used.

5.2.3 Variable Message Signs

The communication requirements for a Variable Message Sign are very basic. In most cases, communication to a VMS is only needed when a message is changed. The limited amount of data makes it possible to use a dial-up telephone line or other low-speed network such as a CDMA modem. If an always-on connection is available, the VMS can be polled on a regular basis to provide real time status updates. The bandwidth requirements are typically <9600 baud and latency and jitter are not a significant concern.

It is important to note that in most cases a CCTV site is placed in front of the VMS to provide a visual verification of the status of the sign. The communication requirements for a CCTV camera are included in previous sections.

5.3 Traffic Control Centers

This section provides more details about the requirements for each of the Traffic Control Centers.

5.3.1 General Communication Requirements

This section includes general communication requirements that apply to all Traffic Control Centers that are part of the CommuterLink system.

5.3.1.1 TCC Video Requirements

The communication system should support the ability to view high quality video from at least four (4) cameras at the same time and should support PTZ control from a computer workstation running a VCS application. Each TCC should be connected to at least one communications hub described later in this document and should be capable of supporting at least a 10 Mbps connection per user workstation. While it is possible to use a half-duplex radio to connect an individual CCTV camera site, a full-duplex connection should be used for all traffic control centers.

5.3.1.2 Traffic Signal Control System Access Requirements

The communication system should support the ability to access the i2TMS traffic signal control system from a computer workstation. Since this application is designed to operate in a LAN environment, a minimum of a 10 Mbps connection is required all the way from the server to the computer workstation. In many cases the server may be located in the same building, but it is possible to install the server at a any of a number of locations in the Dixie region. For example, the server could be located at Saint George City Hall and accessed from the UDOT Traffic and Safety office.

5.3.1.3 ATMS Workstation Requirements

The communication system should support the ability to access the TransSuite server used for camera PTZ control and control of other devices such as a VMS. This application is also designed for a LAN environment, so a 10 Mbps connection is recommended for the complete path from the server to the computer workstation. The server may be located in the same building, but like other servers it could be located at any of a number of locations in the Dixie region.

5.3.2 Saint George TCC

The Saint George TCC is currently an integral part of the system in the Dixie area. No additional connectivity is required for this role as a TCC. It is worth noting that changes are recommended for this site if it is to continue to serve in another role described elsewhere in this document.

5.3.3 UDOT Richfield District / Region Offices

The system should be available at the UDOT offices in Richfield. The connection to the TOC will also provide access at the Richfield offices so no additional connectivity is required for this site.

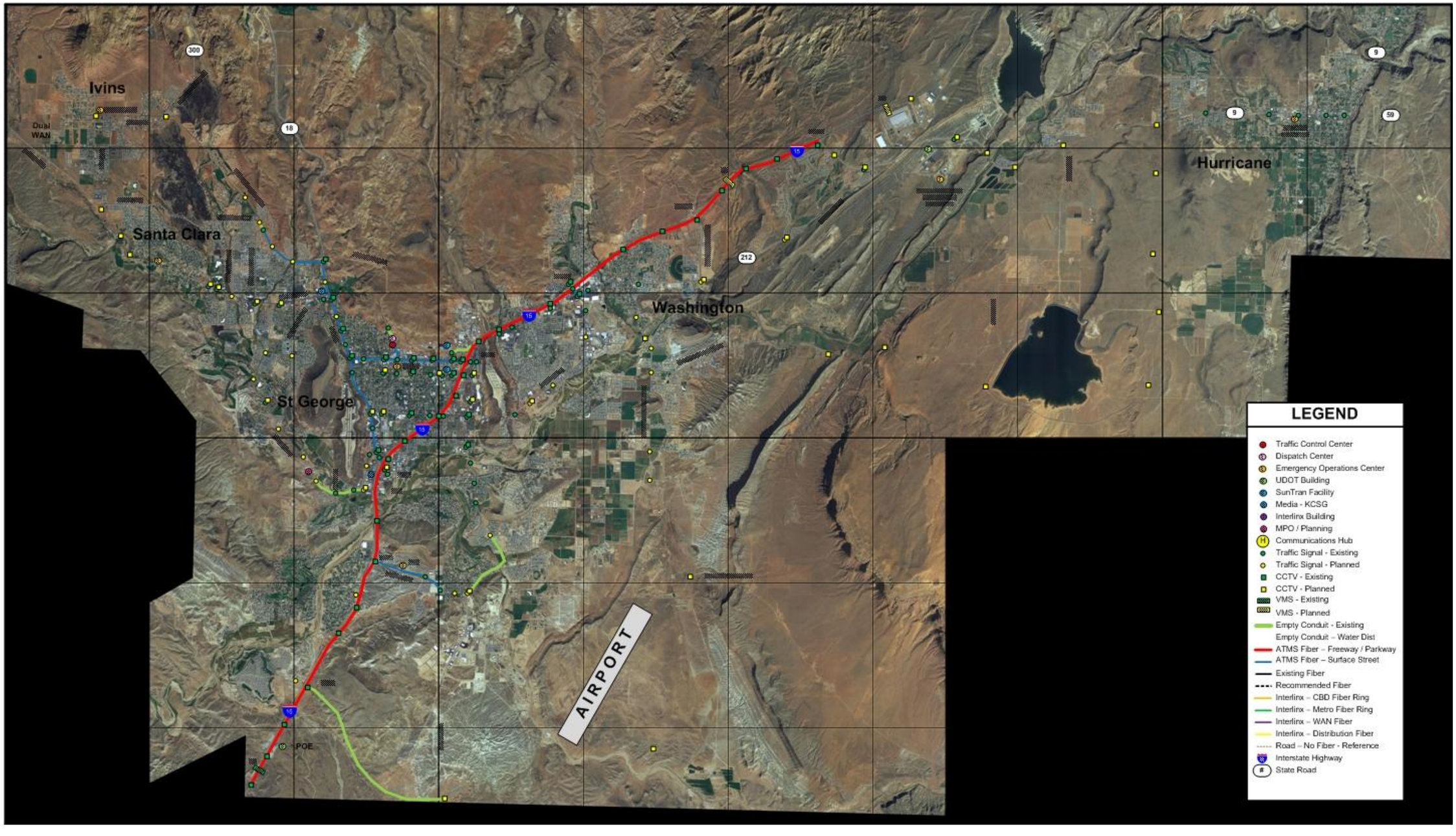
5.3.4 Statewide TOC

The system should be available to the operations staff at the TOC in Salt Lake City. The existing gigabit Ethernet connection meets this requirement. No additional connectivity is required for this site.

5.4 Dixie Regional Computer Center

Access to the servers used to host the applications for the CommuterLink video control system and i2TMS traffic signal control system are critical to the operation of the ATMS in the Dixie region and will be used during emergencies. In order to make sure these systems are available at all times, they should be located in a computer center or similar facility designed for that purpose. The computers should also be connected to the communication network thru two other points such as a communication hub. The site should be connected by a high-speed agency network such as agency owned fiber optic cable. The fiber should enter the building thru two different building service entrances and should have a primary and backup power source such as a diesel generator.

Exhibit 14 – Overview of Communication System Requirements



5.5 Public Safety Dispatch Centers

The CommuterLink system should be extended to each of the Public Safety dispatch centers that provide service to the region. This includes those with offices in the region or others with offices at remote sites. These sites are identified in the following sections.

5.5.1 Saint George Police Dispatch

The Saint George Dispatch Center is already connected to the Saint George City Offices by fiber optic cable. No new fiber connectivity is required at this time, but it will be necessary to add other equipment at this site in order to view CommuterLink video. The requirements for the communication network do not change for PTZ control and can be determined at any time. This center is the primary PSAP for the majority of Washington County.

This facility has an existing cable television network that can be used to distribute video to other sections of the building if needed. Current plans include the installation of multiple video decoders and composite video modulators that will allow CommuterLink video to be combined with other programming and viewed on any television in the building with an integrated tuner.

There are actually four (4) video displays in the dispatch center. There are two located on each side of the clock shown in Exhibit 15. There are only three (3) displays shown in the picture with one just outside of the field of view. The far right monitor will be dedicated to CommuterLink video once it is available. All of the displays have an integrated tuner and can be used to display CommuterLink video if necessary.

Exhibit 15 - Saint George Dispatch Center (911 PSAP)

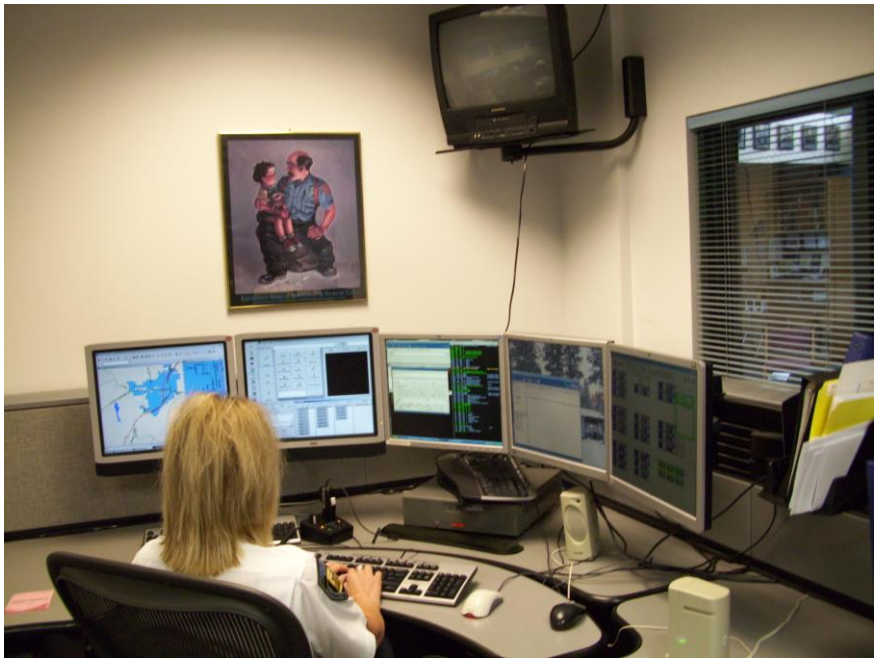
5.5.2 State Department of Public Safety (Cedar City)

The Utah Department of Public Safety (DPS) provides dispatch services to all state agencies in the Dixie area, including the Utah Highway Patrol (UHP) and UDOT. The dispatch center is collocated with the Iron County Sherriff at 2130 North Main Street in Cedar City as shown in the Exhibit 16.

Exhibit 16 – State Dispatch Center at Iron County Sheriff's Office

Video from the CommuterLink system should be extended to this facility. Decisions related to PTZ control do not have an impact on the requirements of the communication system. Video should be available on the video monitor shown in Exhibit 17.

Exhibit 17 – Video Display at DPS Dispatch in Cedar City



5.6 Emergency Operations Centers

According to local officials, fires and floods are among the biggest problems faced by emergency responders in Washington County each year. Federal, state, and local government agencies have established a number of Emergency Operations Centers (EOC) that are activated to deal with large scale problems such as the fire shown in Exhibit 18 along I-15 near the Blue Springs exit.

Exhibit 18 – Fire near I-15 near Blue Springs Exit

Large-scale emergencies such as the flooding shown in Exhibit 19 and fires shown above are not only a significant threat to human life, but they can have a significant impact on both commercial truck traffic and other travelers because of freeway closures. It is important to get accurate and timely information to those who are responsible for managing this type of emergency.

Roadways and bridges are important assets because they provide an evacuation route for those people in the area and also provide a way for emergency responders to get to the area with heavy equipment.

Exhibit 19 – Flooding in Santa Clara (2005)

Washington Diversion Dam, Santa Clara, UT – 01/10/2005

Santa Clara River, UT – 01/12/2005

The cameras located along I-15 such as the own shown in Exhibit 20 are normally used by transportation and public safety agencies to manage incidents along the freeway, but may also provide a way to keep a close watch on rising water levels during an emergency such as a flood.

Exhibit 20 – Camera on I-15 for Traffic Management & Flood Monitoring

5.6.1 Utah Division of Homeland Security (State Office Building)

The Utah Division of Homeland Security, formerly known as Comprehensive Emergency Management (CEM), has a large EOC located in the basement of the State Office Building. This center is already connected to the CommuterLink system has access to all cameras on the system. Video from the Dixie area will be available thru the existing connection. No additional work is required to connect this facility shown in Exhibit 21, but is provided for clarity.

Exhibit 21 – State Division of Homeland Security at State Office Building

5.6.2 BLM Interagency Operations Center (Saint George)

The Bureau of Land Management (BLM) offices in Saint George are used as an Interagency Operations Center for the management of wild fires. This facility is currently located on Riverside Drive in the building shown in Exhibit 22.

Exhibit 22 – BLM Interagency Operations Center in Saint George (Existing Site)

The BLM is considering a move to the current site used by the UDOT maintenance station shown in Exhibit 23 below. UDOT will be moving to a new site along SR-9 near 5300 West and is described in more detail in other sections.

Exhibit 23 – UDOT Maintenance Station 521 (Current Location)

There is an existing fiber route along Brigham Road that could be used to connect to a building at this site. If the BLM moves to this site, the building construction should include the installation of conduit to the nearest CommuterLink splice point. Fiber should be installed to support the display of video. Decisions related to PTZ control do not impact the design of the communication system.

5.6.3 Color Country Interagency Fire Center (Cedar City)

In addition to the BLM offices described above, a network connection should be extended to the Color Country Interagency Fire Center located in Cedar City. Details of this connection are not available at this time, but should be included in projects for Cedar City.

5.6.4 Washington County Administrative Offices (197 East Tabernacle)

The CommuterLink system should be extended to the Washington County Emergency Operations Center located in the basement of the County Administration Building at 197 East Tabernacle in Saint George and is shown in Exhibit 24 below.

Exhibit 24 – Washington County Administrative Offices

Video will be displayed in two areas of the EOC. A video display will be mounted by the County in the center of the north wall shown in Exhibit 25 below. The adjacent room has a video projector.

Exhibit 25 – Washington County's Primary EOC

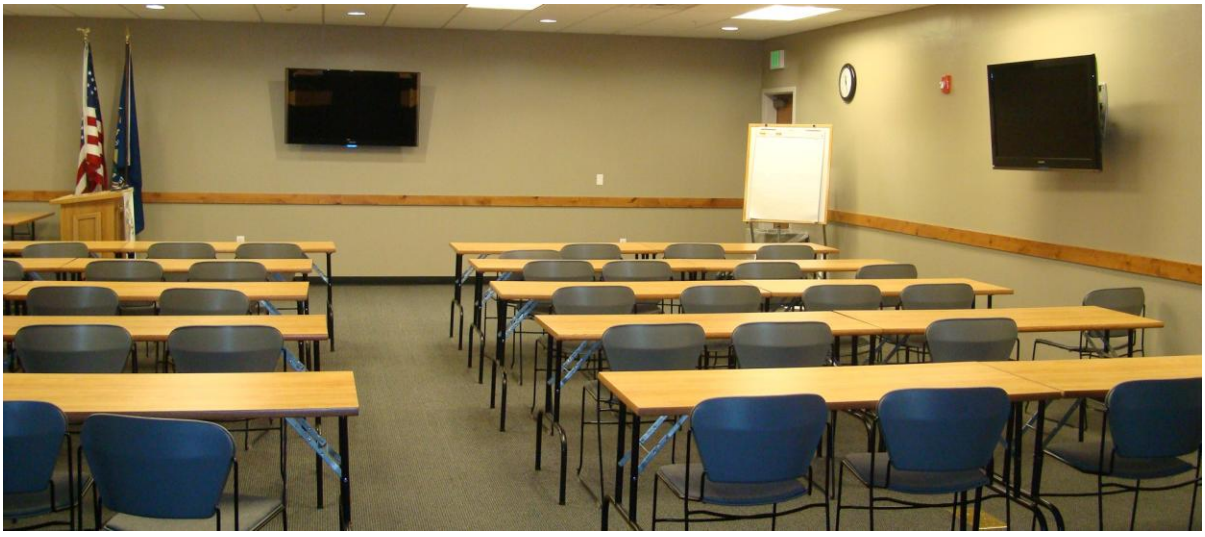
5.6.5 Washington County Sherriff's Office Administrative Offices (SR-9)

Washington County has a secondary EOC located in the Sheriff's Office Administration Building shown in Exhibit 26.

Exhibit 26 - Washington County Sheriff's Office Administration Building (SR-9)

The primary EOC is only activated for major emergencies, but this facility is used on a regular basis for smaller events. This facility is located a short distance from the new UDOT maintenance station on SR-9 at 5300 West and is located next to an existing conduit route installed by the Water District as described later in this document. Video should be available on the displays shown in the Exhibit 27. The County also has an existing video distribution system.

Exhibit 27 – Emergency Center in the Sheriff's Office Administration Building.



5.6.6 Hurricane Police Department

The Hurricane Police Department is located next to SR-9 at 700 West and is shown in Exhibit 28. This facility was recently purchased by the City of Hurricane and is the City's primary Emergency Operations Center. The entire building has backup power from a new diesel generator.

Exhibit 28 – Hurricane Police Department & EOC

Video from the CommuterLink system should be extended to this facility when fiber is installed along SR-9. The City has already installed a vault at SR-9 in anticipation of this connection. More detail is shown in Exhibit 29.

Exhibit 29 – Fiber Vault on SR-9 for Hurricane Police Department

5.6.7 Santa Clara Town Hall

Santa Clara has an EOC located in the Town Hall building shown in Exhibit 30.

Exhibit 30 – Santa Clara Town Hall & EOC

Like other EOCs in the Dixie area, this facility should be connected to the CommuterLink system.

5.6.8 Ivins City Hall

City Hall shown in Exhibit 31 is the used as the command center for all emergencies in Ivins. Existing conference rooms are used as an EOC. The City has plans to build a larger facility near 200 East Center Street. The new site is vacant at this time so no pictures are included. The new facility is located in the center of a new business district. The City of Saint George is planning a large construction project along Center Street in Ivins for the installation of a new water line. The City of Ivins also has a planned project for 200 East and would be the ideal time to connect the new City Hall to the CommuterLink system.

Exhibit 31 – Ivins City Hall & EOC

5.7 Transit (SunTran)

SunTran provides transit services in Saint George and has several key facilities in the area. These facilities are all located next to existing or recommended fiber routes and should be connected to the CommuterLink system. More detail is provided in the following sections.

5.7.1 SunTran Administration Offices (900 East Redd Cliff Parkway)

SunTran has plans to build a new Administration Building near 900 East on Red Hills Parkway. This facility should be connection to the system and is shown in Exhibit 32.

Exhibit 32 – Rendering of New SunTran Administration Building

5.7.2 SunTran Transit Center (700 East 100 South)

The Transit Center shown in Exhibit 33 should be connected to the new Administration Offices using dedicated fiber strands. Any access to the CommuterLink system at this site will be thru the Administration Offices described in the previous section.

Exhibit 33 – SunTran Transfer Station

5.7.3 SunTran Transfer Station (Bluff Street / Sunset Blvd)

The Transfer Station should be connected to the new Administration Offices using dedicated fiber strands. Any access to the CommuterLink system at this site will be thru the Administration Offices described in the previous sections.

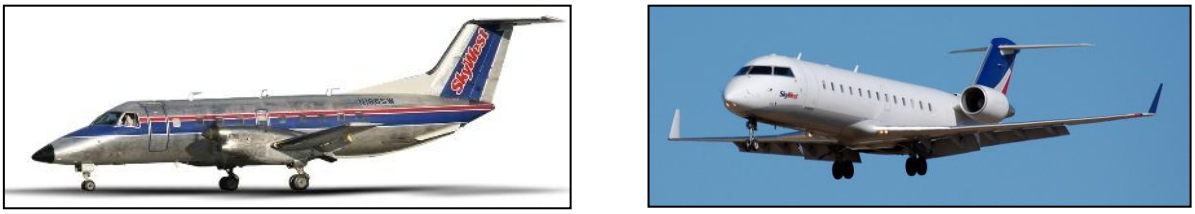
5.8 Saint George Replacement Airport (SGU)

The existing Saint George airport, shown in on the left side of Exhibit 34, is scheduled for replacement in 2011 with construction well underway at the new site just off of the new Southern Parkway as shown on the right.

Exhibit 34 – Saint George Airport

SkyWest Airlines has regularly scheduled flights to Salt Lake City using Brasilia EMB120 ER aircraft with capacity for 30 passengers. The replacement airport was designed to handle the larger Canadair Regional Jets such as the one shown on the right side in Exhibit 35.

Exhibit 35 – Skywest Aircraft



The $123 million project is being funded by the FAA and is being built on a 1,203 acre site with a 9,300 ft runway that can be expanded to 11,500 ft as required in the future. The project also includes a 34,000 square foot, two-story terminal as shown in Exhibit 36.

Exhibit 36 – Airport Terminal Building

The replacement airport is an integral part of the regional transportation system and should be connected to CommuterLink. Once completed, the new Southern Parkway will be the primary link between the replacement airport and the surface transportation network. Conduit has already been installed on segment 1 of the Parkway and will be continued on segment 2. New conduit should also be included in the airport access road with a secondary conduit entrance on the northern access road.

5.9 Media

The media provides traffic reports to the traveling public and are considered an important CommuterLink partner. While low resolution video is sufficient to get and report traffic conditions, the television stations like full motion, high-resolution video for broadcast over the air. The system should provide full motion video if practical and the ability to select video using the media interface.

5.9.1 KCSG

KCSG is the only television station that broadcasts from the Saint George area. The system should include a connection to their new broadcast center shown in Exhibit 37 and located at 158 West 1600 South in Saint George.

Exhibit 37 – KCSG Television Studios

Staff at KCSG have expressed an interest in using one of their four digital channels to broadcast traffic conditions over the air from their tower shown in Exhibit 38.

Exhibit 38 – KCSG Broadcast Tower

5.9.2 KSL / KTVX / KUTV / WB30

The television stations in Salt Lake City already have a connection to the CommuterLink system. No further connectivity is required. This section is included for clarity.

5.10 Other Buildings - Maintenance / Repair & Planning

This section includes the detailed requirements for the other buildings.

5.10.1 UDOT S.W. Traffic & Safety / Signal Shop

UDOT has plans to relocate several offices to a new site along SR-9 at 5300 West. The new facility will be used by the Southwest Traffic & Safety group and the Signal Shop and should be connected to the system with the ability to view video and access the traffic signal system. These new buildings will be located west of the existing State buildings shown in Exhibit 39 and in the same general area as the Sheriff's Office Administration Building.

UDOT ITS staff should coordinate with those responsible for the design and construction of these buildings to make sure a vault is installed at the edge of the property with conduit extending into the building. Construction of this site is scheduled to start in 2009 so it is important to get this work started as soon as possible.

Exhibit 39 – Site for New UDOT Offices on SR-9

Similar planning was done for the construction of the Traffic Operations Center in Salt Lake City and the new Region 3 offices in Orem. Exhibit 40 shows the conduits installed in the UDOT Region 3 computer room before the concrete floor was poured and is provided for comparison.

Exhibit 40 – UDOT Region 3 Building Service Entrance Conduits

5.10.2 Federal Highway Administration (FHWA)

U.S. Department of Transportation
Federal Highway Administration

The FHWA offices in Salt Lake City are already connected to the CommuterLink system. No additional connectivity is required. This section is included for clarity.

5.10.3 Five County Association of Governments

The system should include a connection to the Five County AOG office shown in Exhibit 41. This facility is located near a recommended fiber route along Dixie Drive and is located directly across the street from the InterLinx data center shown in Exhibit 42.

Exhibit 41 – Five County AOG Offices

According to InterLinx staff, there is existing conduit from their primary data center to the building complex where the Five County AOG offices are located. InterLinx provides the last mile WAN connection used to connect the Saint George City Hall to the Traffic Operations Center in Salt Lake City. This is described in more detail in other sections of this document.

Exhibit 42 – InterLinx Data Center near Five County AOG Offices

5.11 UDOT Saint George Port of Entry

The communication system should provide a high-speed connection to the UDOT Port of Entry shown in Exhibits 43. This facility is located at Mile Post (MP) 1 along the east side of I-15.

Exhibit 43 – UDOT Saint George Port of Entry Station

The port has several existing radio systems. One system was installed on 5/29/1996 and is maintained by State DTS. This system is used for a two-way radio system and to provide connectivity to the State's WAN. The existing system is limited to a small number of T-1 circuits.

The antennas and associated radios shown in Exhibit 43 & 44 are used to provide connectivity to roadside sensors such the one mounted on the mast arm shown in Exhibit 44.

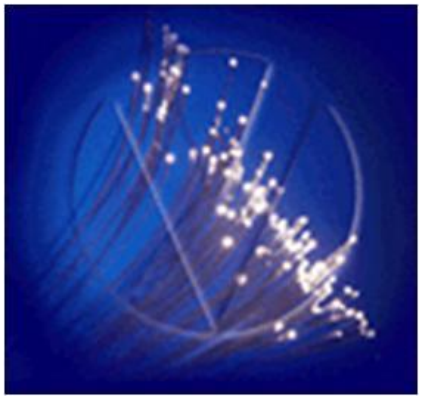
Exhibit 44 – POE Scales & Sign

The CommuterLink fiber should be extended to the Northbound (NB) Port of Entry station and should be used to provide connectivity to new roadside sensors if required for future applications or to replace the existing wireless communication system once it reaches the end of its service life. The system should provide POE staff with access to the cameras along I-15. The need for PTZ control has not been determined at this time, but does not impact the overall communication system requirements. A dedicated fiber pair should be extended from the Port of the Entry to the DTS Hub at Dixie College as replacement for 13 year old radio system.

6. COMMUNICATION ALTERNATIVES

This section will provide some general information about the communication alternatives that are available and will provide more specific detail about the alternatives that apply to each building and roadside device type.

6.1 Agency Owned Single Mode Fiber Optic Cable



Fiber optic cable is available in both Single Mode and Multi Mode variations. Only Single Mode Fiber (SMF) should be considered for deployment. Fiber optic cable is generally accepted as the preferred communication media for all permanent sites. When combined with an Ethernet switch, this provides a very reliable system that is able to meet all of the performance requirements.

The cost of installing conduit and boxes is very expensive compared to other alternatives. It is best to install conduit during major reconstruction projects, but can be installed as a standalone project.

While fiber cable is the preferred option in many cases, there are some conditions that limit the use. This includes:

- Limited right-of-way (railroad, canal)
- Poor ground conditions (rocks)
- Recent construction limiting open trenching
- Complex underground utilities
- Deep canyons
- Archeological sites / Environmental issues

Any one or a combination of these conditions may rule out fiber as an alternative for some applications.

6.2 Agency Owned Wireless

Agency owned wireless networks are a popular option and can be installed in a Point-to-Point or Point-to-Multipoint configuration. Equipment is available in either a licensed or unlicensed frequency range.

The type of equipment, license requirements, and antenna arrangement are all driven by the specific application. For example, licensed radios are typically installed when reliability is very important and is commonly used for public safety and backhaul applications. Point-to-point configurations are typically used for high-capacity full-duplex network connections such as a last-mile backhaul to a fiber network. Point-to-multipoint configurations are often used for applications appropriate for lower bit rate half-duplex operation.

6.3 Agency Owned Copper

Agency owned copper is possible where agencies have an installed base of twisted pair copper in agency owned conduit. The cable is used with agency owned equipment with dedicated DSL ports.

Vendors such as Actelis have dedicated purpose DSL equipment that support speeds up to five (5) Mbps per copper pair in both directions (full duplex). Other vendors such as Ruggedcom support DSL ports that can be added to their Ethernet switch products. Copper is a common media to connect traffic signals in some areas, but has not been used in the Dixie region. This alternative is not practical but is mentioned for clarity.

6.4 Commercial Internet Service

Commercial Internet service is widely available in the Dixie area from companies such as Qwest and Baja Broadband. Both companies could provide service to most areas with bandwidth that is not only adequate for low-speed devices, but with upload speeds that could support good quality MPEG-4 video.

The high temperatures in the summer will require the use of equipment with an extended operating temperature. Most Customer Premise Equipment (CPE) is designed with a 32 – 104 F operating temperature and would not be appropriate for the extreme temperatures inside a roadside equipment cabinet. Companies such as Ruggedcom do offer extended temperature routers such as the own shown in Exhibit 45 with a DSL WAN interface and local Ethernet ports.

Exhibit 45 – Extended Temperature Router with DSL WAN Interface

The use of a Qwest DSL service in the field could be used with either a dedicated high-capacity connection to the Internet in Salt Lake City or in Saint George since Qwest offers service in both areas.

6.5 Commercial Private Data Service

Several commercial companies offer private data service in the Saint George area. This type of service can be expensive and would generally be limited to critical connections such as a building-to-building connection. Service is commonly available in speeds from 56 Kbps – 1,000 Mbps.

6.6 Commercial Wireless Internet

Several companies such as Verizon and AT&T offer commercial wireless Internet access using cellular type technology. Coverage is good in the Dixie metro area and all along I-15. Monthly transfer limits of 5 GB limit this to devices with limited transfer rates such as a VMS sign, but can be used for Video on Demand (VOD) where viewing time is typically limited in duration.

6.7 State WAN / Microwave / VHF Wireless

State DTS maintains an extensive voice and data network with coverage across the entire state. Access points are available at strategically located geographic hubs with access points at the Traffic Operations Center shown in Exhibit 46 in Salt Lake City and at Dixie College Library in Saint George. Each hub typically has two (2) WAN connections. In this case, Qwest Metro Optical Ethernet (QMOE) is used as the primary network connection and the State's microwave system

provides a backup connection to Saint George. The QMOE service provides a Gigabit Ethernet link and the microwave has a DS-3 connection that supports up to 45 Mbps.

The State WAN may already include some of the technologies described in this alternatives section. If used, it is considered an independent system much like UTOPIA or any other commercial network.

Exhibit 46 – Microwave Tower at the Traffic Operations Center

6.8 Plain Old Telephone Service (POTS)

The Public Switched Telephone Network (PSTN) can be used on a limited basic to support devices that are part of the CommuterLink system. In most cases, a regular telephone line, also known as Plain Old Telephone Service (POTS) can be used with a modem to connect VMS signs or a Higway Advisory Radio (HAR). In extreme cases, a telephone line can be used to support video using specialized video encoders.

In most cases a telephone line is considered a method of last resort because it provides limited capacity, must be dialed, and may incur long distance charges. This alternative is included for clarity, but is not recommended for use at this time.

6.9 Washington County Water Conservation District

The Washington County Water Conservation District installed four (4) empty conduits as part of a larger construction project to complete a regional water pipeline. The conduit route starts at the Quail Creek Water Treatment Plant, shown in Exhibit 47, located near SR-9 and 5300.

Exhibit 47 – Quail Creek Water Treatment Plan (SR-9 @ 5300 West)

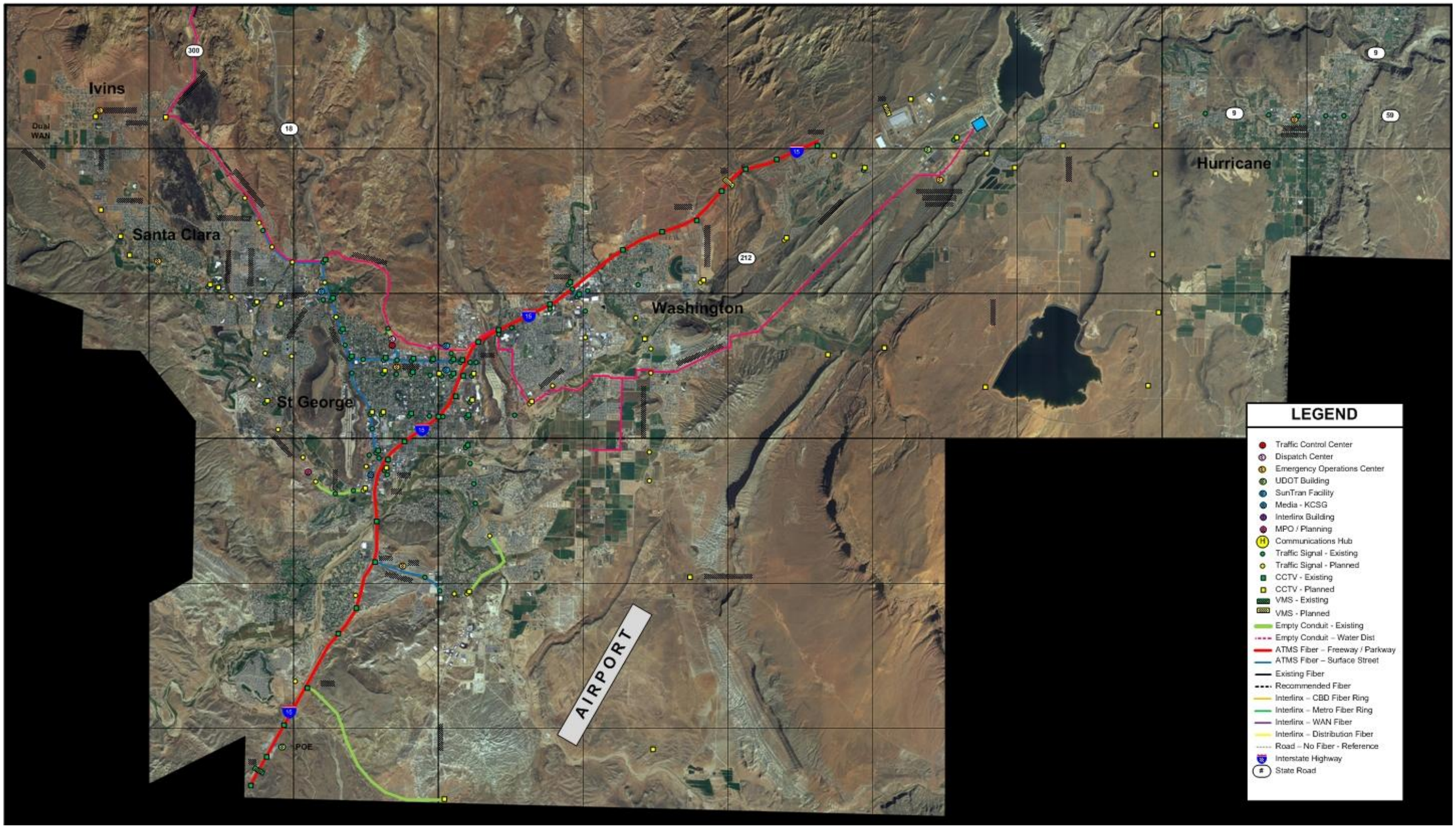
The conduit route extends thru some large undeveloped areas, but eventually crosses I-15 just north of the Saint George Blvd exit and ends up at the Skyline Pumping Station, shown in Exhibit 48, on Red Hills Parkway at about 800 West. This pumping station is located <1,000 feet from the Saint George Fleet Maintenance Building described in later sections.

Exhibit 48 – Skyline Pumping Station (Red Hills Parkway

The conduit extends along Red Hills Parkway all the way to Bluff Street (SR-18) which is the recommended location for an ATMS communications hub and then continues all the way to the City of Ivins along Snow Canyon Parkway as shown in Exhibit 49.

InterLinx has been in negotiations to use one (1) of the conduits along sections of this route. It may be possible to negotiate a direct agreement with the Water District for the use of a conduit or to partner with InterLinx.

Exhibit 49 – Conduit Route along Regional Water Pipeline



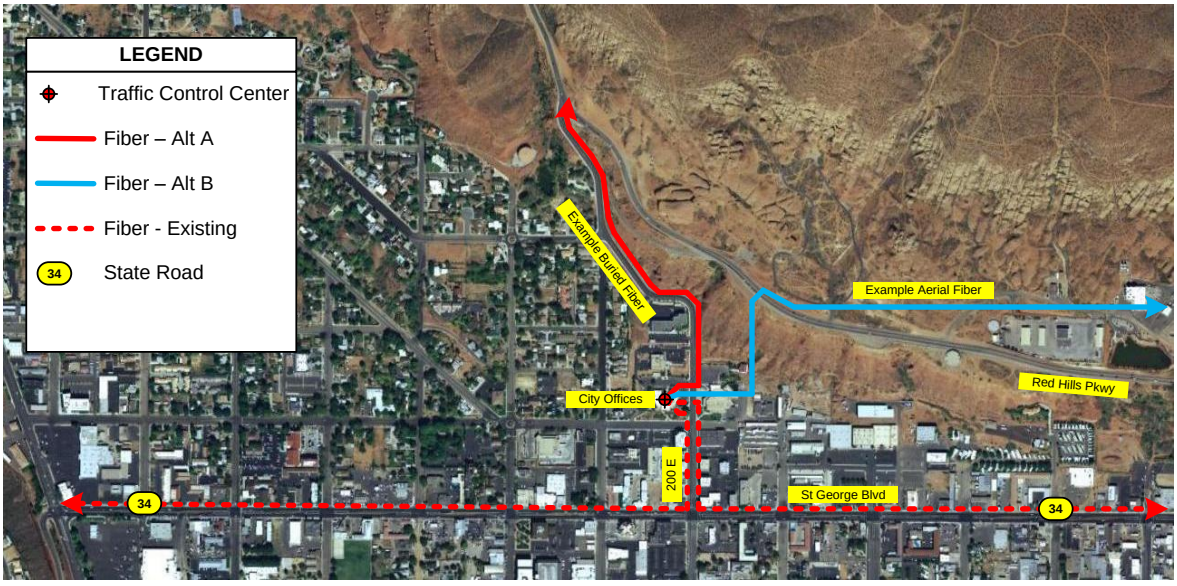
7. DIXIE REGIONAL COMPUTER CENTER ALTERNATIVES

This section includes more detail about the alternatives for the computer center that will house the servers critical to the operation of the CommuterLink system. The requirements for the computer center are described in previous sections of the document.

7.1 Saint George City Offices

The computer systems are currently hosted at the Saint George City Offices in a large basement equipment closet. The facility does have an emergency generator, but there is a very small UPS which would not provide adequate run time in the event of a generator or transfer switch failure. The UPS could be replaced with a larger model to fix this problem. The bigger problem is this building is currently only being serviced by fiber along Saint George Blvd. If this site is to continue to host the servers, this problem should be resolved. It may be possible to use an existing City owned fiber route or install new buried fiber north of the building. This assumes that fiber is available along Red Hills Parkway as recommended in later sections. An overview of this concept is shown in Exhibit 50.

Exhibit 50 – Alternate Fiber Route to Saint George City Hall



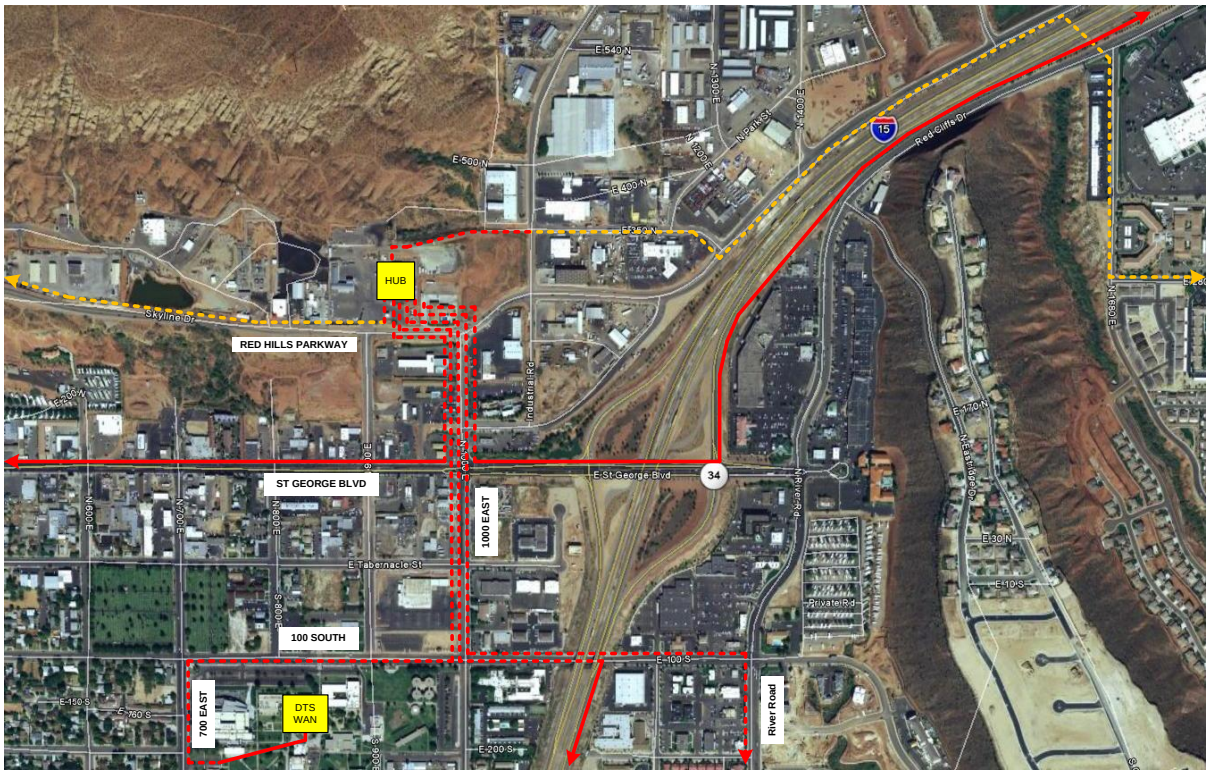
7.2 Saint George Fleet Maintenance Bldg

The City of Saint George recently added onto the fleet maintenance building shown in Exhibit 51. The building has an emergency generator and two conduit routes into the building. This building has an equipment closet and an existing open relay rack that could be used to mount computer equipment and other equipment if necessary.

Exhibit 51 – Saint George Fleet Maintenance Bldg

This building is also in a good position to be used as a communications hub because it is located near several existing and recommended fiber routes as shown in Exhibit 52. This includes fiber on I-15, Saint George Blvd, Red Hills Parkway, 100 South, and River Road. Unlike hubs located along the freeway, there is plenty of room for parking. The building also has electronic locks on all critical doors.

Exhibit 52 – Fiber Routes near the Fleet Maintenance Bldg



In order to be used a computer center and a communication hub, it would be necessary to make changes and improvements to the existing cable system. This includes the possibility of rerouting existing fiber. The specific details should be incorporated into a detailed design project.

The fleet maintenance building is also located near the empty conduit installed along the regional water pipeline installed by the Washington County Water Conservation District and is shown in orange on Exhibit 52. An overview of the entire conduit route is described in other sections of this document.

7.3 Interlinx Data Center

Finally, the computer equipment could be moved to the InterLinx data center shown earlier in Exhibit 42. This is a purpose built building and is ideal for the installation of computer equipment. This facility is located at 1108 West 1600 South. This is across the street from the Five County AOG offices. The use of this site would require some type of payment or trade with Interlinx since this is a commercial facility.

8. RECOMMENDATIONS

This section will provide more detail about the specific recommendations for the communication system that will be required to support the expansion of the CommuterLink system in the Dixie Region. An overview of the recommended communication system is shown in Exhibit 53.

8.1 Continued Support for Existing Communications Architecture

All requirements for the Dixie Region are based on the current architecture for the CommuterLink system.

8.1.1 Multi-Agency Network

The CommuterLink system was originally built as a multi-agency system and was designed, built, and operated for the mutual benefit of all partner agencies and the public they serve. The expansion of CommuterLink into the Dixie area should be done with similar goals in mind.

8.1.2 Internet Protocol

The existing CommuterLink system is supported by an all IP communication network. The expansion into the Dixie area should continue to use IP as the primary network protocol. Existing internal routing protocols should be used for all layer 3 network equipment when possible. Exceptions may need to be made for extended temperature routers that may be installed in roadside cabinets.

8.1.3 IP to the Cabinet

IP based communication systems should be used all the way from the roadside cabinet to the computer systems that is used to control the equipment. This applies to all communications media, including any fiber, wireless, or leased services.

8.1.4 Ethernet

Ethernet should be used to connect all roadside equipment. A small terminal server can be used to connect devices that do not support a native Ethernet interface from the manufacturer. Ethernet should also be used on all fiber interfaces.

8.1.4.1 Gigabit Ethernet Backbone Fiber

Gigabit Ethernet should be used on all backbone fiber segments. This includes fiber between communication hubs and fiber to and between buildings.

8.1.4.2 100 Mbps Distribution Fiber

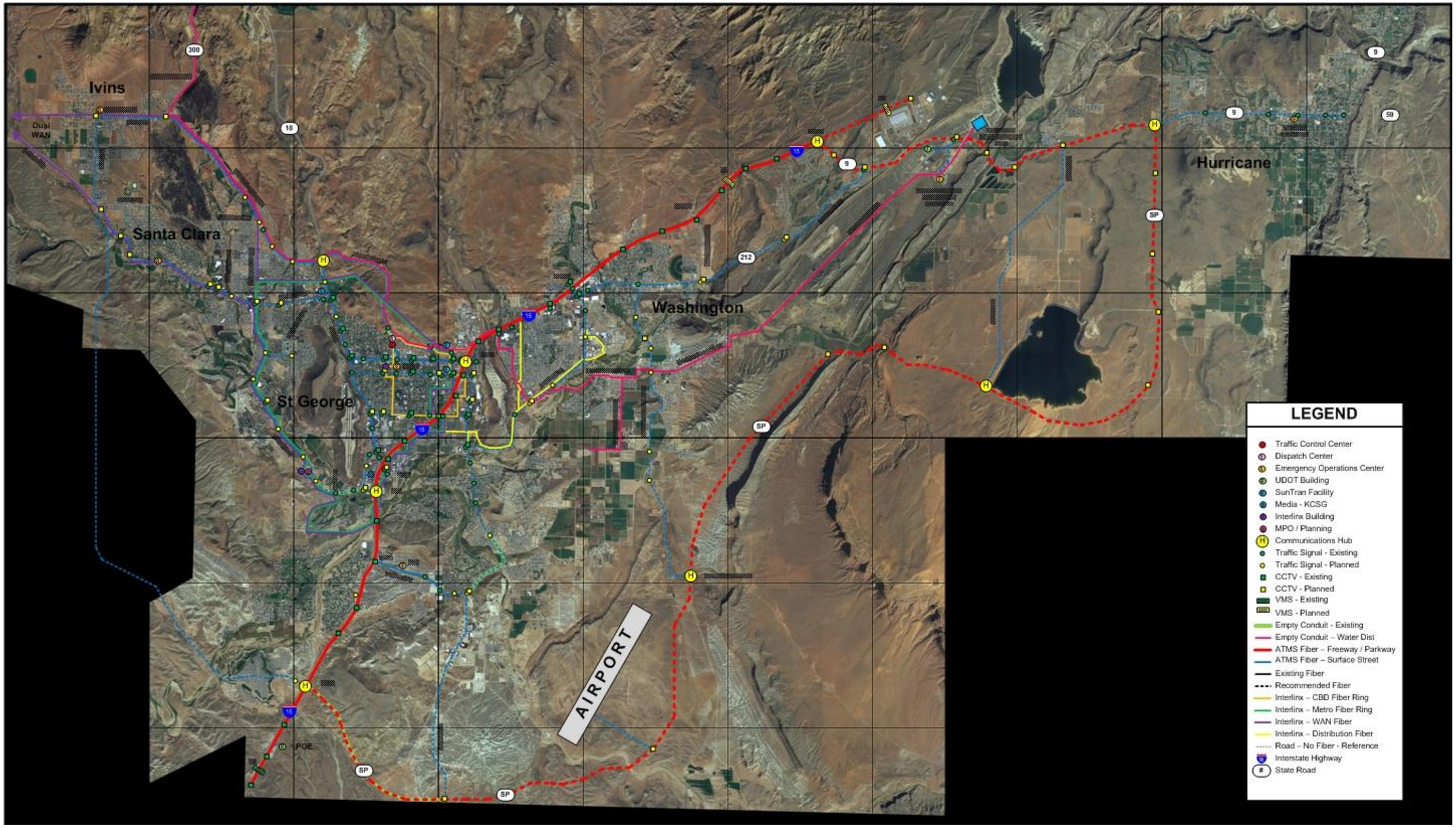
A product manager from Cisco indicated that 100 Mbps Ethernet fiber interfaces are actually more expensive to manufacture than Gigabit Ethernet. The primary reason is the simple economies of scale. Gigabit Ethernet is priced higher for marketing reasons. Ruggedcom still has a 25% premium for field switches with Gigabit vs. 100 Mbps fiber interfaces. This price gap is likely to close over time, but is not likely to change much over the next year.

At this time, a 100 Mbps distribution network has more than adequate bandwidth to support the requirements for all devices, including multiple cameras. The distribution network should continue to use 100 Mbps Ethernet on Single Mode Fiber until there is no cost premium.

8.1.5 IP Multicast

IP multicast should be used on all networks for the replication of video whenever possible. Exceptions may be required for devices connected over the public Internet. Examples may include a DSL connected camera or a VMS sign connected by a 3G wireless WAN technology.

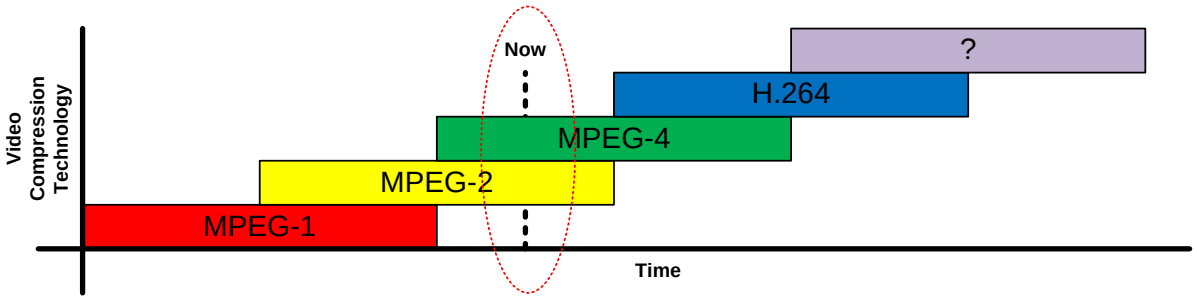
Exhibit 53 – Recommended Communication System



8.1.6 Support for Multiple Encoders

The CommuterLink system has and will continue to use multiple video compression technologies. While Teleste MPEG-4 encoders are being deployed at all new sites, there are older parts of the system that still have VBrick MPEG-4 encoders. Areas in Salt Lake City still have some MPEG-2 encoders. As newer technology becomes available and is implemented in the system, it will take time to phase out the older equipment. With this in mind, it will be necessary to support multiple video compression technologies for the foreseeable future. This concept is shown in Exhibit 54 below.

Exhibit 54 – Multiple Encoder Types



8.1.6.1 Phase Out Support for MPEG-2

MPEG-2 is primarily used in the Salt Lake City metro area. The new decoders from Teleste are able to support both MPEG-2 and MPEG-4 and video from both VBrick and Telste. This capability should allow for the two-way exchange of video between the system in Salt Lake and the Dixie area. The existing MPEG-2 encoders should be phased out as budget is available. This does not have a direct impact on agencies in the Dixie Region, but is provided for clarity.

8.1.6.2 Deploy MPEG-4 for Now

MPEG-4 encoders should be used for all new CCTV deployments in the Dixie area. See equipment standards for more details.

8.1.6.3 H.264 Encoders in the Future

H.264, also known as MPEG-4 Part 10, has become the video compression technology of choice for most video applications. The transition to H.264 was being fueled by the transition from analog to digital in the over the air broadcast market. It is also being pushed because of the bandwidth requirements related to High Definition (HD) video. It has already replaced MPEG-2 as the technology of choice by companies such as DirecTV and Dish Network.

The CommuterLink system does not have any requirement for HD video at this time, but the push toward H.264 in the many of the other markets will also affect the technology used in the ITS market as well. Companies such as VBrick already have H.264 encoders on the market with near term plans for extended temperature variations.

8.1.7 Multi-format (Universal) Decoder

The communication system should be deployed with the ability to decode multiple video formats. This includes support for both MPEG-2 and MPEG-4 as described in previous sections. Refer to the section on equipment standards for more detail.

8.2 High-Level Design Recommendations

This section includes some high-level design recommendations for the communication system.

8.2.1 Regional Fiber Ring with Multiple Hubs

The current communication system is based on a hub and spoke design with the Saint George City Hall Building at the center. This was adequate while the system was small, but does not fit well as the system is expanded to include all agencies and roadside devices in the region.

The system should be expanded with eight (8) communication hubs as listed below and as shown in Exhibit 53:

- I-15 @ Southern Parkway
- I-15 @ Dixie Road (near Bluff Street)
- I-15 @ Saint George Blvd (near Fleet Maintenance Bldg)
- I-15 @ SR-9 (Exit 16)
- Southern Parkway @ SR-9 Interchange
- Southern Parkway @ 4300 West (Hurricane)
- Southern Parkway @ Warner Valley Road (North of Replacement Airport)
- Bluff Street (SR-18) @ Snow Canyon Parkway / Red Hills Parkway

8.2.1.1 Hub on I-15 @ Southern Parkway (Exit 2)

This communication hub should be built as part of the new "Welcome Center" that is planned for construction on the northeast corner of the interchange. The hub should be part of the new building with an outside entrance and dedicated air conditioning system that is independent of the rest of the building.

The installation of this hub will be limited by the construction schedule for the Welcome Center, and will be pushed by the planned deployment of roadside devices along the Southern Parkway. If this hub is needed before the Welcome Center is ready it may be necessary to install a traditional hub buildings such as the ones used in Salt Lake County.

8.2.1.2 Hub on I-15 @ Dixie Drive / Bluff Street (Exit 6)

This communication hub should be built as part of the new Dixie Drive interchange shown in Exhibit 55. The exact placement of the hub should be determined as part of the design of the interchange, and should include rerouting of the Bluff street fiber into the new hub.

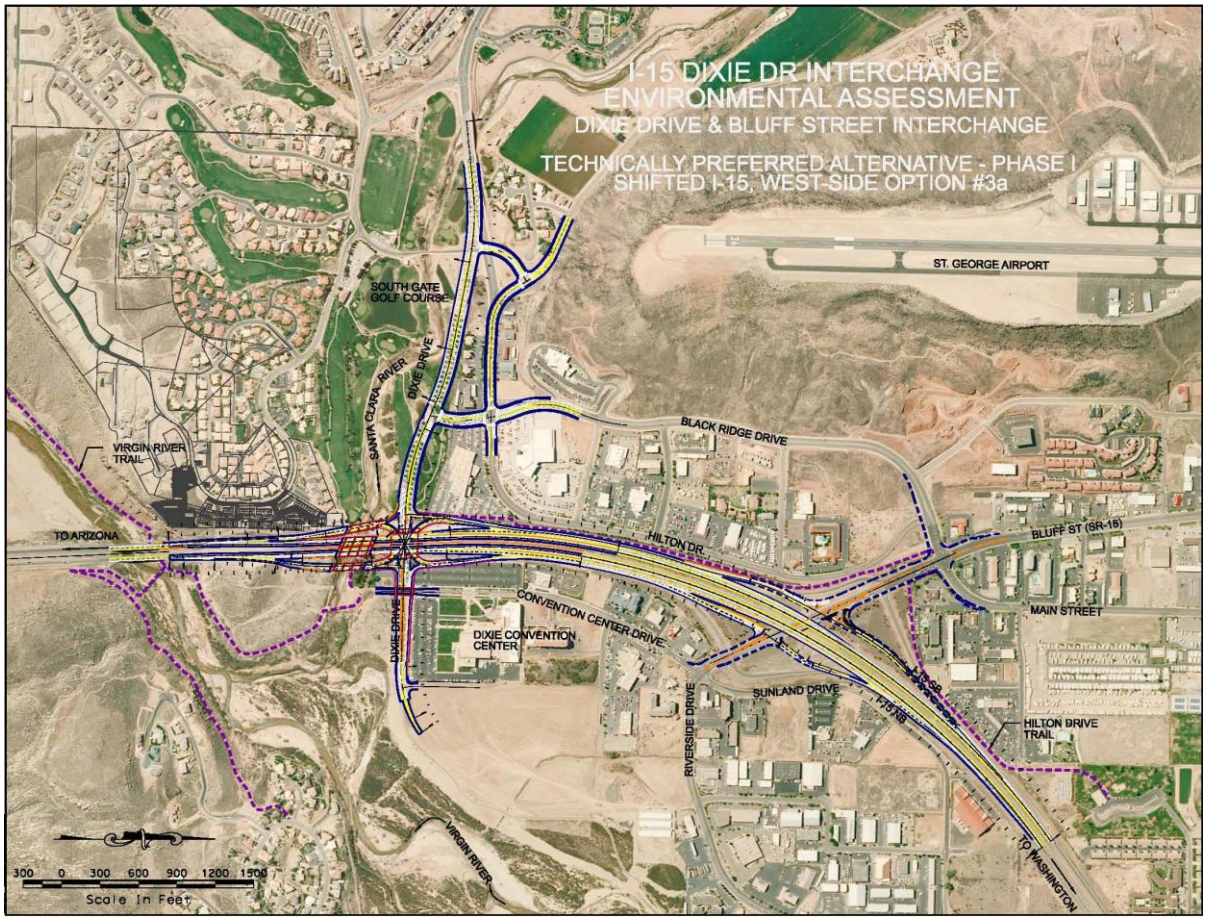
The installation of this hub will be limited by the construction schedule for the new Dixie Drive Interchange and may be pushed by the installation of fiber along Dixie Drive. If communication to the signals along Dixie Drive is important and can't wait for the new hub, the connection should be backhauled to the InterLinx Data Center and routed over existing fiber into the CommuterLink system.

8.2.1.3 Hub on I-15 @ Saint George Blvd (Exit 8)

This communication hub should be funded and built as a standalone project and should include accommodations for the installation of fiber along 100 South and River Road. The exact placement of the hub should be determined as part of the design.

Preliminary information suggests the Saint George Fleet Maintenance Building would be the best location for this communications hub because of the availability of an emergency generator and access to several fiber routes. The location of the hub may also be tied to a decision on where to locate the computer systems.

Exhibit 55 – New Hub on I-15 @ Dixie Drive Interchange



8.2.1.4 Hub on I-15 @ SR-9 (Exit 16)

This communication hub should be built as part of the improvements to SR-9 between I-15 and the Southern Parkway. The hub should be located on the east side of I-15, but the exact placement of the hub should be determined as part of the roadway design. The project should also include accommodations for the future installation of conduit and fiber north on I-15.

8.2.1.5 Hub on Southern Parkway @ SR-9 (Hurricane)

This communication hub should be built as part of the new Southern Parkway interchange at SR-9 in Hurricane. The exact placement of the hub should be determined as part of the design of the interchange, and should include plans for the local distribution fiber along SR-9 into downtown Hurricane and a connection to the EOC located at the Hurricane Police Department.

8.2.1.6 Hub on Southern Parkway @ 4300 West (Hurricane)

This communication hub should be built as part of the new Southern Parkway interchange at 4300 West. The exact placement of the hub should be determined as part of the design of the interchange, and should include conduit for local distribution fiber along 4300 West.

8.2.1.7 Hub on Southern Parkway @ Warner Valley Road (north of Airport)

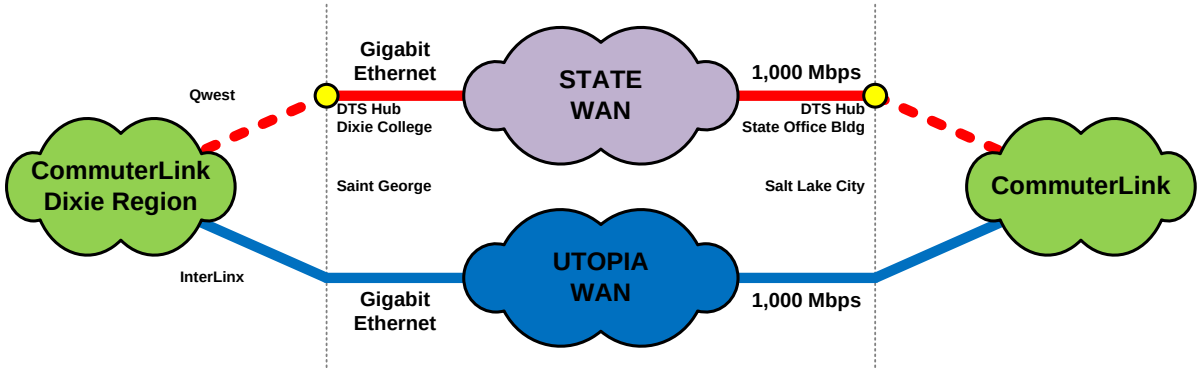
This communication hub should be built as part of the new Southern Parkway interchange at Warner Valley Road. The exact placement of the hub should be determined as part of the design of the

interchange, and should include conduit for local distribution fiber east along Warner Valley Road and north along Washington Field Road.

8.2.2 Dual High-Speed WAN

The existing WAN connection provided by UTOPIA, shown in blue in Exhibit 56, has plenty of bandwidth to support the CommuterLink system as the primary connection between Saint George and Salt Lake City. The existing T-1 connection has some limited utility as a backup connection, but does not have adequate capacity to transport video in the event of a UTOPIA network outage.

Exhibit 56 – Recommended CommuterLink WAN Upgrade



It is recommended that UDOT work together with State DTS to pool resources to provide a redundant WAN connection to between Saint George and Salt Lake City. This will require a fiber connection to the DTS geographic hub located at the Dixie College library shown in Exhibit 57.

Exhibit 57 – DTS Hub @ Dixie College Library

8.2.3 Dixie Regional Data Center

Without improvements, the Saint George City Office building does not meet the communications requirements for the "Data Center" component of the CommuterLink system as outlined in previous sections. If improvements are not practical or desirable at the existing location, the computers should be moved to another location such as the Saint George fleet maintenance building or to the InterLinx data center. Both of these alternatives would meet the recommended requirements and are shown in previous sections of this document.

8.2.4 Distribution Network

This sections provides specific recommendations for the distribution network used to connect roadside devices.

8.2.4.1 Long-Term Fiber Distribution Network

Agencies in the Dixie area should work together on a long-range plan to connect all devices to a fiber optic network. This will require careful planning and close coordination with project managers responsible for roadway projects.

The requirements for the communication system should be prioritized as a region and incorporated into near-term major construction projects such as the Southern Parkway and longer range projects such as the Western Corridor.

If no construction projects are scheduled for critical pieces of the communication system, it will be necessary to prioritize and fund these as individual projects.

8.2.4.2 Point-to-Multipoint Unlicensed Wireless

The existing wireless network should be used to support traffic signals and other low-speed devices until another network is available. The wireless equipment should be taken out of service or moved to other locations after the upgrade. This has already been done along Bluff Street (SR-18).

8.2.4.3 Commercial DSL (Internet or Private)

Commercial DSL service should be used on an interim basis for clusters of low-speed devices that are not practical to reach using the existing Motorola Canopy radio network and for CCTV locations that are not connected via fiber. This concept is shown in Exhibit 58 & 59.

Exhibit 58 – Typical Cabinet with DSL WAN Router

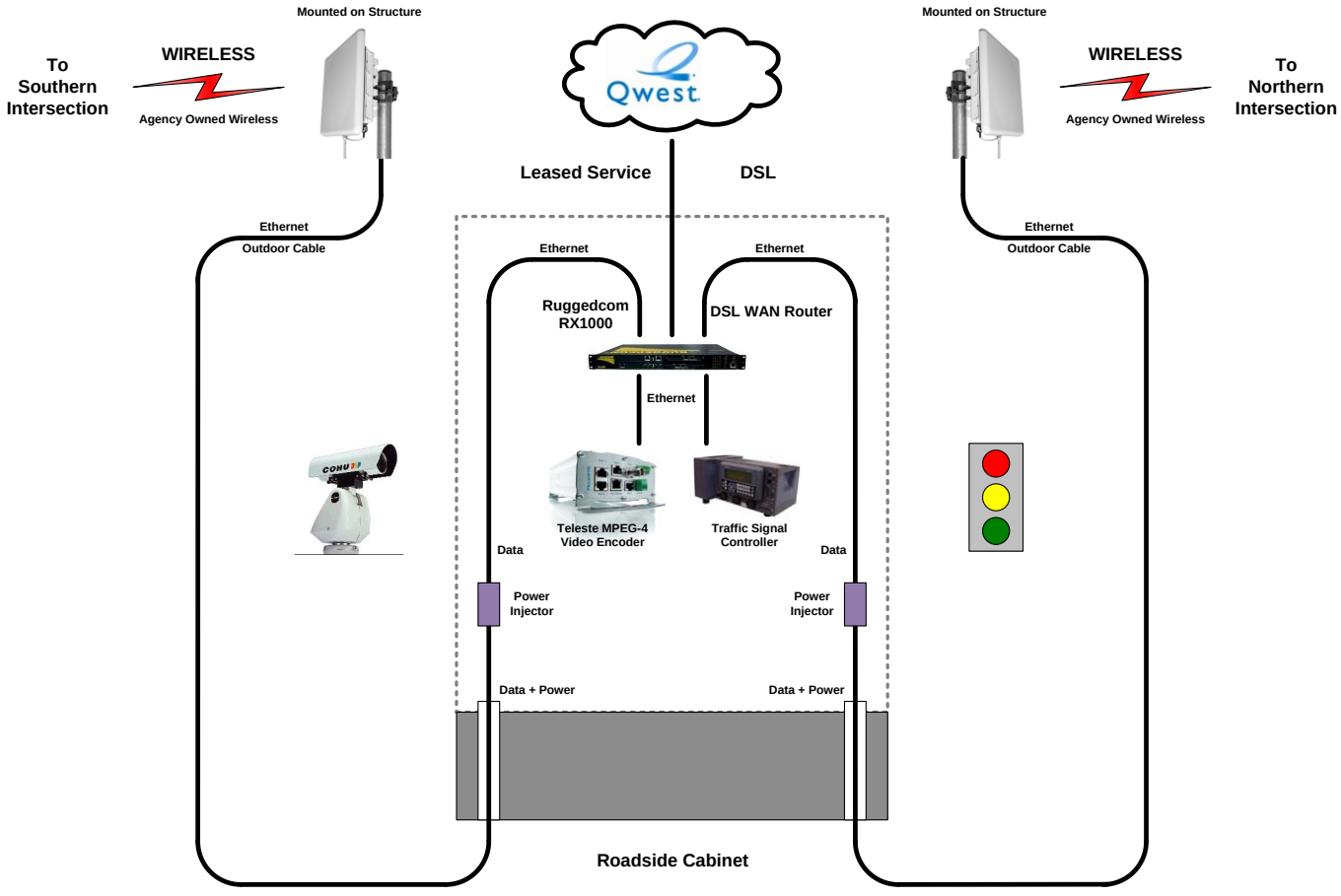
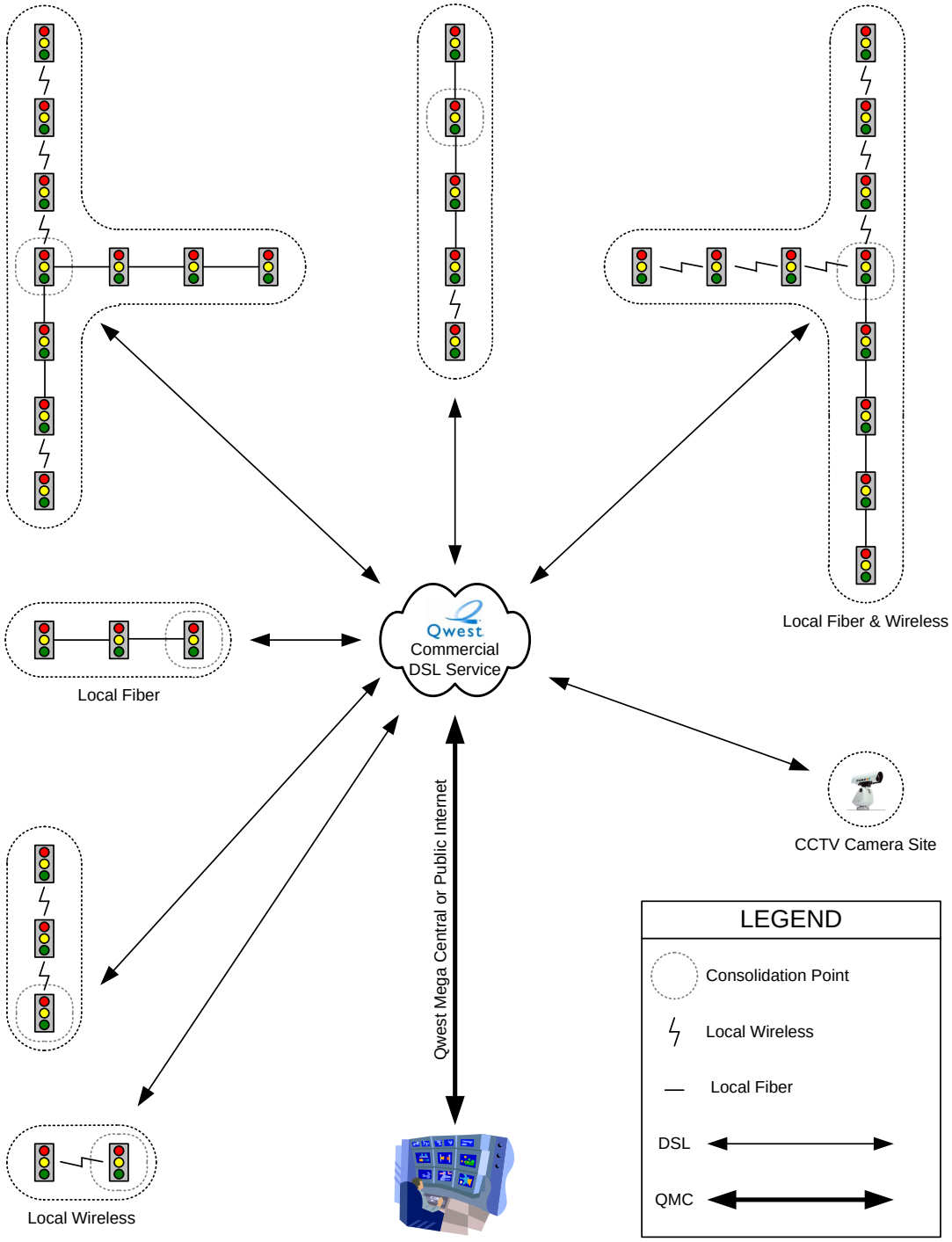


Exhibit 59 – Qwest Commercial DSL Service



8.3 Distribution Network

This section includes specific recommendations for the distribution network used to connect roadside devices and will be organized by route.

8.3.1 I-15

The majority of the devices along I-15 have already been connected. The exceptions are the two (2) VMS that are planned near the SR-9 interchange at Exit 16 and the southbound CCTV that will be located just north of the sign. Fiber should be extended from the new hub to these devices.

8.3.2 SR-9 from I-15 to the Southern Parkway

Fiber should be installed along this section of SR-9. This section is not only required to connect the roadside devices, but will be a critical part of the backbone that will connect I-15 and the new Southern Parkway. Construction should be done as part of the SR-9 improvements that have been planned.

8.3.3 SR-9 from the Southern Parkway to 100 East (Hurricane)

Fiber should be installed from the new Southern Parkway interchange to 100 East in Hurricane. This project can be done at any time and should be coordinated with other improvements that may be scheduled for SR-9. There are five (5) existing traffic signals in this area, but no plans for CCTV cameras.

If connectivity is required early, local fiber or a wireless network should be installed to connect the five (5) local signals together and then connected back to the Hurricane Police Department. A Qwest DSL circuit can be used to provide the long haul connection back to the computer center. This concept is shown in Exhibit 58 & 59. The specific details should be part of the design.

8.3.4 Southern Parkway from SR-9 to the Airport

Conduit and pull boxes should be installed along this section of the Southern Parkway during the roadway construction. Fiber should not be installed until the roadside devices are installed or the entire path is complete. The schedule and priority for this project will be determined by the construction of the roadway.

8.3.5 Southern Parkway from the Airport to River Road

Conduit and pull boxes should be installed in this section of the Southern Parkway during the roadway construction. Fiber should not be installed until the roadside devices are installed or the entire path is complete. The schedule and priority for this project will be determined by the construction of the roadway.

8.3.6 Southern Parkway from the River Road to I-15

Conduit and pull boxes have already been installed in section 1 of the Southern Parkway during previous roadway construction projects. Fiber should not be installed until the roadside devices are installed or the entire path is complete. The schedule and priority for this project will be determined by the installation of roadside devices and complete access thru the new realignment of River Road.

8.3.7 Western Corridor from I-15 to Santa Clara

The long-term plan for roadside equipment along the Western Corridor have not been finalized. Preliminary information suggests there will be very limited access along this road with no plans for traffic signals. Conduit and fiber should only be installed if devices are planned for this section. This section will not be used for backbone communications.

8.3.8 River Road from the Southern Parkway to Brigham Road

Conduit and fiber should be installed along River Road from the Southern Parkway to Brigham Road. This section will not only provide service to devices along this section of River Road, but when combined with other sections, will provide a backup path for devices along I-15 from Mile Post 0 to Saint George Blvd at Exit 8 and for devices along the Southern Parkway from I-15 to River Road. Devices along River Road should be connected to the hub near Saint George Blvd and to the hub at the Southern Parkway.

8.3.9 River Road from 100 South to Brigham Road

Conduit and fiber should be installed along River Road from 100 South 2450 South. Fiber should be installed in existing conduit from 2450 South to Brigham Road. This section will not only provide service to devices along this section of River Road, but when combined with other sections, will provide a backup path for devices along I-15 from Mile Post 0 to Saint George Blvd at Exit 8. Devices along River Road should be connected to the hub near Saint George Blvd and the hub at the Southern Parkway.

8.3.10 Dixie Drive from I-15 to Sunset Blvd

Conduit and fiber should be installed along Dixie Drive from I-15 to Sunset Blvd. While there are some short sections of existing conduit, the majority of this route will require the installation of new conduit and boxes.

InterLinx installed aerial fiber along Dixie Drive as part of their effort to provide a long-haul connection to Salt Lake City and is shown as a purple line on Exhibit 53. According to InterLinx staff, this route has a very limited number of splice points. The limited access points and lack of slack loops eliminate the possibility of using the InterLinx fiber route for connectivity to traffic signals and CCTV cameras along this section of road.

This section of fiber will not only provide service to devices along this section of Dixie Drive, but when combined with other sections, will provide a backup path for devices along Bluff Street from I-15 to Snow Canyon Parkway.

8.3.11 Sunset Blvd from Bluff Street to 200 East in Ivins

Conduit and fiber should be installed along Sunset Blvd from Bluff Street to 200 East in Ivins. While there are some short sections of existing conduit, the majority of this route will require the installation of new conduit and boxes.

As mentioned in previous sections, InterLinx installed aerial fiber along Bluff Street as part of their effort to provide a long-haul connection to Salt Lake City and is shown as a purple line on Exhibit 53. According to InterLinx staff, this route has a very limited number of splice points. The limited access points and lack of slack loops eliminate the possibility of using the InterLinx fiber route for connectivity to traffic signals and CCTV cameras along this section of road.

This section of fiber will not only provide service to devices along this section of Bluff Street, but when combined with other sections, will provide a backup path for devices along Snow Canyon Parkway from Bluff Street to Ivins City Hall.

8.3.12 200 East in Ivins from Center Street to Old Highway 91

Conduit and fiber should be installed along 200 East in Ivins from Center Street to Old Highway 91. This work should be incorporated into the planned reconstruction of 200 East and should be coordinated with the Saint George construction project to install a significant section of water line along Center Street.

While there no roadside devices along this section of road, it provided a critical link between the devices on Snow Canyon Parkway and Sundset Blvd. Devices along this entire route will use the hub on Bluff Street and Dixie Drive with a backup path along Bluff Street. While this project will also be used for the connection to the EOC at the new Ivins City Hall, the primary purpose and benefit is for the redundancy in the distribution network. This project should be identified and funded as a regional priority.

8.3.13 Center Street in Ivins from Center Street to SR-300

Conduit and fiber should be installed along Center Street in Ivins from 200 East to SR-300. This work should be incorporated into the Saint George project to install water lines along this route and should be coordinated with the Ivins reconstruction project on 200 East.

While there are a limited number of roadside devices along this section of road, it will provide a critical link between the devices on Snow Canyon Parkway and Sundset Blvd. Devices along this entire route will use the hub on Bluff Street and Dixie Drive with a backup path along Bluff Street. Like the previous project, this will also be used for the connection to the EOC at the new Ivins City Hall, but the primary purpose and benefit is for the redundancy in the distribution network. This project should be identified and funded as a regional priority.

8.3.14 Snow Canyon Parkway from SR-300 to Dixie Downs Road

Agencies should work with the Water District to negotiate the use of the existing conduit along Snow Canyon Parkway. If an agreement can be made fiber should be installed along this section and connected to the existing fiber that ends at Dixie Downs Road. This work should be done as a standalone project and coordinated with the construction project on Center Street in Ivins.

While there are a limited number of roadside devices along this section of road, it will provide a critical link between the devices on Snow Canyon Parkway and Sundset Blvd. Devices along this entire route will use the hub on Bluff Street and Dixie Drive with a backup path along Bluff Street. Like the previous project, this will also be used for the connection to the EOC at the new Ivins City Hall, but the primary purpose and benefit is for the redundancy in the distribution network. This project should be identified and funded as a regional priority.

8.3.15 Red Hills Parkway from Bluff Street to 1000 East

Agencies should work with the Water District to negotiate the use of the existing conduit along Snow Canyon Parkway. If an agreement can be made fiber should be installed along this section and connected to the existing fiber that ends near 1000 East. This work should be done as a standalone project and coordinated with the construction of the communications hub on Bluff Street.

While there are a limited number of roadside devices along this section of road, it will provide a backup path for the devices along Saint George Blvd and a section of Bluff Street. Any devices along this route will use the hub on Bluff Street and Saint George Blvd with a backup path along Saint George Blvd.

8.3.16 100 South from Bluff Street to River Road

Conduit and fiber should be installed along 100 South from Bluff Street to River Road. This work should be done as a standalone project and coordinated with the installation of the new communications hub near I-15 and Saint George Blvd.

Devices along this route will use the hub on Saint George Blvd and Dixie Drive with a backup path along I-15. This fiber route will also provide service to the DTS Regional Hub at the Dixie College Library and to the SunTran Transit Center.

8.3.17 700 South from Bluff Street to River Road

Conduit and fiber should be installed along 700 South from Bluff Street to River Road. This work should be done as a standalone project and coordinated with the installation of the new communications hub near I-15 and Saint George Blvd.

Devices along this route will use the hub on Saint George Blvd and Dixie Drive with a backup path along I-15. This fiber route will only be used for devices along 700 South.

8.3.18 Washington Field Road from SR-212 to Warner Valley Road

Conduit and fiber should be installed along Washington Field Road from SR-212 to Warner Valley Road. This work should be done as a standalone project and coordinated with the installation of the new communications hub on the Southern Parkway at Warner Valley Road.

Devices along this route will use the hubs on Saint George Blvd and Warner Valley Road with a backup path along the southern route of I-15 and the Southern Parkway. This fiber route will only be used for devices along Washington Field Road.

8.3.19 SR-212 from I-15 to SR-9

Conduit and fiber should be installed along SR-212 from I-15 to SR-9. While there are some short sections of existing conduit, the majority of this route will require the installation of new conduit and boxes. This work should be done coordinated with the improvement scheduled in Washington from 500 West to 300 East.

Devices along this route will use the hubs on I-15 at Saint George Blvd and SR-9 with a backup path along the I-15. This fiber route will only be used for devices along Washington Field Road.

Construction of this fiber route should be put on hold until there is sufficient demand from the installation of roadside devices in the area which will be tied to development in the area.

8.3.20 3700 West on SR-9 to 4300 West on the Southern Parkway

Conduit and fiber should be installed from 3700 West on RR-9 to 4300 West on the Southern Parkway. Devices along this route will use the hubs on the Southern Parkway at SR-9 and 4300 West. This fiber route will only be used for local devices. Construction of this fiber route should be put on hold until there is sufficient demand from the installation of roadside devices in the area which will be tied to development in the area.

8.4 Traffic Control Centers

This section will provide specific recommendations for the connect to each Traffic Control Center.

8.4.1 Saint George TCC

No additional connectivity is required for this site to continue in the role as a Traffic Control Center. However, a redundant connection if required to continue in the role as a data center. These recommendations are addressed in other sections of this document.

8.4.2 UDOT Richfield District / Region Offices

No additional connectivity is required for the offices in Richfield. It may be necessary to replace the VBrick MPEG-4 decoders used at these site in order to take advantage of the higher resolution video from the Teleste encoders that will be deployed in the Dixie region.

8.4.3 Statewide TOC

No additional connectivity is required for this site. The TOC already has Teleste MPEG-4 decoders and should be ready for video from these sites.

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8.5 Public Safety Dispatch Center

This section will provide specific recommendations for the connect to each of the Public Safety Dispatch Centers.

8.5.1 Saint George Police Dispatch

New video decoders and modulators should be installed at this site.

8.5.2 State Department of Public Safety (Cedar City)

UDOT should work with InterLinx to provide a high-speed connection from Cedar City to Saint George. This will take time to complete the construction of the fiber route.

As an interim measure, the T-1 circuit from Saint George to Salt Lake City should be reused to provide a connection to the Public Safety Dispatch Center in Cedar City. The T-1 should support one (1) video stream with control over the Internet using the existing media interface.

The project will require the installation of network equipment such as a T-1 router and a Teleste video decoder near the video monitor and the use of existing or new Cat 5e UTP cable.

8.6 Emergency Operations Centers

8.6.1 BLM Interagency Operations Center (Saint George)

The BLM should include an additional two (2) inch conduit in the building service entrance that is part of the new building. Conduit should also be extended from the building entrance to an existing CommuterLink splice point along Brigham Road.

8.6.2 Color Country Interagency Fire Center (Cedar City)

UDOT should work with staff at the Color Country Interagency Fire Center in Cedar City to work on the details of the connection to this site. At a minimum, this project will require the installation of network equipment such as a T-1 router and a Teleste video decoder. Video selection will be done over the Internet with the existing media interface.

8.6.3 Utah Division of Homeland Security (State Office Building)

No changes are required for this site.

8.6.4 Washington County Administrative Offices (197 East Tabernacle)

A connection to this site should be done as part of the construction along 100 South.

8.6.5 Washington County Sheriff's Office Administration Building (SR-9)

The fiber connection to this site should be done as part of the construction on SR-9 or as part of the fiber along the Regional Pipeline.

8.6.6 Hurricane Police Department

The fiber connection should be done as part of the work along SR-9. At a minimum, this project will require the installation of network equipment such as an Ethernet switch and a Teleste video decoder. Video selection will be done over the Internet with the existing media interface.

8.6.7 Santa Clara Town Hall

The connection to the EOC in the Santa Clara Town Hall should be done as part of the construction along Sunset Blvd. At a minimum, this project will require the installation of network equipment such as an Ethernet switch and a Teleste video decoder. Video selection will be done over the Internet with the existing media interface.

8.7 Transit (SunTran)

This section will include specific recommendations related to SunTran.

8.7.1 SunTran Administration Offices (9xx Redd Cliff Parkway)

The new SunTran Administration Offices will be constructed next to the Saint George Fleet Maintenance Building with fiber between buildings. Connectivity to this site will be thru the Fleet Maintenance Building.

8.7.2 SunTran Transit Center (700 East 100 South)

A connection to this site should be done as part of the construction along 100 South.

8.7.3 SunTran Transfer Station (Bluff Street / Sunset Blvd)

A connection to this site should be done as part of the construction along Sunset Blvd.

8.8 Media

This section will include specific recommendations related to the Media.

8.8.1 KCSG

The construction to the KCSG studio should be done as a standalone project or as part of the fiber work on Black Ridge Drive. At a minimum, this project will require the installation of network equipment such as an Ethernet switch and a Teleste video decoder. Video selection will be done over the Internet with the existing media interface.

8.8.2 KSL / KTVX / KUTV / WB30

No additional work is required for the existing television stations to access the CCTV cameras in Saint George. This section is provided for clarity.

8.9 Other Sites - Maintenace / Repair & Planning

This section includes specific recommendations related to these sites.

8.9.1 UDOT S.W. Traffic & Safety / Signal Shop

ITS should staff should coordinate with those responsible for construction of the new buildings to make sure conduit is extended from a communications closet to fiber planned for SR-9.

8.9.2 Federal Highway Administration (FHWA)

No additional work is required for the staff at FHWA to access the CCTV cameras in Saint George. This section is provided for clarity.

8.9.3 Five County Association of Governments

The connection to the offices for the Five County AOG should be done as part of the work along Dixie Drive and should include the connection to the InterLinx data center across the street.

8.10 UDOT Saint George Port of Entry

The connection to the Saint George Port of Entry should be done as a standalone project. Connectivity will come thru the new communications hubs scheduled for I-15 at the Southern Parkway.

9. CONTRUCTION STANDARDS

This section includes specific recommendations related to the construction standards used in the Dixie Region.

9.1 Hub (Equipment Shelter)

Existing building should be used as a communication hub if practical. If not a standalone building or double cabinet should be used.

9.1.1 Rack Space

All communication hubs should have space for two equipment racks. Once side for fiber and a UPS and the other for the active electronics.

9.1.2 Air Conditioning & Monitored Environmental Alarms

All communication hubs should have air conditioning equipment with environmental monitors and monitored alarms. This is very important with the high temperatures that are common in the area.

9.1.3 Power Conditioning & Battery Backup

Each hub should also have a UPS to provide power conditioning with adequate batteries to provide a minimum of 4 hours of service. The UPS should have a network management agent with alarm reporting to notify staff of an extended outage.

9.1.4 Backup Generator

Preference should be given to sites with an existing emergency generator with enough fuel for 24 hours.

9.1.5 Card Reader & Alarm

Preference should be given to sites with a card reader and alarm system.

9.2 Conduit & Boxes

All conduit should be installed using the standards outlined by UDOT, including those related to the installation of a trace wire and the use of 2" conduit.

9.3 Single Mode Fiber (SMF)

All fiber should be installed using the standards outlined by UDOT. All outside plant fiber cable should be terminated with ST connectors. Fiber jumpers will be used at the communication hub to convert from ST if required.

9.4 Building Cable Entrance

A building service entrance should have a minimum of one (1) 2" conduit for the installation of fiber optic cable and should not be shared with other commercial service providers such as Qwest.

10. COMMUNICATION EQUIPMENT STANDARDS

This section includes specific recommendation related to equipment standards. In most instances, existing equipment standards should be used unless problems have been identified.

10.1 Ethernet Switches (Hubs)

Cisco Layer 3 Ethernet switches should be used at all communications hubs.

10.2 Ethernet Switches (Roadside Cabinets)

Ruggedcom RS900 Ethernet switches should be used at all roadside cabinets with fiber.

10.3 Video Encoders

Teleste MPEG-4 encoders should be installed at all CCTV sites. The VBrick MPEG-4 encoders should not be used.