Large Scale WiFi Deployment using MPLS/VPLS

Robert Patrick Harris, April 2015

Introduction

- Pat Harris
- Sr. Network Eng. for United States Sugar Corp.
- About U. S. Sugar Corp.
- Built around Mikrotik
- Our wireless system

United States Sugar Corporation

A brief summary of U. S. Sugar Corp.

- Headquartered in Clewiston, Florida, the Company farms over 180,000 acres and operates a state-of-the-art citrus nursery on 80 acres in Northern Florida.
- U.S. Sugar is the USA's largest vertically integrated producer of sugarcane and refined cane sugar.
- Our subsidiary, Southern Gardens Citrus, is one of Florida's major growers of oranges and processors of orange juice products.
- In season, we process up to 42,000 tons of sugarcane per day and produce ~750,000 tons of refined sugar per year.

Operational Excellence

Due to the size of our land holdings and the real-time, requirements of Opx, an innovative solution was required.

Cellular connectivity was ruled out due to cost availability and reliability.

Other technologies considered, such as WiMax, were also deemed too costly to deliver an expected ROI.

The chosen solution was to build a private wireless WAN based upon the 802.11 standard.

A combination of 120 to 140 foot towers, 50 foot towers, leased towers and sites on suitable tall structures within our plant facilities were used.

Design Considerations and requirements

- Direct client access.
- System wide roaming.
- Scalability
- Redundancy
- Enterprise security options compatible with a diverse array of client systems.
- Performance
- Cost
- Ease of Maintenance
- Ease of installation
- Availability of components

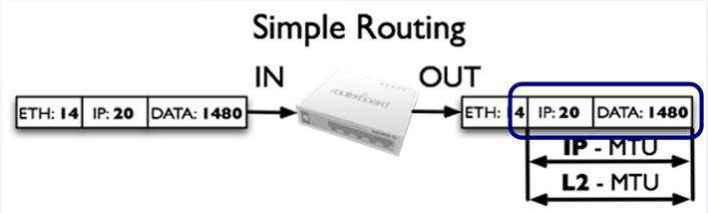
The solution to these requirements were met by ***Mikrotik***

Building an MPLS/VPLS System

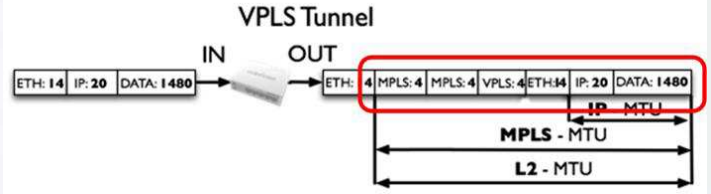
- When reviewing and selecting hardware consider interface MTU capability.

Referencing ***Mikrotik*** documentation regarding maximum transmission unit on RouterBoards it will be understood the requirements imposed when implementing VLAN's, MPLS, VPLS etc.

-Example of normal frame.



- Example of frame with additional bytes supporting MPLS and VPLS.



Reference Material drawn from:

http://wiki.mikrotik.com/wiki/Manual:Maximum_Transmission_Unit_on_RouterBoards

Building an MPLS/VPLS System

Normalize ROS and firmware releases.

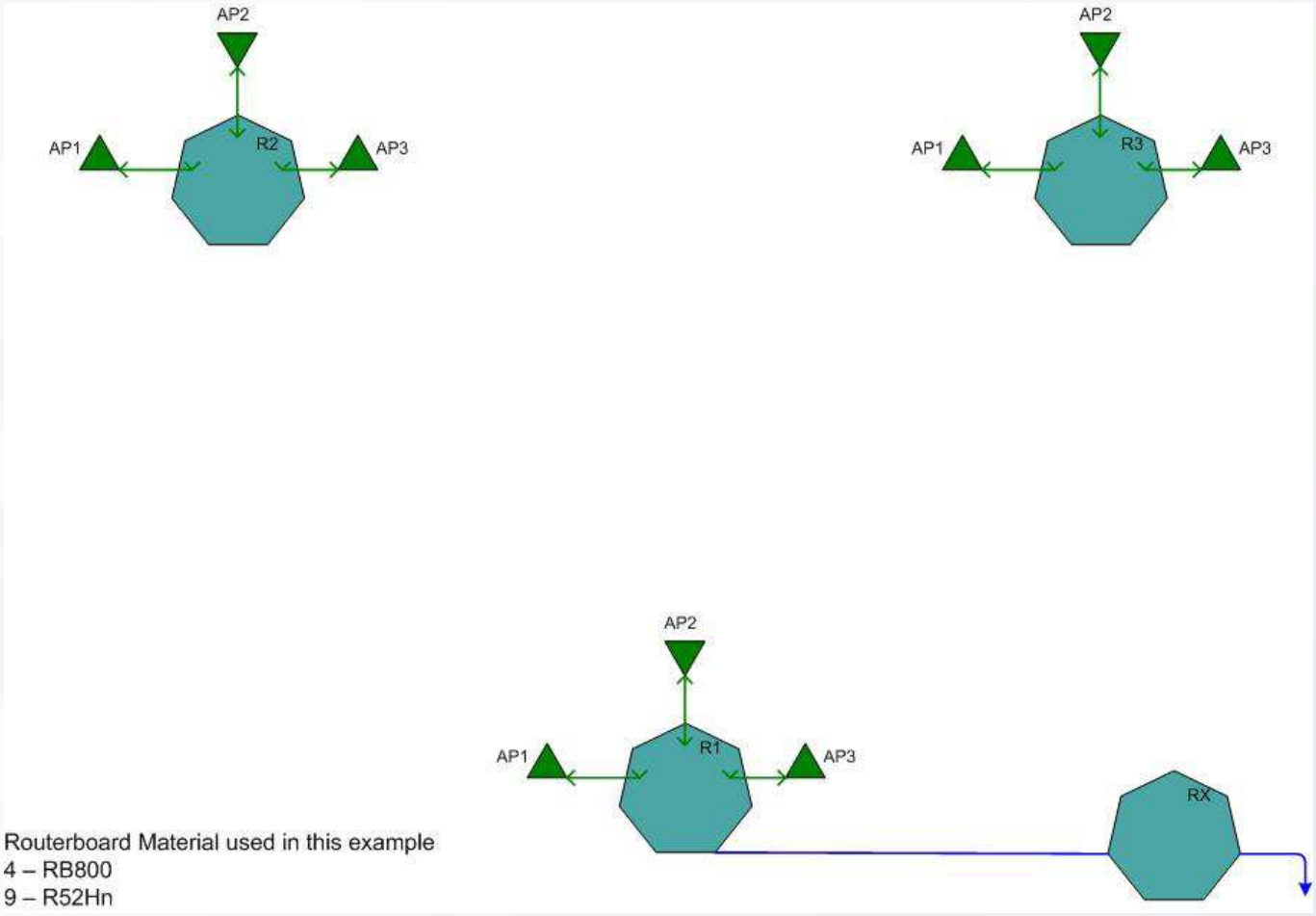
It is much easier to configure and troubleshoot systems when working on a common release. We are currently on release 6.27 with no problems.

Configure the system building blocks, loopback's, interfaces, logging, alerting, monitoring, dhcp, authentication methods, clock etc.

We can reference a small model system with some example output from a real production system.

Building an MPLS/VPLS System

A model to build upon.



Routerboard Material used in this example
4 – RB800
9 – R52Hn

Building an MPLS/VPLS System

```
# on router X
/interface bridge
    add name=Loopback0 protocol-mode=rstp
    add name=Bridge_E2
/interface bridge port add interface=ether2 disabled=no

# on routers 1, 2 and 3
/interface bridge
    add name=Loopback0 protocol-mode=rstp
    add name=VPLS_Bridge  ← Note no stp mode for this configuration
/interface bridge port add interface=AP1 horizon=1 disabled=no
/interface bridge port add interface=AP2 horizon=1 disabled=no
/interface bridge port add interface=AP3 horizon=1 disabled=no
```

Note: repeat configuration for each identical site, modify as required.

Building an MPLS/VPLS System

Establish IP connectivity, configure and address interfaces. RouterX

```
/ip address
    add address=1.0.0.1/32 disabled=no interface=Loopback0
    add address=172.16.1.2/30 disabled=no interface=ether1 network=172.16.1.0
    add address=172.16.2.1/30 disabled=no interface=ether2 network=172.16.2.0
    add address=10.5.5.1/24 disabled=no interface=Bridge_E2 network=10.5.5.0
# our example is small so we will issue DHCP from RouterX
/ip pool add name=pool1 ranges=10.5.5.10-10.5.5.250
/ip dhcp-server add name=vpls_dhcp interface=Bridge_E2 lease-time=3d \
  address-pool=pool1 add-arp=yes authoratative=after-2sec-delay
/ip dhcp network set address=10.5.5.0/24 gateway=10.5.5.1 netmask=24\
   dns-server=10.x.x.3,10.x.x.4
```

Output from a production tower.

```
[admin@USSC-VAUGHN-800] > ip dhcp-server print detail
Flags: X - disabled, I - invalid
 0   name="dhcp1" interface=VAUGHN_LANtoREF_LAN lease-time=1d
     address-pool=dhcp_pool1 bootp-support=static add-arp=yes
     authoritative=after-2sec-delay use-radius=yes lease-script=""
```


UNITED STATES SUGAR CORPORATION SOUTHERN GARDENS

Building an MPLS/VPLS System

Establish IP connectivity, configure wireless security profiles and address interfaces. Router1

/interface wireless security-profiles [Example]

add authentication-types=wpa2-psk group-ciphers=aes-ccm name=Profile1

unicast-ciphers=aes-ccm wpa2-pre-shared-key=K3y0fy0urC401c33

add authentication-types=wpa2-psk group-ciphers=aes-ccm name=Profile2

unicast-ciphers=aes-ccm wpa2-pre-shared-key= K3y0fy0urC401c34

Note: If radius authentication and accounting are used, the following commands are added to your wireless security profile.

radius-mac-authentication=yes radius-mac-accounting=yes interim-update=2m

/ip address

add address=1.1.1.1/32 disabled=no interface=Loopback0

add address=172.16.2.2/30 interface=ether2 network=172.16.2.0 disabled=no

add address=10.1.1.1/30 interface=wlan1 network=10.1.1.0 disabled=no

add address=10.1.1.5/30 interface=wlan2 network=10.1.1.0 disabled=no

add address=10.5.5.5/24 interface=VPLS_Bridge network=10.5.5.0 disabled=no

Building an MPLS/VPLS System

Establish IP connectivity, configure wireless security profiles and address interfaces. Router2

/interface wireless security-profiles [Example]

add authentication-types=wpa2-psk group-ciphers=aes-ccm name=Profile1

unicast-ciphers=aes-ccm wpa2-pre-shared-key=K3y0fy0urC401c33

add authentication-types=wpa2-psk group-ciphers=aes-ccm name=Profile2

unicast-ciphers=aes-ccm wpa2-pre-shared-key= K3y0fy0urC401c34

Note: If radius authentication and accounting are used, the following commands are added to the security profile.

radius-mac-authentication=yes radius-mac-accounting=yes interim-update=2m

/ip address

add address=1.1.1.2/32 disabled=no interface=Loopback0

add address=10.1.1.2/30 interface=wlan1 network=10.1.1.0 disabled=no

add address=10.1.1.9/30 interface=wlan2 network=10.1.1.0 disabled=no

add address=10.5.5.6/24 interface=VPLS_Bridge network=10.5.5.0 disabled=no

Building an MPLS/VPLS System

Establish IP connectivity, configure wireless security profiles and address interfaces. Router3

/interface wireless security-profiles [Example]

add authentication-types=wpa2-psk group-ciphers=aes-ccm name=Profile1

unicast-ciphers=aes-ccm wpa2-pre-shared-key=K3y0fy0urC401c33

add authentication-types=wpa2-psk group-ciphers=aes-ccm name=Profile2

unicast-ciphers=aes-ccm wpa2-pre-shared-key= K3y0fy0urC401c34

Note: If radius authentication and accounting are used, the following commands are added to the security profile.

radius-mac-authentication=yes radius-mac-accounting=yes interim-update=2m

/ip address

add address=1.1.1.3/32 disabled=no interface=Loopback0

add address=10.1.1.10/30 interface=wlan1 network=10.1.1.0 disabled=no

add address=10.1.1.6/30 interface=wlan2 network=10.1.1.0 disabled=no

add address=10.5.5.7/24 interface=VPLS_Bridge network=10.5.5.0 disabled=no

Building an MPLS/VPLS System

Establish IP connectivity, ensure devices see their neighbors, Links Up! Router1

/interface wireless

set interface=wlan1 band=5ghz or 2ghz channel-width=choose bandwidth
frequency=5XXX or 2XXX ht-txchains=0,1 if supported name=NameYourIF
mode=ap-bridge ssid=link1 nv2-cell-radius=SET as required
nv2-preshared-key=" K3y0fy0urC401c33 " nv2-qos=default nv2-queue-count=4
nv2-security=enabled security-profile=Profile1 tdma-period-size=2
wireless-protocol=nv2 wmm-support=enabled default-forwarding=no disabled=no
set interface=wlan2 band=5ghz or 2ghz channel-width=choose bandwidth
frequency=5XXX or 2XXX ht-txchains=0,1 if supported name=NameYourIF
mode=station ssid=link2 nv2-cell-radius=SET as required
nv2-preshared-key=" K3y0fy0urC401c33 " nv2-qos=default nv2-queue-count=4
nv2-security=enabled security-profile=Profile1 tdma-period-size=2
wireless-protocol=nv2 wmm-support=enabled default-forwarding=no disabled=no

Building an MPLS/VPLS System

Establish IP connectivity, ensure devices see their neighbors. Router1

/interface wireless

set interface=wlan3 band=5ghz or 2ghz channel-width=choose bandwidth frequency=5XXX or 2XXX ht-txchains=0,1 if supported name=NameYourIF security-profile=Profile2 mode=ap-bridge ssid=AP1 disabled=no wireless-protocol=802.11 wmm-support=enabled default-forwarding=no

set interface=wlan4 band=5ghz or 2ghz channel-width=choose bandwidth frequency=5XXX or 2XXX ht-txchains=0,1 if supported name=NameYourIF security-profile=Profile2 mode=ap-bridge ssid=AP2 disabled=no wireless-protocol=802.11 wmm-support=enabled default-forwarding=no

set interface=wlan5 band=5ghz or 2ghz channel-width=choose bandwidth frequency=5XXX or 2XXX ht-txchains=0,1 if supported name=NameYourIF security-profile=Profile2 mode=ap-bridge ssid=AP3 disabled=no wireless-protocol=802.11 wmm-support=enabled default-forwarding=no

Building an MPLS/VPLS System

Establish IP connectivity, ensure devices see their neighbors, Links Up! Router2

/interface wireless

set interface=wlan1 band=5ghz or 2ghz channel-width=choose bandwidth frequency=5XXX or 2XXX ht-txchains=0,1 if supported name=NameYourIF mode=station ssid=link1 nv2-cell-radius=SET as required nv2-preshared-key=" K3y0fy0urC401c33 " nv2-qos=default nv2-queue-count=4 nv2-security=enabled security-profile=Profile1 tdma-period-size=2 wireless-protocol=nv2 wmm-support=enabled default-forwarding=no disabled=no

set interface=wlan2 band=5ghz or 2ghz channel-width=choose bandwidth frequency=5XXX or 2XXX ht-txchains=0,1 if supported name=NameYourIF mode=ap-bridge ssid=link2 nv2-cell-radius=SET as required nv2-preshared-key=" K3y0fy0urC401c33 " nv2-qos=default nv2-queue-count=4 nv2-security=enabled security-profile=Profile1 tdma-period-size=2 wireless-protocol=nv2 wmm-support=enabled default-forwarding=no disabled=no

UNITED STATES SUGAR CORPORATION SOUTHERN GARDENS

Building an MPLS/VPLS System

Establish IP connectivity, ensure devices see their neighbors. Router2

/interface wireless

set interface=wlan3 band=5ghz or 2ghz channel-width=choose bandwidth frequency=5XXX or 2XXX ht-txchains=0,1 if supported name=NameYourIF security-profile=Profile2 mode=ap-bridge ssid=AP1 disabled=no wireless-protocol=802.11 wmm-support=enabled default-forwarding=no

set interface=wlan4 band=5ghz or 2ghz channel-width=choose bandwidth frequency=5XXX or 2XXX ht-txchains=0,1 if supported name=NameYourIF security-profile=Profile2 mode=ap-bridge ssid=AP2 disabled=no wireless-protocol=802.11 wmm-support=enabled default-forwarding=no

set interface=wlan5 band=5ghz or 2ghz channel-width=choose bandwidth frequency=5XXX or 2XXX ht-txchains=0,1 if supported name=NameYourIF security-profile=Profile2 mode=ap-bridge ssid=AP3 disabled=no wireless-protocol=802.11 wmm-support=enabled default-forwarding=no

Building an MPLS/VPLS System

Establish IP connectivity, ensure devices see their neighbors, Links Up! Router3

/interface wireless

set interface=wlan1 band=5ghz or 2ghz channel-width=choose bandwidth
frequency=5XXX or 2XXX ht-txchains=0,1 if supported name=NameYourIF
mode=station ssid=link1 nv2-cell-radius=SET as required
nv2-preshared-key=" K3y0fy0urC401c33 " nv2-qos=default nv2-queue-count=4
nv2-security=enabled security-profile=Profile1 tdma-period-size=2
wireless-protocol=nv2 wmm-support=enabled default-forwarding=no disabled=no
set interface=wlan2 band=5ghz or 2ghz channel-width=choose bandwidth
frequency=5XXX or 2XXX ht-txchains=0,1 if supported name=NameYourIF
mode=ap-bridge ssid=link2 nv2-cell-radius=SET as required
nv2-preshared-key=" K3y0fy0urC401c33 " nv2-qos=default nv2-queue-count=4
nv2-security=enabled security-profile=Profile1 tdma-period-size=2
wireless-protocol=nv2 wmm-support=enabled default-forwarding=no disabled=no

Building an MPLS/VPLS System

Establish IP connectivity, ensure devices see their neighbors. Router3

/interface wireless

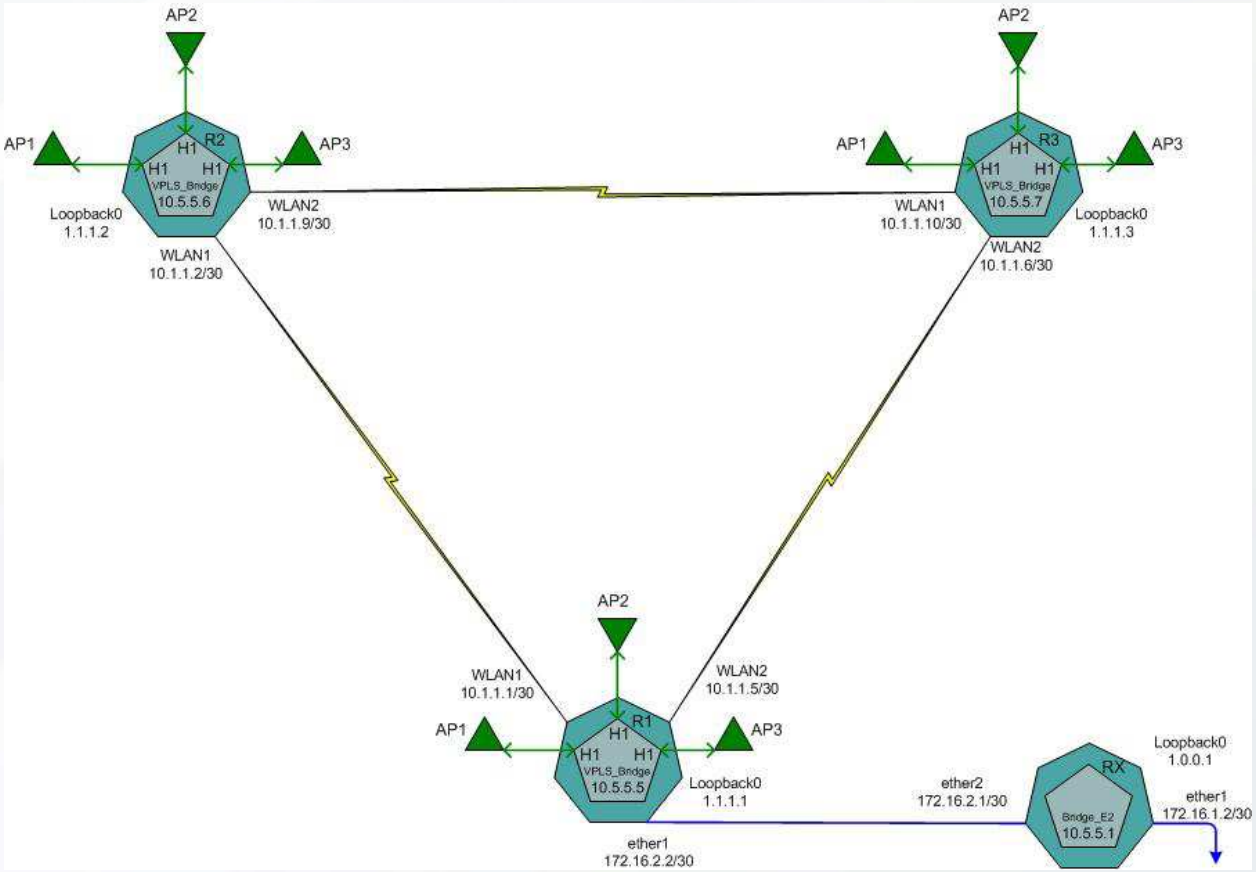
set interface=wlan3 band=5ghz or 2ghz channel-width=choose bandwidth frequency=5XXX or 2XXX ht-txchains=0,1 if supported name=NameYourIF security-profile=Profile2 mode=ap-bridge ssid=AP1 disabled=no wireless-protocol=802.11 wmm-support=enabled default-forwarding=no

set interface=wlan4 band=5ghz or 2ghz channel-width=choose bandwidth frequency=5XXX or 2XXX ht-txchains=0,1 if supported name=NameYourIF security-profile=Profile2 mode=ap-bridge ssid=AP2 disabled=no wireless-protocol=802.11 wmm-support=enabled default-forwarding=no

set interface=wlan5 band=5ghz or 2ghz channel-width=choose bandwidth frequency=5XXX or 2XXX ht-txchains=0,1 if supported name=NameYourIF security-profile=Profile2 mode=ap-bridge ssid=AP3 disabled=no wireless-protocol=802.11 wmm-support=enabled default-forwarding=no

Building an MPLS/VPLS System

What we have as an example. Three linked sites each with two backhauls and three access points for broadcast.



Building an MPLS/VPLS System

Configure and secure your routing protocols on your routers. For R1, R2 and R3

/routing ospf instance

set [find default=yes] redistribute-connected=as-type-1 \

redistribute-static=as-type-1 router-id="**Loopback0**"

/routing ospf interface

add authentication=**md5** authentication-key=**ospfkey** interface=**Wlan1** \

network-type=**point-to-point**

add interface=**Loopback0** network-type=**broadcast** passive=**yes**

add authentication=**md5** authentication-key=**ospfkey** interface=**Wlan2** \

network-type=**point-to-point**

/routing ospf network

add area=backbone network=**10.1.1.0/24**

add area=backbone network=**Loopback0/32**

For R1 include the following config.

add authentication=**md5** authentication-key=**ospfkey** interface=**ether1** \

network-type=**point-to-point**

Add area=backbone network=**172.16.2.0/24**

Building an MPLS/VPLS System

Configure and secure your routing protocols on your router X.

```
/routing ospf instance
set [ find default=yes ] redistribute-connected=as-type-1 \
    redistribute-static=as-type-1 router-id="Loopback0"
/routing ospf interface
add authentication=md5 authentication-key=ospfkey interface=ether1 \
    network-type=point-to-point
add interface=Loopback0 network-type=broadcast passive=yes
add authentication=md5 authentication-key=ospfkey interface=ether2 \
    network-type=point-to-point
/routing ospf network
add area=backbone network=10.1.1.0/24
add area=backbone network=172.16.1.0/30
add area=backbone network=172.16.2.0/30
add area=backbone network=Loopback0/32
```

Building an MPLS/VPLS System

[admin@Ref_800] > routing ospf neighbor print

0 instance=default router-id=**10.X.X.105** address=172.X.X.129 interface=Interface1
priority=1 dr-address=0.0.0.0 backup-dr-address=0.0.0.0 state="**Full**"
state-changes=4 ls-retransmits=0 ls-requests=0 db-summaries=0
adjacency=**8w4d20h11m10s**

1 instance=default router-id=**10.X.X.70** address=192.X.X.2 interface=Interface2
priority=1 dr-address=0.0.0.0 backup-dr-address=0.0.0.0 state="**Full**"
state-changes=4 ls-retransmits=0 ls-requests=0 db-summaries=0
adjacency=**2w5d10h18m13s**

Building an MPLS/VPLS System

Now we will add MPLS to our network, all interfaces forwarding traffic up to PE should be included in this configuration.

 # on all routers

/mpls

set dynamic-label-range=**16000-1048575 <- Consider leaving an open range for future options**

/mpls ldp

set enabled=yes lsr-id=**Loopback0** transport-address=**Loopback0**

 # on router X

/mpls interface

set [find default=yes] mpls-mtu=**1526 <- As required and supported**

add interface=ether2 mpls-mtu=**1526 <- As required and supported**

/mpls ldp interface

add interface=**ether2**

Building an MPLS/VPLS System

 # on router R1
/mpls
set dynamic-label-range=**16000-1048575 <- Consider leaving an open range for future options**

/mpls ldp
set enabled=yes lsr-id=**Loopback0** transport-address=**Loopback0**

/mpls interface
set [find default=yes] mpls-mtu=**1526 <- As required and supported**
add interface=ether1 mpls-mtu=**1526 <- As required and supported**
add interface=wlan1 mpls-mtu= **1526<- As required and supported**
add interface=wlan2 mpls-mtu=**1526 <- As required and supported**
/mpls ldp interface
add interface=**ether1**
add interface=**wlan1**
add interface=**wlan2**

Building an MPLS/VPLS System

 # on router R2 and R3

/mpls

set dynamic-label-range=**16000-1048575 <- Consider leaving an open range for future options**

/mpls ldp

set enabled=yes lsr-id=**Loopback0** transport-address=**Loopback0**

/mpls interface

set [find default=yes] mpls-mtu=**1526 <- As required and supported**

add interface=wlan1 mpls-mtu=**1526 <- As required and supported**

add interface=wlan2 mpls-mtu=**1526 <- As required and supported**

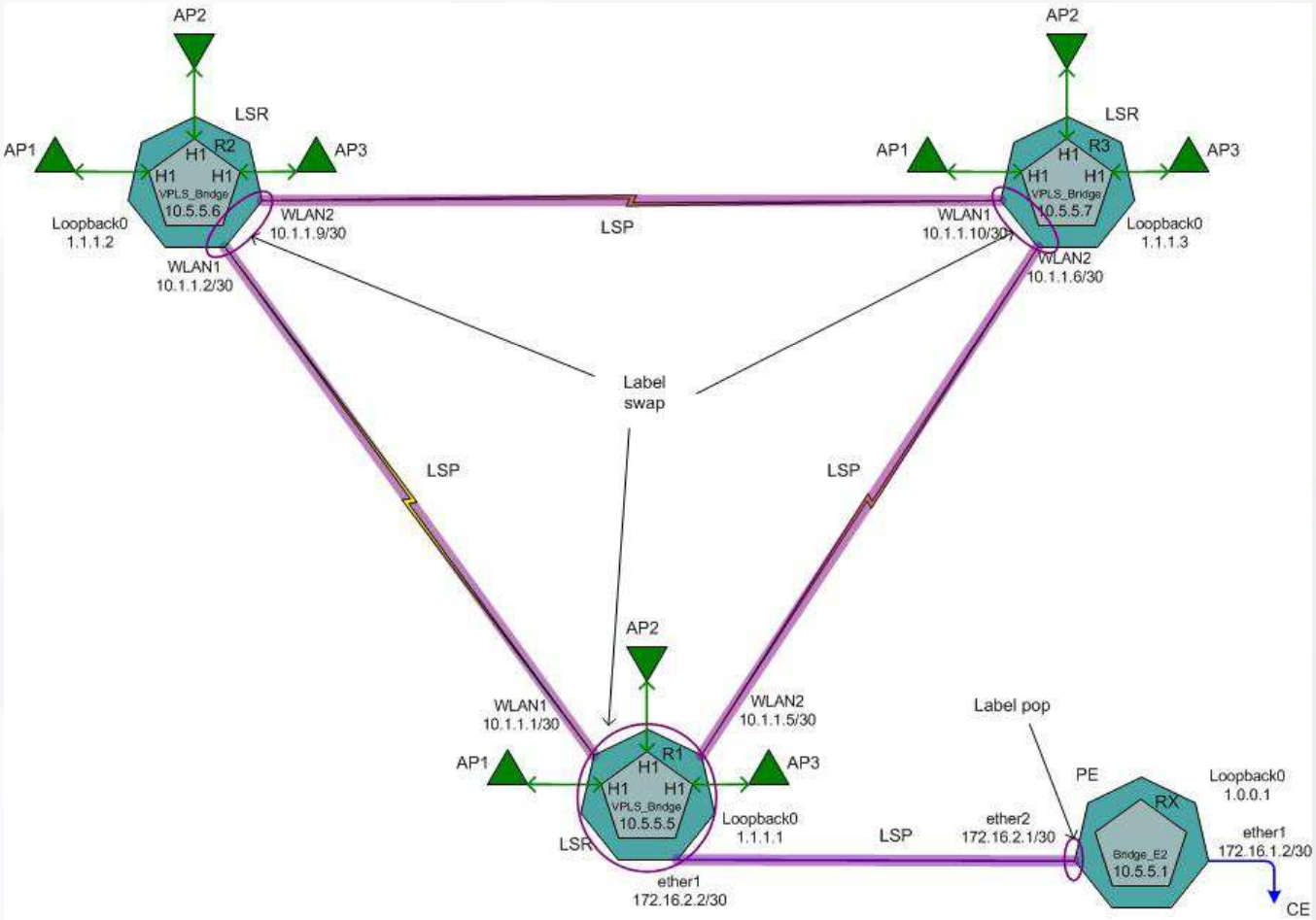
/mpls ldp interface

add interface=**wlan1**

add interface=**wlan2**

Building an MPLS/VPLS System

Now we have added MPLS to our system.



Building an MPLS/VPLS System

An example from a production Tower.

```
[admin@USSC-VAUGHN-800] > mpls ldp neighbor print
Flags: X - disabled, D - dynamic, O - operational, T - sending-targeted-hello,V - vpls
 #              TRANSPORT            LOCAL-TRANSPORT      PEER                SEN
 0 DO           10.x.x.128           10.x.x.119           10.x.x.128:0         no
 1 DO           10.x.x.116           10.x.x.119           10.x.x.116:0         no
[admin@USSC-VAUGHN-800] > mpls remote-bindings print
Flags: X - disabled, A - active, D - dynamic
 #    DST-ADDRESS       NEXTHOP            LABEL      PEER
 0 AD 10.x.x.105/32     172.x.x.197        23897      10.x.x.128:0
 1 AD 10.x.x.0/24       172.x.x.197        23134      10.x.x.128:0
 2 AD 172.x.x.184/30    172.x.x.197        23136      10.x.x.128:0
 3 AD 10.x.x.0/24       172.x.x.197        23137      10.x.x.128:0
 4 AD 172.x.x.0/24      172.x.x.197        23139      10.x.x.128:0
 5 AD 10.x.x.0/24       172.x.x.197        23140      10.x.x.128:0
 6 AD 10.x.x.0/24       172.x.x.197        23141      10.x.x.128:0
 7 AD 10.x.x.115/32     172.x.x.98         16348      10.x.x.116:0
```

Building an MPLS/VPLS System

[admin@USSC-VAUGHN-800] > mpls local-bindings print
Flags: X - disabled, A - advertised, D - dynamic,
L - local-route, G - gateway-route, e - egress

#	DST-ADDRESS	LABEL	PEERS
0 ADLe	10.X.X.119/32	impl-null	10.X.X.116:0
			10.X.X.128:0
1 ADG	172.X.X.44/30	43353	10.X.X.116:0
			10.X.X.128:0
2 ADG	10.X.X.109/32	43354	10.X.X.116:0
			10.X.X.128:0
3 ADG	10.X.X.107/32	43355	10.X.X.116:0

Building an MPLS/VPLS System

We will use BGP to signal reach ability for our VPLS tunnels.

On a tower router (R2) we will use the default instance.

```
/routing bgp instance set router-id=1.1.1.2 client-to-client-reflection=yes
/routing bgp peer set address-families=l2vpn name=R2_R1peer remote-address=1.1.1.1\
 remote-as=65530 tcp-md5-key=bgpkey update-source=Loopback0
```

On a tower router (R3) we will also use the default instance.

```
/routing bgp instance set router-id=1.1.1.3 client-to-client-reflection=yes
/routing bgp peer set address-families=l2vpn name=R3_R1peer remote-address=1.1.1.1\
 remote-as=65530 tcp-md5-key=bgpkey update-source=Loopback0
```

On router (RX) we will use the default instance.

```
/routing bgp instance set router-id=1.0.0.1 client-to-client-reflection=yes
/routing bgp peer set address-families=l2vpn name=RX_R1peer remote-address=1.1.1.1\
 remote-as=65530 tcp-md5-key=bgpkey update-source=Loopback0
```

Building an MPLS/VPLS System

Even though our example system is quite small we will use route reflection.

So on a tower router (R1) we will again use the default instance.

```
/routing bgp instance set router-id=1.1.1.1 client-to-client-reflection=yes

/routing bgp peer set address-families=l2vpn name=R1_R2peer remote-address=1.1.1.2\
 remote-as=65530 route-reflect=yes tcp-md5-key=bgpkey update-source=Loopback0

/routing bgp peer set address-families=l2vpn name=R1_R3peer remote-address=1.1.1.3\
 remote-as=65530 route-reflect=yes tcp-md5-key=bgpkey update-source=Loopback0

/routing bgp peer set address-families=l2vpn name=R1_RXpeer remote-address=1.0.0.1\
 remote-as=65530 route-reflect=yes tcp-md5-key=bgpkey update-source=Loopback0
```

Building an MPLS/VPLS System

Output from a route reflector.

```
[admin@USSC600-433] > routing bgp peer print
Flags: X - disabled, E - established
 #   INSTANCE          REMOTE-ADDRESS          REMOTE-AS
 0 E default           10.x.x.103                65530
 1 E default           10.x.x.107                65530        <- Peer is another reflector
 2 E default           10.x.x.109                65530
 3 E default           10.x.x.115                65530
 4 E default           10.x.x.111                65530
 5 E default           10.x.x.120                65530
 6 E default           10.x.x.114                65530
```

etc.

Output from a tower.

```
[admin@USSC-VAUGHN-800] > routing bgp peer print
Flags: X - disabled, E - established
 #    INSTANCE         REMOTE-ADDRESS      REMOTE-AS
 0 E   default          10.x.x.107            65530          <- peered with route reflectors
 1 E   default          10.x.x.105            65530           <- peered with route reflectors
```

Building an MPLS/VPLS System

```
[admin@USSC-VAUGHN-800] > routing bgp peer print detail
Flags: X - disabled, E - established
 0 E name="VA-LH433peer" instance=default remote-address=10.X.X.107
     remote-as=65530 tcp-md5-key=“bgpkey" nexthop-choice=default
     multihop=no route-reflect=no hold-time=3m ttl=255 in-filter=""
     out-filter="" address-families=l2vpn update-source=Loopback0
     default-originate=never remove-private-as=no as-override=no passive=no
     use-bfd=no

 1 E name="VA-600_433peer" instance=default remote-address=10.X.X.105
     remote-as=65530 tcp-md5-key=“bgpkey" nexthop-choice=default
     multihop=no route-reflect=no hold-time=3m ttl=255 in-filter=""
     out-filter="" address-families=l2vpn update-source=Loopback0
     default-originate=never remove-private-as=no as-override=no passive=no
     use-bfd=no
```

Building an MPLS/VPLS System

Set up your vpls tunnels

```
/interface vpls bgp-vpls <- Egress Bridge
# on router RX
add bridge=Bridge_E2 bridge-cost=0 bridge-horizon=3 export-route-targets=1:1 \
   import-route-targets=1:1 site-id=4 name=VPLS_RX>R1 route-distinguisher=1:1
add bridge=Bridge_E2 bridge-cost=0 bridge-horizon=3 export-route-targets=2:2 \
   import-route-targets=2:2 site-id=4 name=VPLS_RX>R2 route-distinguisher=2:2
add bridge=Bridge_E2 bridge-cost=0 bridge-horizon=3 export-route-targets=3:3 \
   import-route-targets=2:2 site-id=4 name=VPLS_RX>R3 route-distinguisher=3:3

/interface vpls bgp-vpls  <- Tower Bridge R1
   add name="VPLS_R1>RX" route-distinguisher=1:1 import-route-targets=1:1
            export-route-targets=1:1 site-id=1 bridge=VPLS_Bridge
            bridge-cost=0 bridge-horizon=2 use-control-word=yes
```

Building an MPLS/VPLS System

Set up your vpls tunnels

/interface vpls bgp-vpls <- Tower Bridge R2

add name="VPLS_R2>RX" route-distinguisher=2:2 import-route-targets=2:2
export-route-targets=2:2 site-id=2 bridge=VPLS_Bridge
bridge-cost=0 bridge-horizon=2 use-control-word=yes

/interface vpls bgp-vpls <- Tower Bridge R3

add name="VPLS_R3>RX" route-distinguisher=3:3 import-route-targets=3:3
export-route-targets=3:3 site-id=3 bridge=VPLS_Bridge
bridge-cost=0 bridge-horizon=2 use-control-word=yes

Building an MPLS/VPLS System

Output from an egress bridge.

```
[admin@REF-RB1200] > interface vpls print brief
Flags: X - disabled, R - running, D - dynamic, B - bgp-signaled, C - cisco-bgp-signaled
 #    NAME          REMOTE-PEER     VPLS-ID                  VPLS
 0 RDB vpls328      10.X.X.104                               VPLS_5n
 1 RDB vpls329      10.X.X.123                               REF1200-
 2 RDB vpls330      10.X.X.122                               REF1200-
 3 RDB vpls343      10.X.X.104                               REF1200-
 4 RDB vpls380      10.X.X.126                               REF1200-
 5 RDB vpls382      10.X.X.118                               VPLS_5n
 6 RDB vpls387      10.X.X.118                               REF1200-
ETC.
```

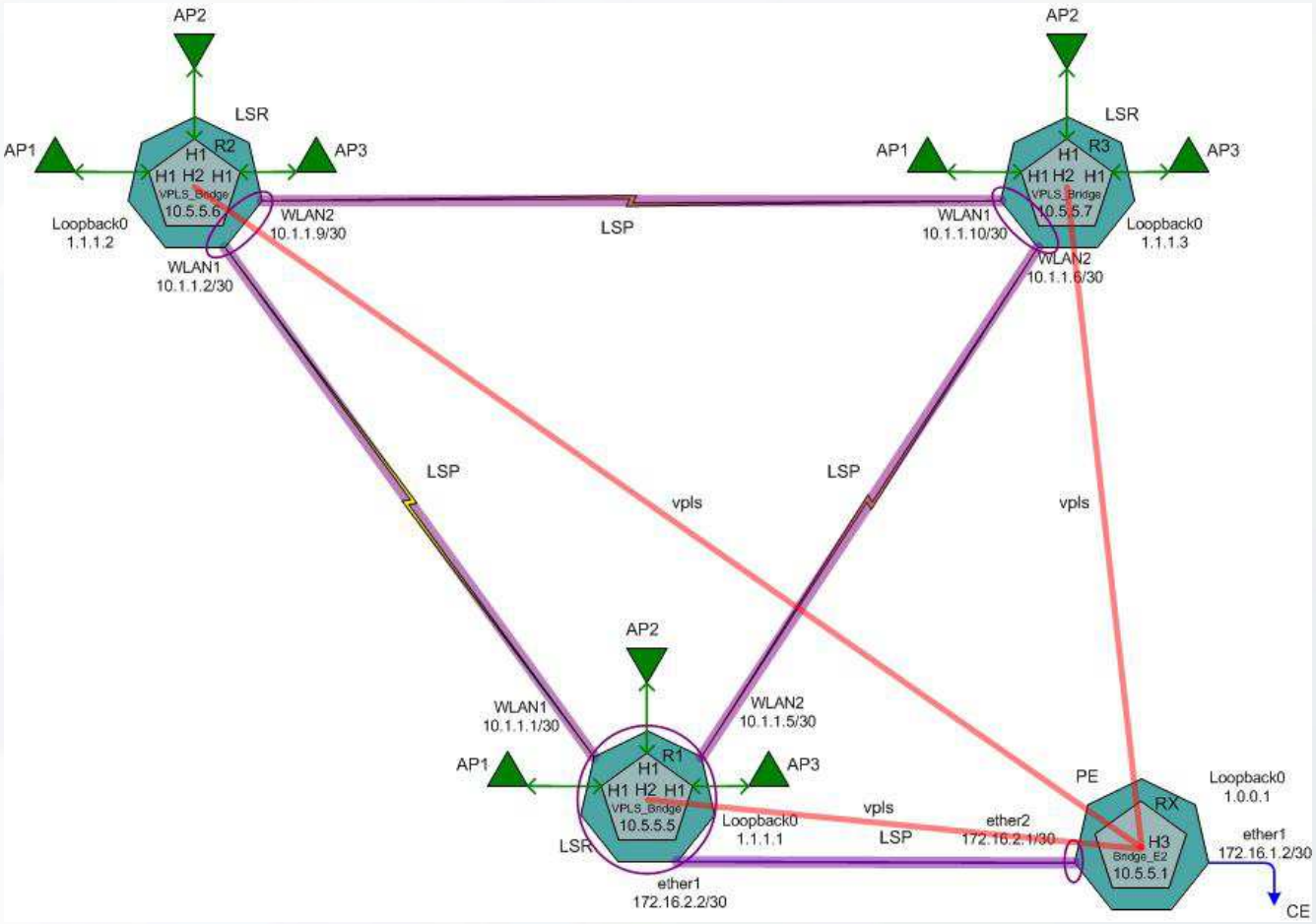
Output from a tower bridge.

```
[admin@USSC-VAUGHN-800] > interface vpls bgp-vpls print
Flags: X - disabled, I - inactive
 #           NAME                ROUTE-DISTINGUISHER          SITE-ID BRIDGE
 0           VA-REF1200          8:8                          14 VAUGHN_LANto...
```


UNITED STATES SUGAR CORPORATION SOUTHERN GARDENS

What we have built.

How has our system evolved. Our tower LANs can forward data.



A few tips.

Disable services not required for operations, Set ACL's for access to management protocols and consider disabling unsecure services.

/ip service set address=10.10.10.10 port=8291 disabled=no

/ip service set address=10.10.10.10 port=22 disabled=no

/ip service disable 0

/ip service disable 1

Output from a production router.

[admin@RB2011-H] > ip service print

Flags: X - disabled, I - invalid

#	NAME	PORT	ADDRESS	CERTIFICATE
0	X telnet	23	10.X.X.0/24	
			172.X.X.0/24	
1	X ftp	21	10.X.X.0/24	

Time is an important component to coordinate system functions, scheduling, logging etc.

/system ntp client set enabled=yes primary-ntp=10.x.x.1 secondary-ntp=10.x.x.2

/system clock set time-zone-name=est5edt

Additional Tips.

- Alerting can be considered and configured in various ways . We use the Dude and Solar Winds NPM, there are many options both commercial and open source to choose from. Also consider configuring an alert upon login to critical devices.
- tool e-mail set address=Mail Xchanger n.n.n.n from=YourDevice@yourco.com
- system logging action set name=action1 target=email email-to=netadmin@yourco.com
- system logging set topics=account action=action1
- Authentication to your device may be managed in various ways. ***Mikrotik*** supports various options. Consider limiting access to your device by subnet, user group with reduced privilege. Radius authentication offers more centralized control of access and accountability for logged in users.
- user group add name=limitpriv policy=local,telnet,ssh,read,winbox,!ftp,!reboot,!write,!policy,!test,!password,!web,!sniff,!sensitive,!api
- user aaa set use-radius=yes accounting=yes default-group=limitpriv
- radius add service=login address=1.1.1.1 secret=secret

Note: If radius authentication and accounting are used, the following commands are added to your wireless security profile.

radius-mac-authentication=**yes** radius-mac-accounting=**yes** interim-update=**(n)m** <- your call

Some log output from the radius server

Passed Authentication examples:

Date	Time	Message-Type	User-Name	Group-Na	NAS-Port	NAS-IP-Address
4/5/2015	0:54:28	Authen OK	00:17:47:12:34:56	Group 3	2202046826	172.X.X.34
4/5/2015	0:58:30	Authen OK	00:20:4A:12:34:56	Group 3	2202046827	172.X.X.34
4/5/2015	4:27:29	Authen OK	00:17:47:12:34:56	Group 3	2202046832	172.X.X.34
4/5/2015	4:29:58	Authen OK	00:19:88:12:34:56	Group 3	2202046833	172.X.X.34

Failed Authentication examples:

Date	Time	Message-Type	User-Name	Group-Name	Caller-ID	Authen-Failure-Code	NAS-IP-Address
4/5/2015	0:01:50	Authen failed	90:B6:86:21:A2:EE	Default Group	90-B6-86-21-A2-EE	External DB user invalid or bad password	10.X.X.130
4/5/2015	16:37:45	Authen failed	00:1C:58:57:40:8B	Default Group	1:0:1c:58:57:40:8b	External DB user invalid or bad password	172.X.X.34
4/5/2015	16:37:45	Authen failed	00:1C:58:57:40:8B	Default Group	1:0:1c:58:57:40:8b	External DB user invalid or bad password	10.X.X.119
4/5/2015	16:44:35	Authen failed	00:1C:58:57:40:8B	Default Group	1:0:1c:58:57:40:8b	External DB user invalid or bad password	172.X.X.34
4/5/2015	16:44:35	Authen failed	00:1C:58:57:40:8B	Default Group	1:0:1c:58:57:40:8b	External DB user invalid or bad password	10.X.X.119
4/5/2015	20:56:00	Authen failed	90:B6:86:21:A2:EE	Default Group	90-B6-86-21-A2-EE	External DB user invalid or bad password	10.X.X.130

Additional notes:

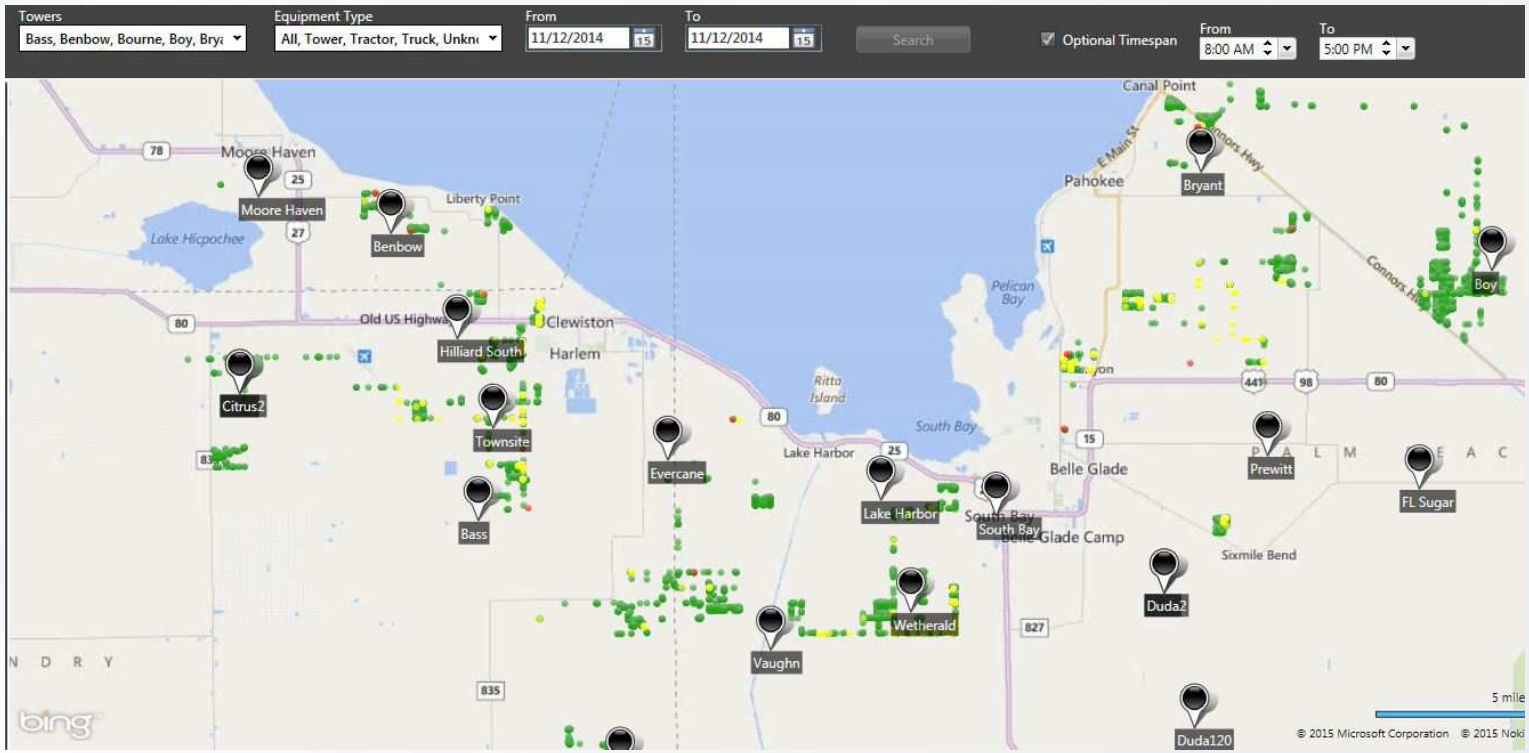
- You may enhance your system with traffic engineering, packet marking and prioritization, consider scripting to automate desired functions.

One of the scripts we run collect registration stats from the towers that are uploaded via FTP and combined with GPS location data that is fed to an application that displays. Client signal level and quality in relation to location from tower.

```
:for fileCount from=1 to=1440 do={
interface wireless registration-table print stats file="/Stats/WiFistats$fileCount";
:delay 1m;
}
```

How is this data used?

An application developed in house renders the data collected from the towers into a format that permits the overall observation of client performance. Over time this data can reveal a dynamic coverage map and output can be compared against baseline performance to identify and address any possible issues.

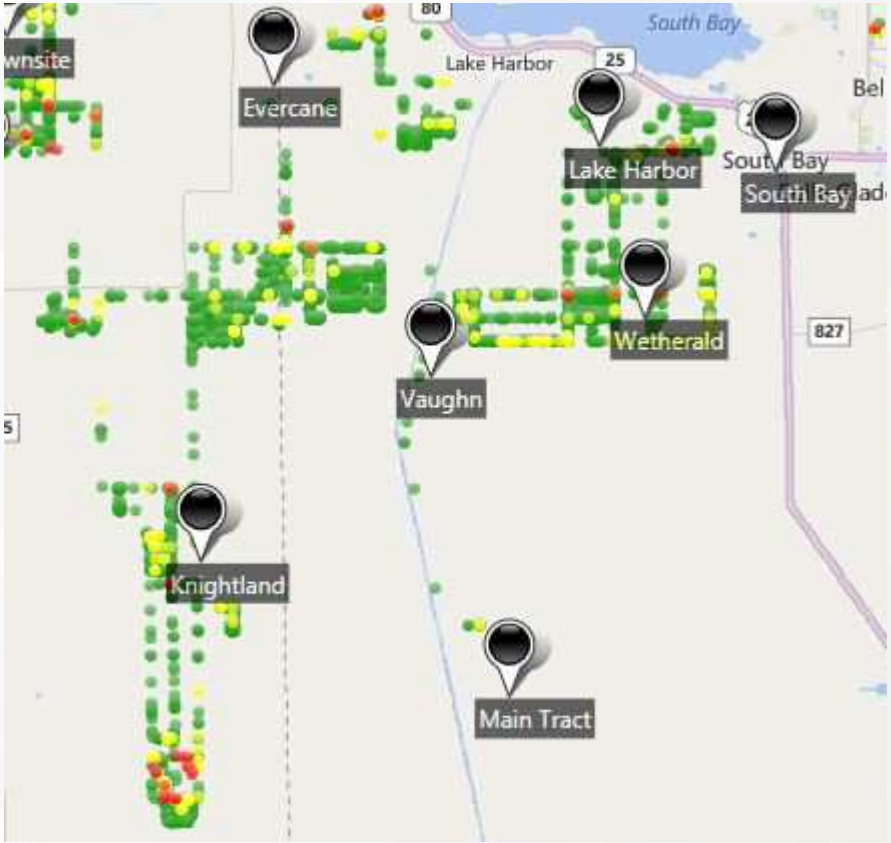


How is this data used?

Additional output. Hovering a data point with some statistical detail

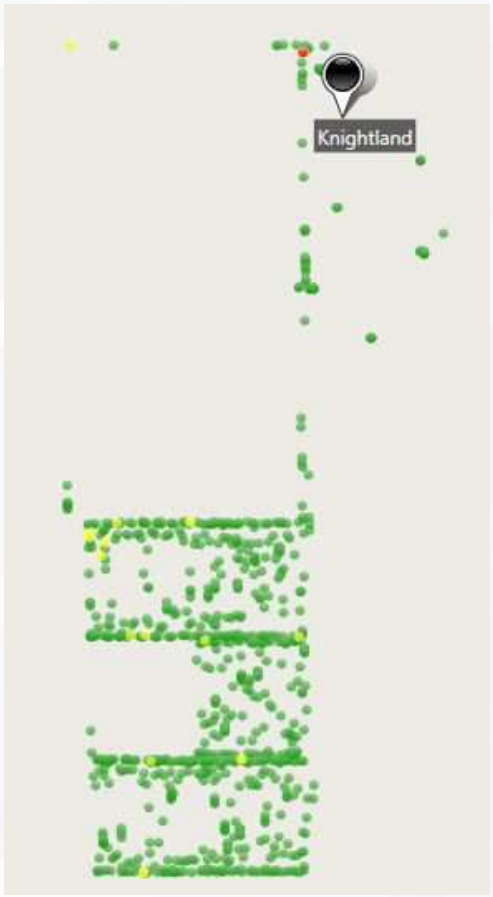
How is this data used?

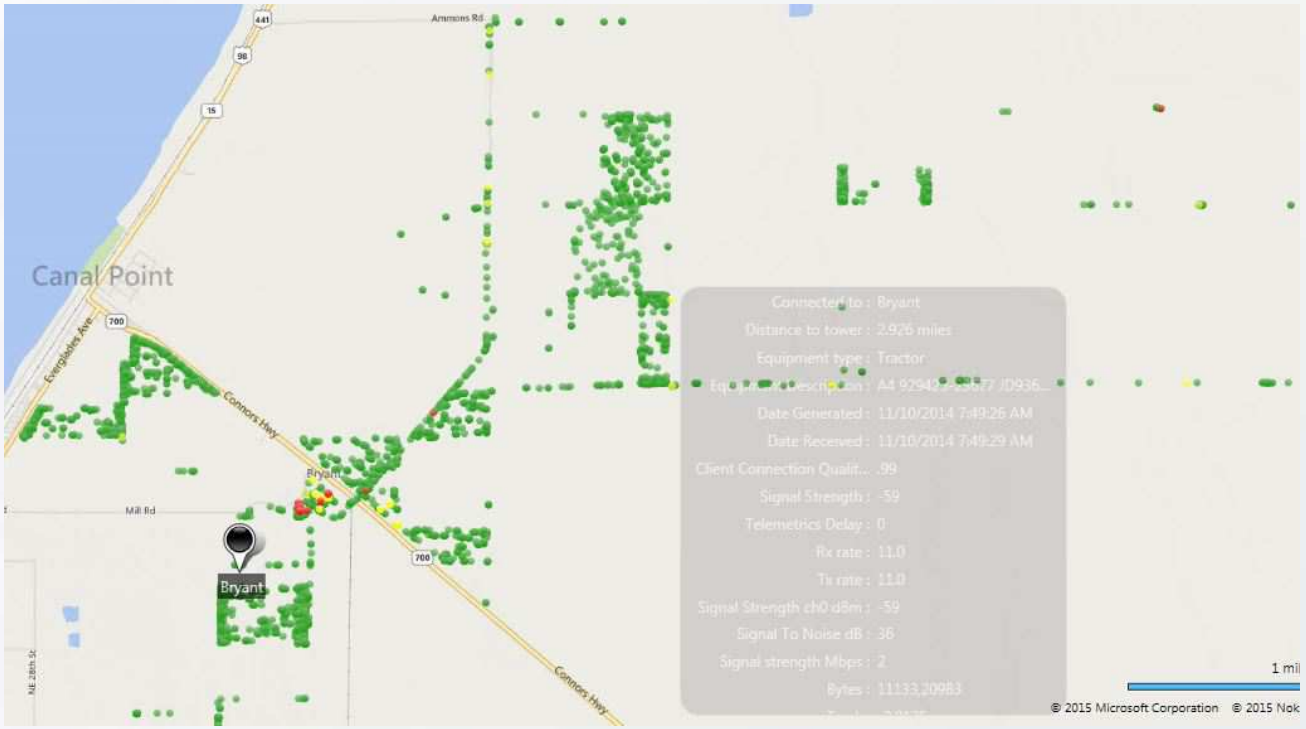
Additional output. Zoomed in reveals more activity.



How is this data used?

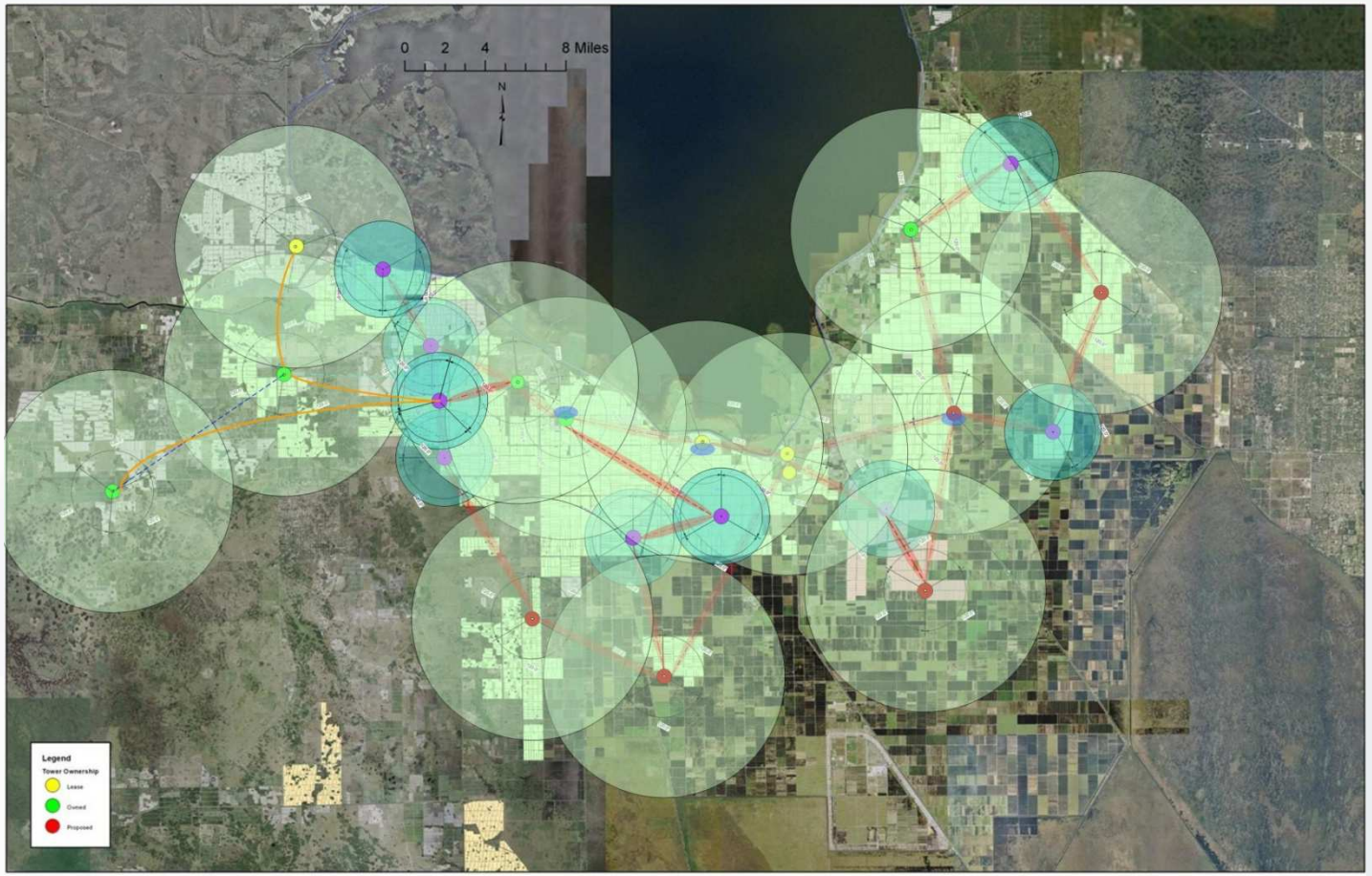
Additional output. Zoomed in views. The daily progress may be followed.



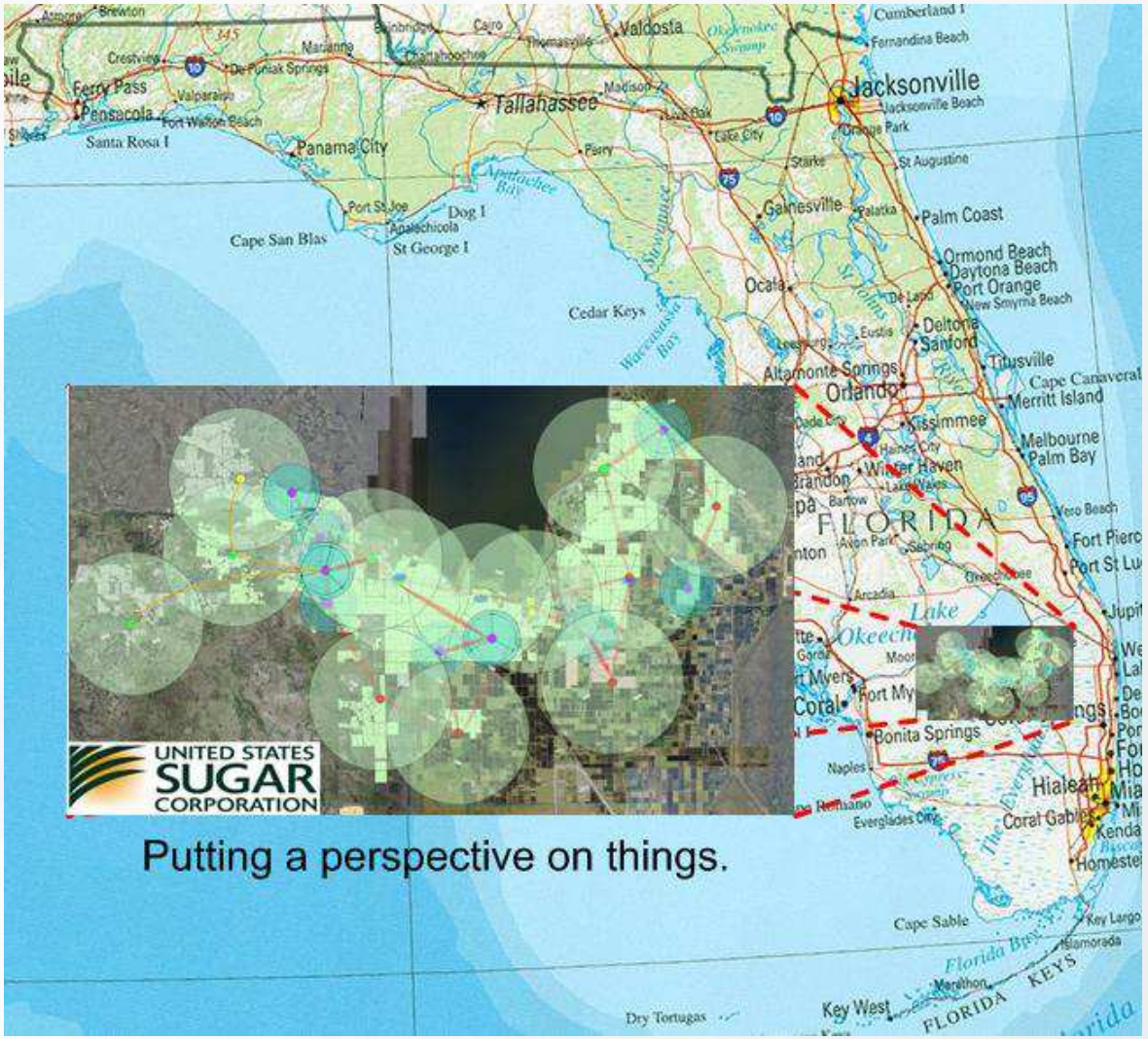


Our System

A 300~ square mile (77,600 hectare) network.



Our System

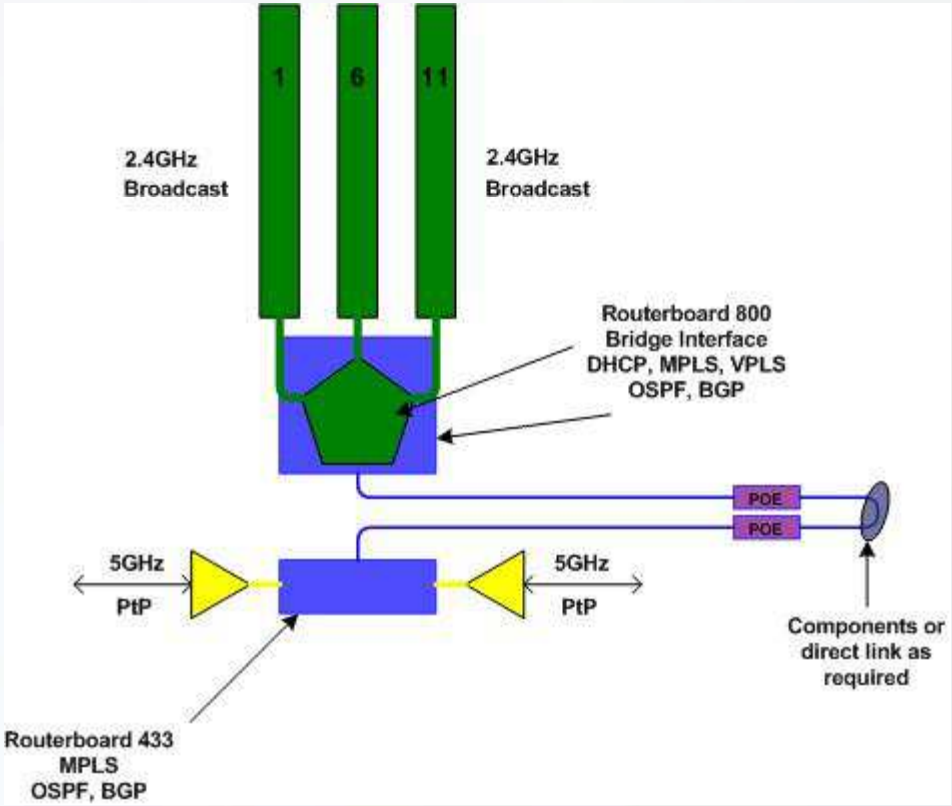


UNITED STATES SUGAR CORPORATION SOUTHERN GARDENS

Our System

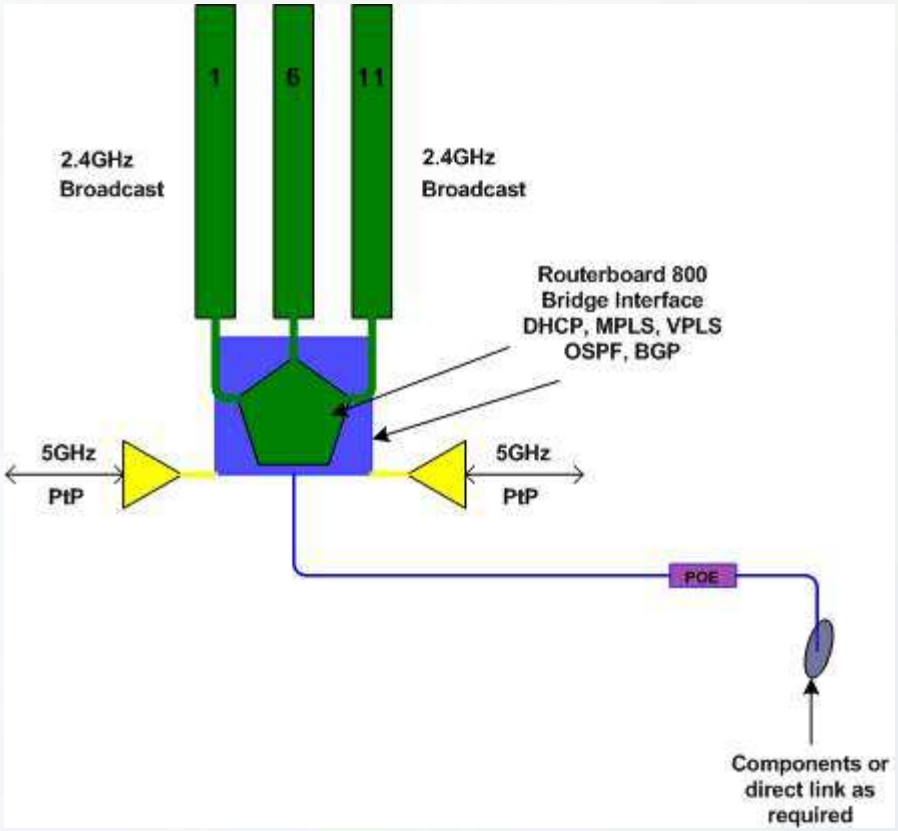
Configurations

- We will display two different form factors as applied in the field.
- One design employs separate Routerboards for the point to point and broadcast duties.



Configurations

- We will display two different form factors as applied in the field.
- The other combines point to point and broadcast duties.



Reference Material

- http://wiki.mikrotik.com/wiki/Manual:MPLS/EXP_bit_behaviour
- http://wiki.mikrotik.com/wiki/MPLSVPLS
- http://wiki.mikrotik.com/wiki/DSCP_based_QoS_with_HTB
- http://wiki.mikrotik.com/wiki/BGP_based_VPLS
- **MUM US09: MPLS by Janis Megis**
- Routerboard MTU
- MPLS TE

Conclusion

Thank You for your time…

Questions?

United States Sugar Corporation