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Network Testing and Emulation Solutions

LANforge WiFi Access Point Network with 802.11r

Goal: Configure four virtual APs in an 802.11r network to test fast transition (FT) clients. Configure four virtual Access Points to use 802.11r with FT-EAP. This example uses a LANforge CT525 system but a similar procedure will work on all multi-radio systems.

The wifi clients under test are also 802.11r enabled so that they can initiate FT Requests and roam. Here we are using another LANforge WiFire as the system under test to emulate 802.11r stations and force them to roam.

In LANforge, each virtual access point will be running its own hostapd process configured to enable 802.11r and bridged to other virtual access points. The bridged VAP network will emulate the Distributed System (DS) for FT over-the-DS roaming.
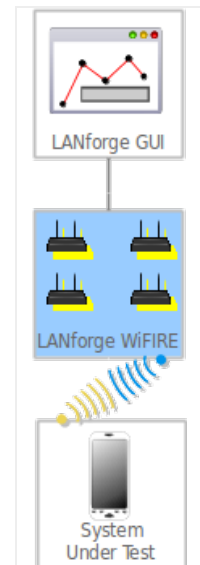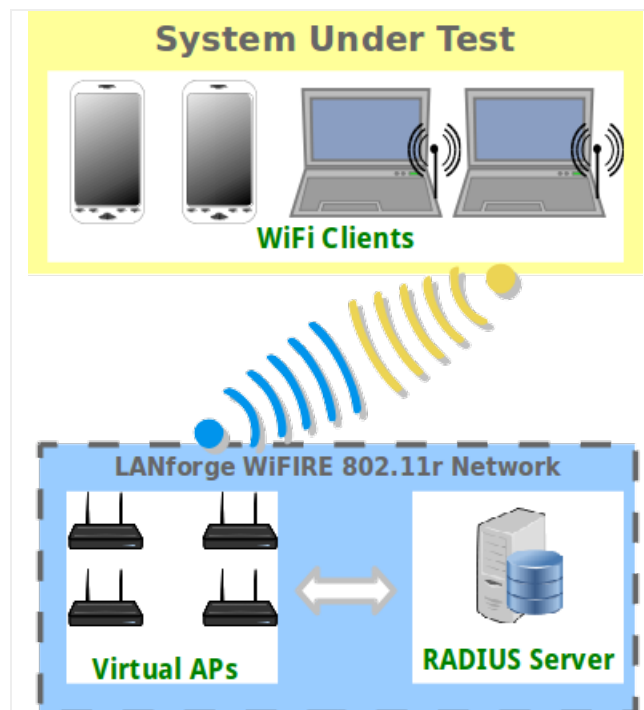
1. Setup a virtual access points on a wifi NIC and configure it for a channel and SSID.

A. Go to the Port Mgr tab, select the parent device such as wiphy0, select Create, then fill out appropriate information and create a virtual access point.

Create VLANs on Port: 1.1.06

1. ○ MAC-VLAN   ○ 802.1Q-VLAN   ○ Redirect   ○ Bridge   ○ GRE Tunnel
   ○ WiFi STA   ● WiFi VAP   ○ WiFi Monitor   ○ WiFi Virtual Radio

2. Shelf: 1 ▼   Resource: 1 (ben-5pci) ▼   Port: 6 (wiphy0) ▼

3. VLAN ID: [   ]   ☐ DHCP-IPv4
   Parent MAC: 04:f0:21:20:37:00   DHCP Client ID: None ▼
   MAC Addr: xx:xx:xx:*:*:xx ▼   IP Address: [   ]   Global IPv6: AUTO
   Quantity: 1   IP Mask or Bits: [   ]   Link IPv6: AUTO
                 Gateway IP: [   ]   IPv6 GW: AUTO
   #1 Redir Name: [   ]   #2 Redir Name: [   ]
   STA ID: 0   SSID: roamer ▼
   WiFi AP: [   ]   Key/Phrase: [   ]
   ☐ WPA   ☑ WPA2   ☐ WEP

4. ☐ Down
   [Apply]   [Cancel]   Ready

B. Modify the new vap, select the **Advanced Configuration** tab in the Port-Modify window and check the box Advanced/802.1x and fill in the RADIUS IP/Port/Secret. Here the RADIUS server will be a freeradius process configured on localhost. The default RADIUS secret is **lanforge** and the default login is **testuser/testpasswd** when freeradius is installed via lf_kinstall.pl --do_radius.

vap0 (ben-5pci) Configure Settings

Port Status Information
Current: LINK-DOWN GRO NONE
Driver Info: Port Type: WIFI-AP   Parent: wiphy0

Port Configurables

Standard Configuration | Advanced Configuration | Misc Configuration | Custom WiFi

Advanced WiFi Settings

Select 'WPA2' on the Standard Configuration screen to enable Advanced/802.1x
and enable Advanced/802.1x to enable most of these. Enabling 802.11u enables others.

Ignore Probes: zero (0%) ▼   HESSID: 00:00:00:00:00:00
Ignore Auth-Assoc: zero (0%) ▼   Realm: [   ]
Ignore Assoc: zero (0%) ▼   IMSI: [   ]
Ignore Re-Assoc: zero (0%) ▼   Milenage: [   ]
Corrupt GTK: zero (0%) ▼   Domain: [   ]
HS20 Capabilities [   ]   Consortium: [   ]
HS20 Oper Class [   ]   RADIUS IP: 127.0.0.1
HS20 WAN Metrics [   ]   RADIUS Port: 1812
Ieee80211w: Disabled (0) ▼   RADIUS Secret: lanforge
Venue Group: Unspecified (0) ▼   Venue Type: Unspecified (0) ▼
Network Type: Private (0) ▼   Address Types: Not Available (0) ▼
Network Auth: [   ]   3GPP Cell Net: [   ]

☐ Use 80211d   ☐ Use 80211h   ☐ Short-Preamble
☑ Advanced/802.1x   ☐ HotSpot 2.0   ☐ Disable DGAF
☐ Enable 802.11u   ☐ 802.11u Internet   ☐ 802.11u ASRA   ☐ 802.11u ESR   ☐ 802.11u UESA

[Print] [View Details] [Logs]   [Probe] [Display Scan] [Sync]   [Apply] [OK]   [Cancel]

C. Repeat above steps A and B to create a single vap on wiphy1, wiphy2 and wiphy3 for a total of four virtual access points.

Create VLANs on Port: 1.1.07

1
- ○ MAC-VLAN ○ 802.1Q-VLAN ○ Redirect ○ Bridge ○ GRE Tunnel
- ○ WiFi STA ⦿ WiFi VAP ○ WiFi Monitor ○ WiFi Virtual Radio

2
Shelf: 1 ▾   Resource: 1 (ben-5pci) ▾   Port: 7 (wiphy1) ▾

3

VLAN ID:		☐ DHCP-IPv4
Parent MAC: 04:f0:21:20:37:03	DHCP Client ID: None ▾	
MAC Addr: xx:xx:xx:*:*:xx ▾	IP Address:	Global IPv6: AUTO
Quantity: 1	IP Mask or Bits:	Link IPv6: AUTO
	Gateway IP:	IPv6 GW: AUTO
#1 Redir Name:	#2 Redir Name:	
STA ID: 1	SSID: roamer ▾	
WiFi AP:	Key/Phrase:	
☐ WPA	☑ WPA2	☐ WEP

4
☐ Down

[Apply]   [Cancel]   Ready

Create VLANs on Port: 1.1.08

1
- ○ MAC-VLAN ○ 802.1Q-VLAN ○ Redirect ○ Bridge ○ GRE Tunnel
- ○ WiFi STA ⦿ WiFi VAP ○ WiFi Monitor ○ WiFi Virtual Radio

2
Shelf: 1 ▾   Resource: 1 (ben-5pci) ▾   Port: 8 (wiphy2) ▾

3

VLAN ID:		☐ DHCP-IPv4
Parent MAC: 04:f0:21:20:37:06	DHCP Client ID: None ▾	
MAC Addr: xx:xx:xx:*:*:xx ▾	IP Address:	Global IPv6: AUTO
Quantity: 1	IP Mask or Bits:	Link IPv6: AUTO
	Gateway IP:	IPv6 GW: AUTO
#1 Redir Name:	#2 Redir Name:	
STA ID: 2	SSID: roamer ▾	
WiFi AP:	Key/Phrase:	
☐ WPA	☑ WPA2	☐ WEP

4
☐ Down

[Apply]   [Cancel]   Ready

Create VLANs on Port: 1.1.09

1
- ○ MAC-VLAN ○ 802.1Q-VLAN ○ Redirect ○ Bridge ○ GRE Tunnel
- ○ WiFi STA ⦿ WiFi VAP ○ WiFi Monitor ○ WiFi Virtual Radio

2
Shelf: 1 ▾   Resource: 1 (ben-5pci) ▾   Port: 9 (wiphy3) ▾

3

VLAN ID:		☐ DHCP-IPv4
Parent MAC: 04:f0:21:20:37:0b	DHCP Client ID: None ▾	
MAC Addr: xx:xx:xx:*:*:xx ▾	IP Address:	Global IPv6: AUTO
Quantity: 1	IP Mask or Bits:	Link IPv6: AUTO
	Gateway IP:	IPv6 GW: AUTO
#1 Redir Name:	#2 Redir Name:	
STA ID: 3	SSID: roamer ▾	
WiFi AP:	Key/Phrase:	
☐ WPA	☑ WPA2	☐ WEP

4
☐ Down

[Apply]   [Cancel]   Ready

2. Modify each vap, select the **Custom Wifi** tab and enter the additional lines that will be appended to each vap hostapd configuration file.

    A. For each vap, fill in the first 8 lines to enable 802.11r as well as the **first** part of the 3 r0kh entries and 3 r1kh entries for neighboring vap's.

    The first part of the **r0kh** is the neighboring vap MAC address and NAS identifier which in this example is the MAC without colon delimeters.

    The first part of the **r1kh** is the neighboring vap MAC address and r1kh-id which in this example are the same.

vap1 (ben-5pci) Configure Settings

Port Status Information

Current: DOWN LINK-DOWN GRO NONE

Driver Info: Port Type: WIFI-AP   Parent: wiphy1

Port Configurables

| Standard Configuration | Advanced Configuration | Misc Configuration | Custom WiFi |

Custom WiFi

User-Specified supplicant/hostapd configuration text:

```
wpa_key_mgmt=FT-EAP
ft_over_ds=1
nas_identifier=04f021699103
mobility_domain=4321
r0_key_lifetime=10000
r1_key_holder=04f021699103
reassociation_deadline=1000
pmk_r1_push=1

r0kh=04:f0:21:b9:8f:00 04f021b98f00
r0kh=04:f0:21:33:28:06 04f021332806
r0kh=04:f0:21:b1:d7:0b 04f021b1d70b

r1kh=04:f0:21:b9:8f:00 04:f0:21:b9:8f:00
r1kh=04:f0:21:33:28:06 04:f0:21:33:28:06
r1kh=04:f0:21:b1:d7:0b 04:f0:21:b1:d7:0b
```

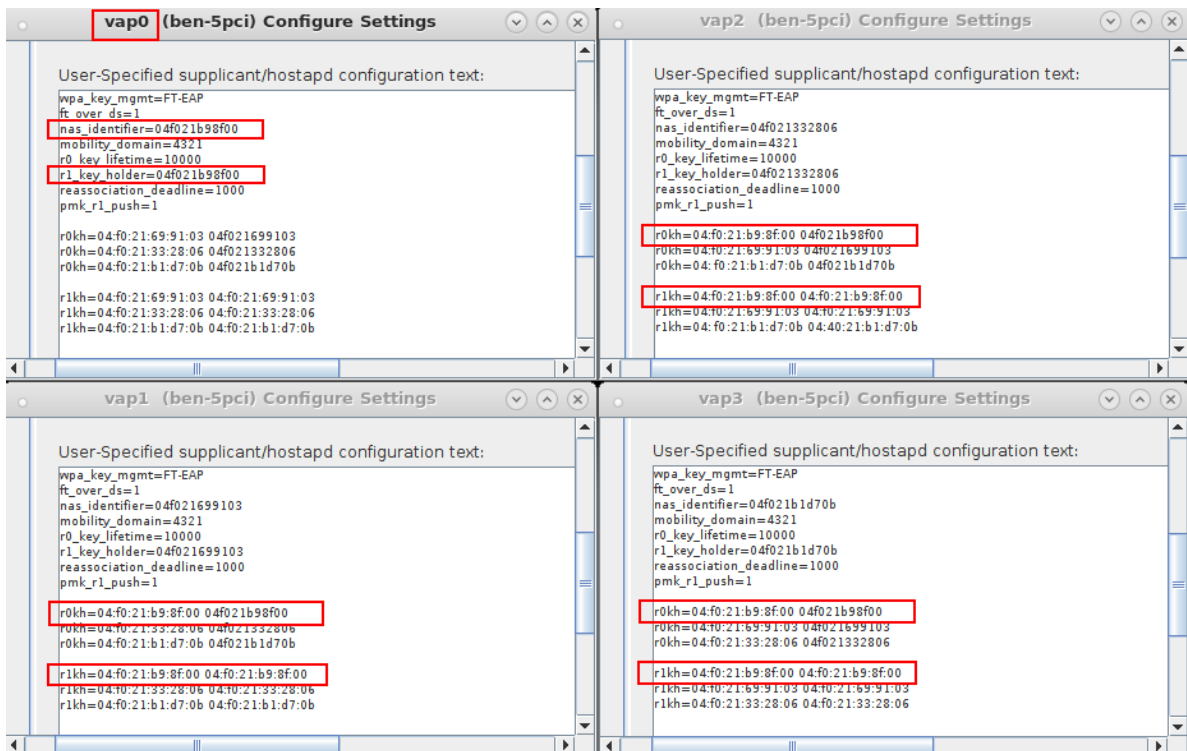| Print | View Details | Logs | | Probe | Display Scan | Sync | | Apply | OK | | Cancel |

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vap2 (ben-5pci) Configure Settings

Port Status Information

Current: DOWN LINK-DOWN GRO NONE

Driver Info: Port Type: WIFI-AP   Parent: wiphy2

Port Configurables

| Standard Configuration | Advanced Configuration | Misc Configuration | Custom WiFi |

Custom WiFi

User-Specified supplicant/hostapd configuration text:

```
wpa_key_mgmt=FT-EAP
ft_over_ds=1
nas_identifier=04f021332806
mobility_domain=4321
r0_key_lifetime=10000
r1_key_holder=04f021332806
reassociation_deadline=1000
pmk_r1_push=1

r0kh=04:f0:21:b9:8f:00 04f021b98f00
r0kh=04:f0:21:69:91:03 04f021699103
r0kh=04:f0:21:b1:d7:0b 04f021b1d70b

r1kh=04:f0:21:b9:8f:00 04:f0:21:b9:8f:00
r1kh=04:f0:21:69:91:03 04:f0:21:69:91:03
r1kh=04:f0:21:b1:d7:0b 04:40:21:b1:d7:0b
```

| Print | View Details | Logs | | Probe | Display Scan | Sync | | Apply | OK | | Cancel |

vap3 (ben-5pci) Configure Settings

Port Status Information

Current: DOWN LINK-DOWN GRO NONE

Driver Info: Port Type: WIFI-AP Parent: wiphy3

Port Configurables

Standard Configuration | Advanced Configuration | Misc Configuration | Custom WiFi

Custom WiFi

User-Specified supplicant/hostapd configuration text:

```
wpa_key_mgmt=FT-EAP
ft_over_ds=1
nas_identifier=04f021b1d70b
mobility_domain=4321
r0_key_lifetime=10000
r1_key_holder=04f021b1d70b
reassociation_deadline=1000
pmk_r1_push=1

r0kh=04:f0:21:b9:8f:00 04f021b98f00
r0kh=04:f0:21:69:91:03 04f021699103
r0kh=04:f0:21:33:28:06 04f021332806

r1kh=04:f0:21:b9:8f:00 04:f0:21:b9:8f:00
r1kh=04:f0:21:69:91:03 04:f0:21:69:91:03
r1kh=04:f0:21:33:28:06 04:f0:21:33:28:06
```

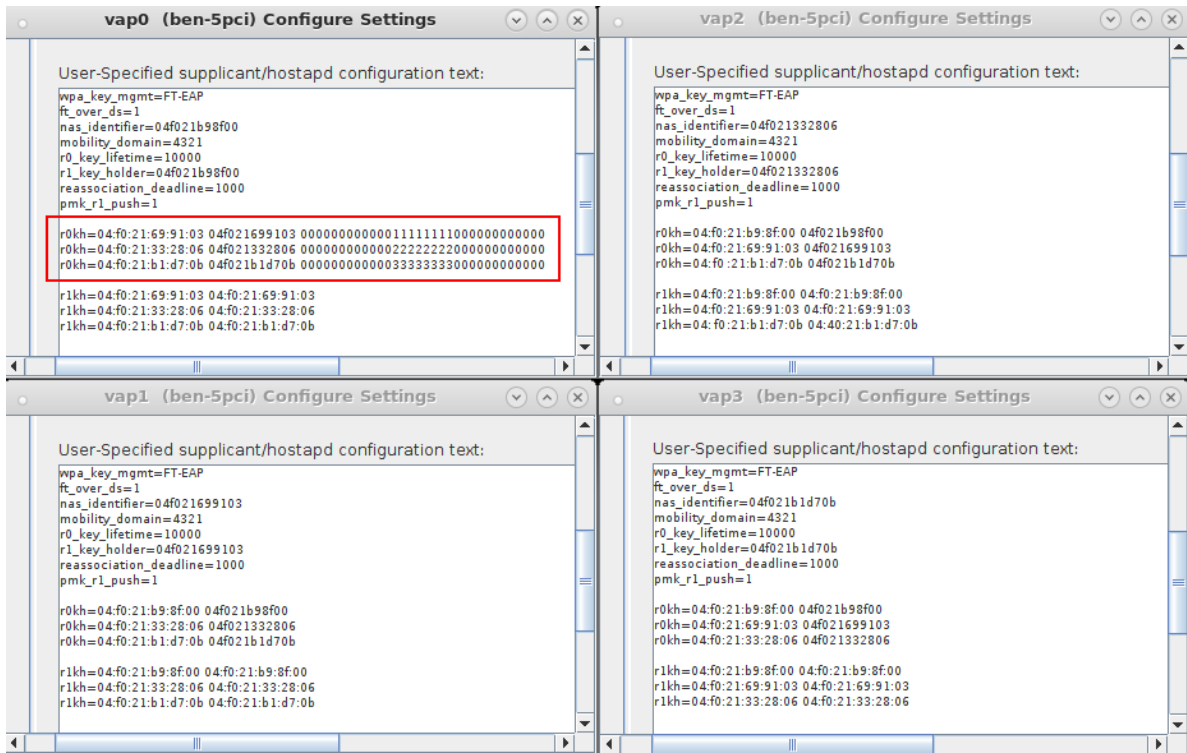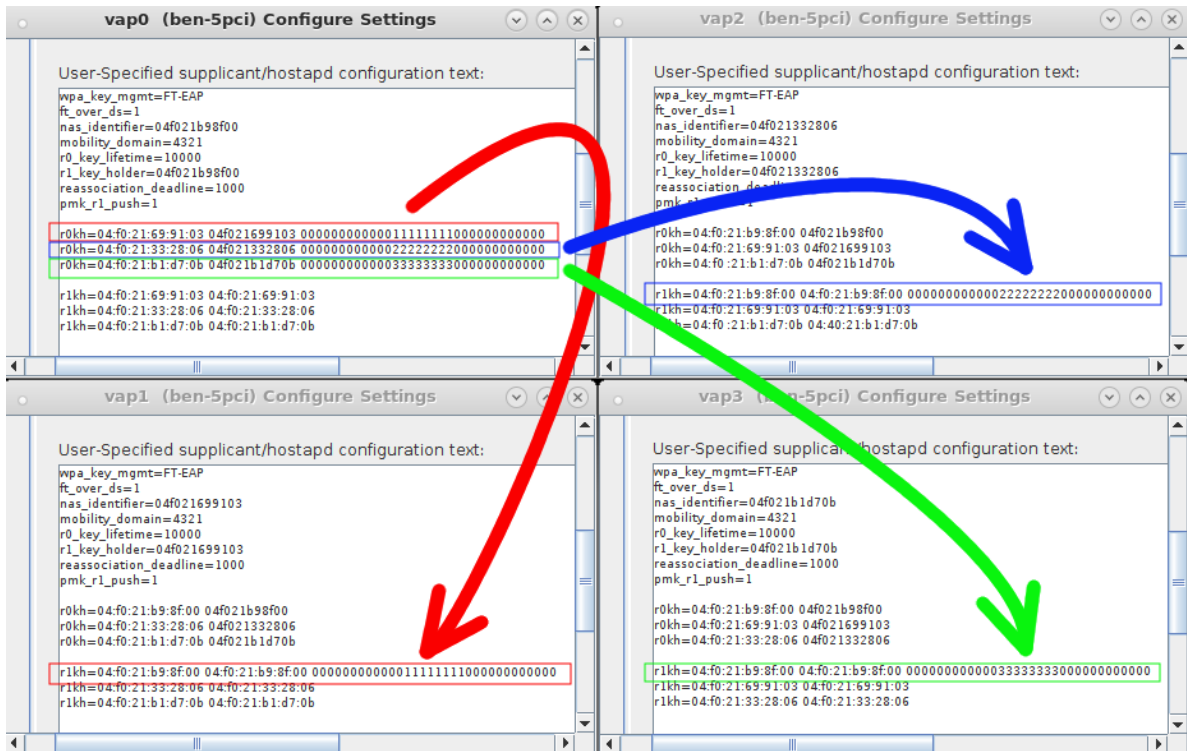Print | View Details | Logs | Probe | Display Scan | Sync | Apply | OK | Cancel

B. Each vap will be represented by a corresponding r0kh and r1kh entry in all of the neighboring vap's custom configuration sections. Here vap0 entries are highlighted.
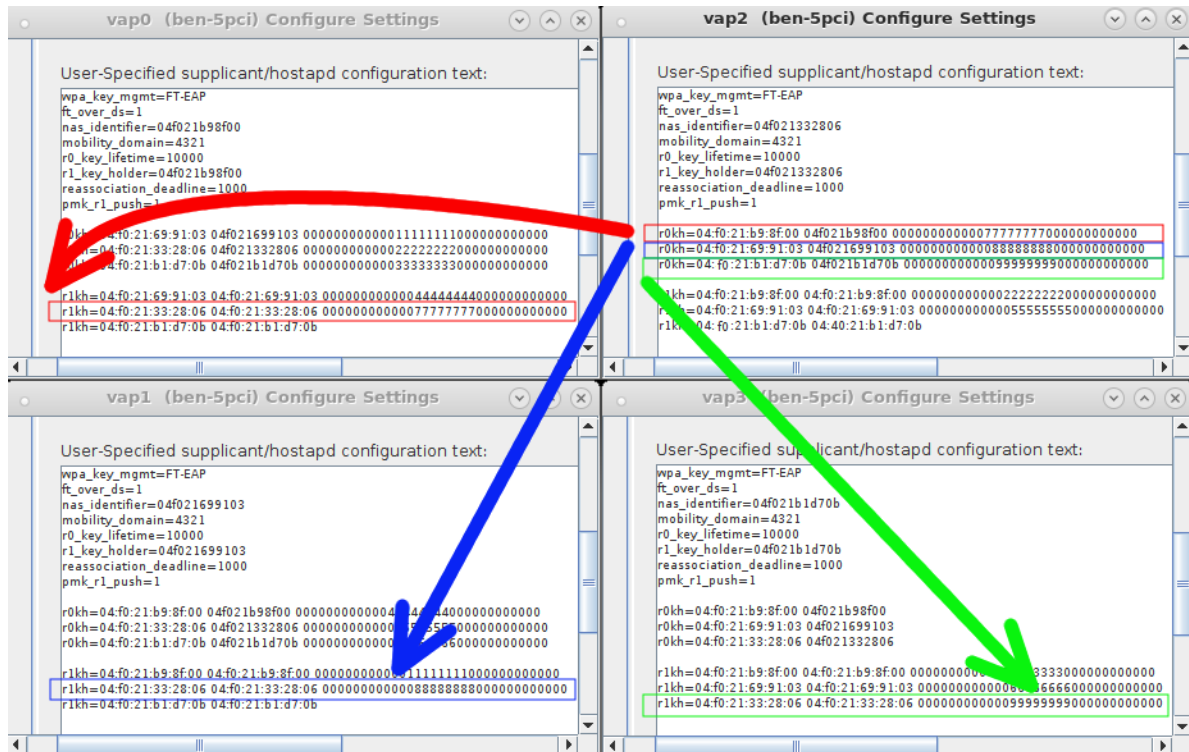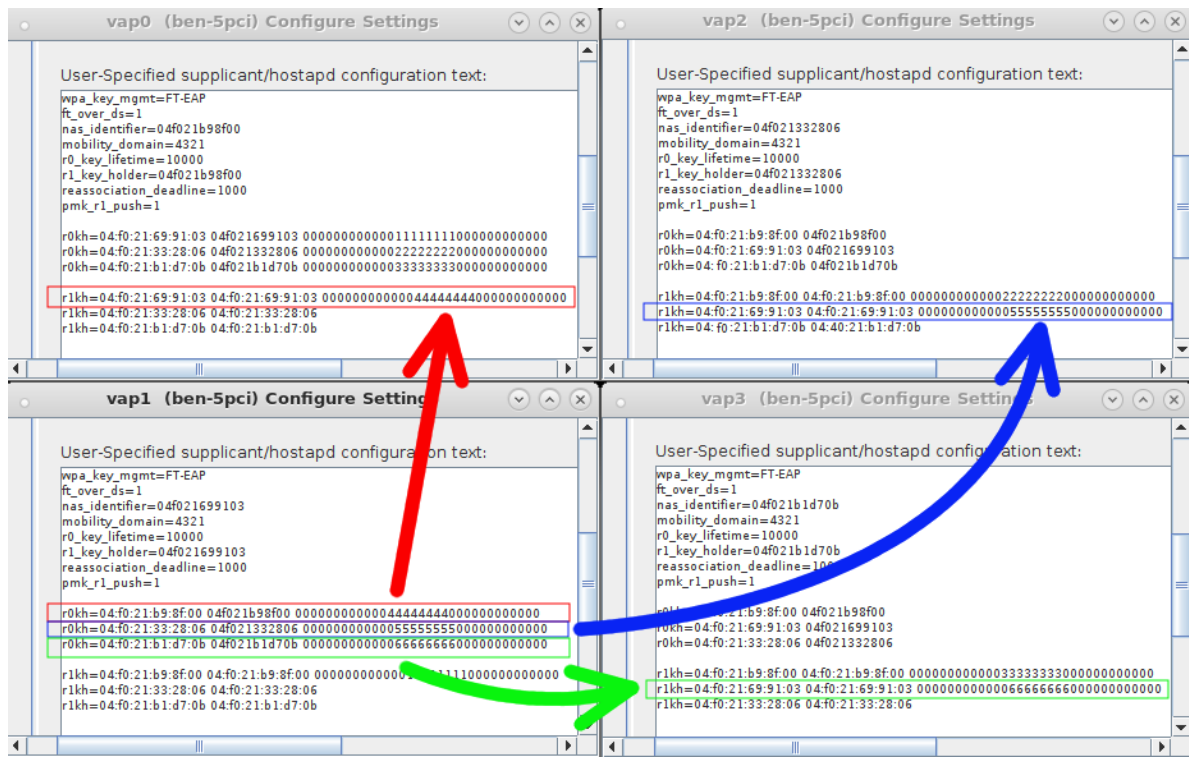
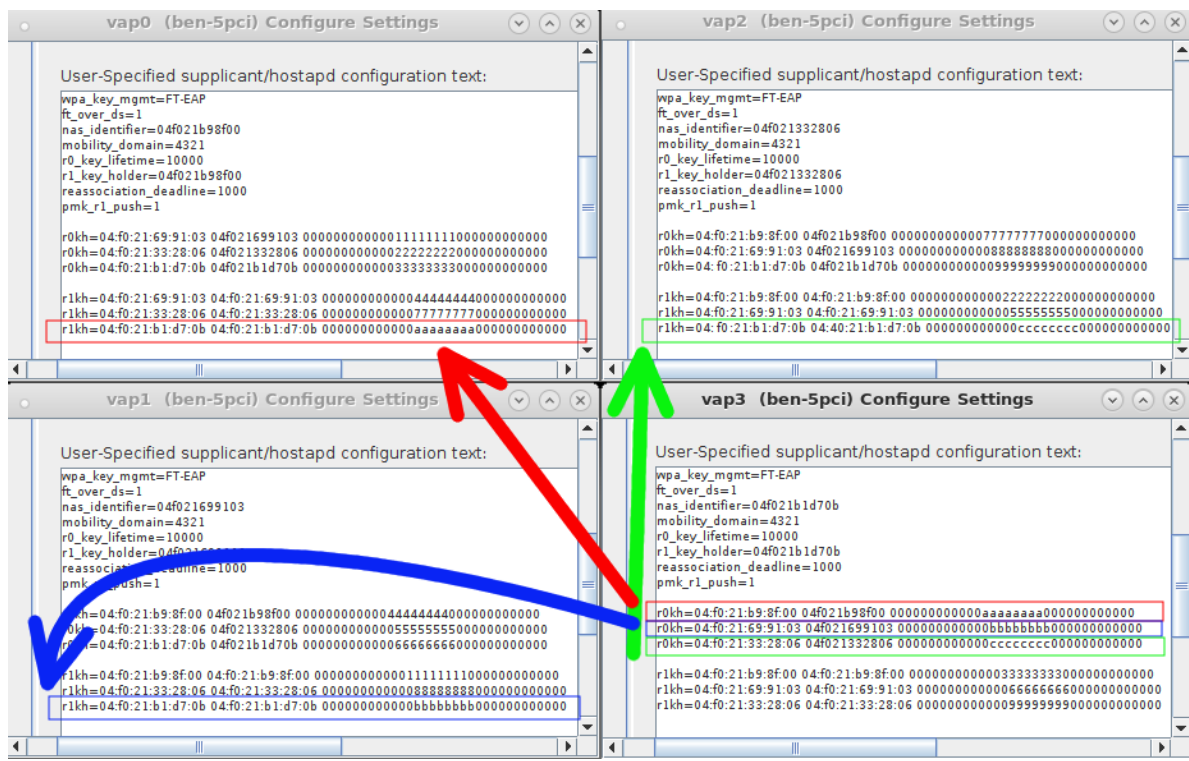C. Generate a unique 128-bit AES hex key for each r0kh entry in the vap.

vap0 (ben-5pci) Configure Settings

User-Specified supplicant/hostapd configuration text:

wpa_key_mgmt=FT-EAP
ft_over_ds=1
nas_identifier=04f021b98f00
mobility_domain=4321
r0_key_lifetime=10000
r1_key_holder=04f021b98f00
reassociation_deadline=1000
pmk_r1_push=1

r0kh=04:f0:21:69:91:03 04f021699103 00000000000011111111000000000000
r0kh=04:f0:21:33:28:06 04f021332806 00000000000022222222000000000000
r0kh=04:f0:21:b1:d7:0b 04f021b1d70b 00000000000033333333000000000000

r1kh=04:f0:21:69:91:03 04:f0:21:69:91:03
r1kh=04:f0:21:33:28:06 04:f0:21:33:28:06
r1kh=04:f0:21:b1:d7:0b 04:f0:21:b1:d7:0b

vap2 (ben-5pci) Configure Settings

User-Specified supplicant/hostapd configuration text:

wpa_key_mgmt=FT-EAP
ft_over_ds=1
nas_identifier=04f021332806
mobility_domain=4321
r0_key_lifetime=10000
r1_key_holder=04f021332806
reassociation_deadline=1000
pmk_r1_push=1

r0kh=04:f0:21:b9:8f:00 04f021b98f00
r0kh=04:f0:21:69:91:03 04f021699103
r0kh=04:f0:21:b1:d7:0b 04f021b1d70b

r1kh=04:f0:21:b9:8f:00 04:f0:21:b9:8f:00
r1kh=04:f0:21:69:91:03 04:f0:21:69:91:03
r1kh=04:f0:21:b1:d7:0b 04:40:21:b1:d7:0b

vap1 (ben-5pci) Configure Settings

User-Specified supplicant/hostapd configuration text:

wpa_key_mgmt=FT-EAP
ft_over_ds=1
nas_identifier=04f021699103
mobility_domain=4321
r0_key_lifetime=10000
r1_key_holder=04f021699103
reassociation_deadline=1000
pmk_r1_push=1

r0kh=04:f0:21:b9:8f:00 04f021b98f00
r0kh=04:f0:21:33:28:06 04f021332806
r0kh=04:f0:21:b1:d7:0b 04f021b1d70b

r1kh=04:f0:21:b9:8f:00 04:f0:21:b9:8f:00
r1kh=04:f0:21:33:28:06 04:f0:21:33:28:06
r1kh=04:f0:21:b1:d7:0b 04:f0:21:b1:d7:0b

vap3 (ben-5pci) Configure Settings

User-Specified supplicant/hostapd configuration text:

wpa_key_mgmt=FT-EAP
ft_over_ds=1
nas_identifier=04f021b1d70b
mobility_domain=4321
r0_key_lifetime=10000
r1_key_holder=04f021b1d70b
reassociation_deadline=1000
pmk_r1_push=1

r0kh=04:f0:21:b9:8f:00 04f021b98f00
r0kh=04:f0:21:69:91:03 04f021699103
r0kh=04:f0:21:33:28:06 04f021332806

r1kh=04:f0:21:b9:8f:00 04:f0:21:b9:8f:00
r1kh=04:f0:21:69:91:03 04:f0:21:69:91:03
r1kh=04:f0:21:33:28:06 04:f0:21:33:28:06

D. Copy the r0kh keys to the r1kh lines that correspond to the vap.

vap0 (ben-5pci) Configure Settings

User-Specified supplicant/hostapd configuration text:

wpa_key_mgmt=FT-EAP
ft_over_ds=1
nas_identifier=04f021b98f00
mobility_domain=4321
r0_key_lifetime=10000
r1_key_holder=04f021b98f00
reassociation_deadline=1000
pmk_r1_push=1

r0kh=04:f0:21:69:91:03 04f021699103 00000000000011111111000000000000
r0kh=04:f0:21:33:28:06 04f021332806 00000000000022222222000000000000
r0kh=04:f0:21:b1:d7:0b 04f021b1d70b 00000000000033333333000000000000

r1kh=04:f0:21:69:91:03 04:f0:21:69:91:03
r1kh=04:f0:21:33:28:06 04:f0:21:33:28:06
r1kh=04:f0:21:b1:d7:0b 04:f0:21:b1:d7:0b

vap2 (ben-5pci) Configure Settings

User-Specified supplicant/hostapd configuration text:

wpa_key_mgmt=FT-EAP
ft_over_ds=1
nas_identifier=04f021332806
mobility_domain=4321
r0_key_lifetime=10000
r1_key_holder=04f021332806
reassociation_dead...
pmk...

r0kh=04:f0:21:b9:8f:00 04f021b98f00
r0kh=04:f0:21:69:91:03 04f021699103
r0kh=04:f0:21:b1:d7:0b 04f021b1d70b

r1kh=04:f0:21:b9:8f:00 04:f0:21:b9:8f:00 00000000000022222222000000000000
r1kh=04:f0:21:69:91:03 04:f0:21:69:91:03
r1kh=04:f0:21:b1:d7:0b 04:40:21:b1:d7:0b

vap1 (ben-5pci) Configure Settings

User-Specified supplicant/hostapd configuration text:

wpa_key_mgmt=FT-EAP
ft_over_ds=1
nas_identifier=04f021699103
mobility_domain=4321
r0_key_lifetime=10000
r1_key_holder=04f021699103
reassociation_deadline=1000
pmk_r1_push=1

r0kh=04:f0:21:b9:8f:00 04f021b98f00
r0kh=04:f0:21:33:28:06 04f021332806
r0kh=04:f0:21:b1:d7:0b 04f021b1d70b

r1kh=04:f0:21:b9:8f:00 04:f0:21:b9:8f:00 00000000000011111111000000000000
r1kh=04:f0:21:33:28:06 04:f0:21:33:28:06
r1kh=04:f0:21:b1:d7:0b 04:f0:21:b1:d7:0b

vap3 (ben-5pci) Configure Settings

User-Specified supplicant/hostapd configuration text:

wpa_key_mgmt=FT-EAP
ft_over_ds=1
nas_identifier=04f021b1d70b
mobility_domain=4321
r0_key_lifetime=10000
r1_key_holder=04f021b1d70b
reassociation_deadline=1000
pmk_r1_push=1

r0kh=04:f0:21:b9:8f:00 04f021b98f00
r0kh=04:f0:21:69:91:03 04f021699103
r0kh=04:f0:21:33:28:06 04f021332806

r1kh=04:f0:21:b9:8f:00 04:f0:21:b9:8f:00 00000000000033333333000000000000
r1kh=04:f0:21:69:91:03 04:f0:21:69:91:03
r1kh=04:f0:21:33:28:06 04:f0:21:33:28:06

E. Repeat steps C and D for the other three vap's.

vap0 (ben-5pci) Configure Settings

User-Specified supplicant/hostapd configuration text:

```
wpa_key_mgmt=FT-EAP
ft_over_ds=1
nas_identifier=04f021b98f00
mobility_domain=4321
r0_key_lifetime=10000
r1_key_holder=04f021b98f00
reassociation_deadline=1000
pmk_r1_push=1

r0kh=04:f0:21:69:91:03 04f021699103 00000000000011111111000000000000
r0kh=04:f0:21:33:28:06 04f021332806 00000000000022222222000000000000
r0kh=04:f0:21:b1:d7:0b 04f021b1d70b 00000000000033333333000000000000

r1kh=04:f0:21:69:91:03 04:f0:21:69:91:03 00000000000044444444000000000000
r1kh=04:f0:21:33:28:06 04:f0:21:33:28:06
r1kh=04:f0:21:b1:d7:0b 04:f0:21:b1:d7:0b
```

vap2 (ben-5pci) Configure Settings

User-Specified supplicant/hostapd configuration text:

```
wpa_key_mgmt=FT-EAP
ft_over_ds=1
nas_identifier=04f021332806
mobility_domain=4321
r0_key_lifetime=10000
r1_key_holder=04f021332806
reassociation_deadline=1000
pmk_r1_push=1

r0kh=04:f0:21:b9:8f:00 04f021b98f00 00000000000022222222000000000000
r0kh=04:f0:21:69:91:03 04f021699103
r0kh=04:f0:21:b1:d7:0b 04f021b1d70b

r1kh=04:f0:21:b9:8f:00 04:f0:21:b9:8f:00 00000000000022222222000000000000
r1kh=04:f0:21:69:91:03 04:f0:21:69:91:03 00000000000055555555000000000000
r1kh=04:f0:21:b1:d7:0b 04:40:21:b1:d7:0b
```

vap1 (ben-5pci) Configure Settings

User-Specified supplicant/hostapd configuration text:

```
wpa_key_mgmt=FT-EAP
ft_over_ds=1
nas_identifier=04f021699103
mobility_domain=4321
r0_key_lifetime=10000
r1_key_holder=04f021699103
reassociation_deadline=1000
pmk_r1_push=1

r0kh=04:f0:21:b9:8f:00 04f021b98f00 00000000000044444444000000000000
r0kh=04:f0:21:33:28:06 04f021332806 00000000000055555555000000000000
r0kh=04:f0:21:b1:d7:0b 04f021b1d70b 00000000000066666666000000000000

r1kh=04:f0:21:b9:8f:00 04:f0:21:b9:8f:00 00000000000011111111000000000000
r1kh=04:f0:21:33:28:06 04:f0:21:33:28:06
r1kh=04:f0:21:b1:d7:0b 04:f0:21:b1:d7:0b
```

vap3 (ben-5pci) Configure Settings

User-Specified supplicant/hostapd configuration text:

```
wpa_key_mgmt=FT-EAP
ft_over_ds=1
nas_identifier=04f021b1d70b
mobility_domain=4321
r0_key_lifetime=10000
r1_key_holder=04f021b1d70b
reassociation_deadline=1000
pmk_r1_push=1

r0kh=04:f0:21:b9:8f:00 04f021b98f00
r0kh=04:f0:21:69:91:03 04f021699103
r0kh=04:f0:21:33:28:06 04f021332806

r1kh=04:f0:21:b9:8f:00 04:f0:21:b9:8f:00 00000000000033333333000000000000
r1kh=04:f0:21:69:91:03 04:f0:21:69:91:03 00000000000066666666000000000000
r1kh=04:f0:21:33:28:06 04:f0:21:33:28:06
```

vap0 (ben-5pci) Configure Settings

User-Specified supplicant/hostapd configuration text:

```
wpa_key_mgmt=FT-EAP
ft_over_ds=1
nas_identifier=04f021b98f00
mobility_domain=4321
r0_key_lifetime=10000
r1_key_holder=04f021b98f00
reassociation_deadline=1000
pmk_r1_push=1

r0kh=04:f0:21:69:91:03 04f021699103 00000000000011111111000000000000
r0kh=04:f0:21:33:28:06 04f021332806 00000000000022222222000000000000
r0kh=04:f0:21:b1:d7:0b 04f021b1d70b 00000000000033333333000000000000

r1kh=04:f0:21:69:91:03 04:f0:21:69:91:03 00000000000044444444000000000000
r1kh=04:f0:21:33:28:06 04:f0:21:33:28:06 00000000000077777777000000000000
r1kh=04:f0:21:b1:d7:0b 04:f0:21:b1:d7:0b
```

vap2 (ben-5pci) Configure Settings

User-Specified supplicant/hostapd configuration text:

```
wpa_key_mgmt=FT-EAP
ft_over_ds=1
nas_identifier=04f021332806
mobility_domain=4321
r0_key_lifetime=10000
r1_key_holder=04f021332806
reassociation_deadline=1000
pmk_r1_push=1

r0kh=04:f0:21:b9:8f:00 04f021b98f00 00000000000077777777000000000000
r0kh=04:f0:21:69:91:03 04f021699103 00000000000088888888000000000000
r0kh=04:f0:21:b1:d7:0b 04f021b1d70b 00000000000099999999000000000000

r1kh=04:f0:21:b9:8f:00 04:f0:21:b9:8f:00 00000000000022222222000000000000
r1kh=04:f0:21:69:91:03 04:f0:21:69:91:03 00000000000055555555000000000000
r1kh=04:f0:21:b1:d7:0b 04:40:21:b1:d7:0b
```

vap1 (ben-5pci) Configure Settings

User-Specified supplicant/hostapd configuration text:

```
wpa_key_mgmt=FT-EAP
ft_over_ds=1
nas_identifier=04f021699103
mobility_domain=4321
r0_key_lifetime=10000
r1_key_holder=04f021699103
reassociation_deadline=1000
pmk_r1_push=1

r0kh=04:f0:21:b9:8f:00 04f021b98f00 00000000000044444444000000000000
r0kh=04:f0:21:33:28:06 04f021332806 00000000000055555555000000000000
r0kh=04:f0:21:b1:d7:0b 04f021b1d70b 00000000000066666666000000000000

r1kh=04:f0:21:b9:8f:00 04:f0:21:b9:8f:00 00000000000011111111000000000000
r1kh=04:f0:21:33:28:06 04:f0:21:33:28:06 00000000000088888888000000000000
r1kh=04:f0:21:b1:d7:0b 04:f0:21:b1:d7:0b
```

vap3 (ben-5pci) Configure Settings

User-Specified supplicant/hostapd configuration text:

```
wpa_key_mgmt=FT-EAP
ft_over_ds=1
nas_identifier=04f021b1d70b
mobility_domain=4321
r0_key_lifetime=10000
r1_key_holder=04f021b1d70b
reassociation_deadline=1000
pmk_r1_push=1

r0kh=04:f0:21:b9:8f:00 04f021b98f00
r0kh=04:f0:21:69:91:03 04f021699103
r0kh=04:f0:21:33:28:06 04f021332806

r1kh=04:f0:21:b9:8f:00 04:f0:21:b9:8f:00 00000000000033333333000000000000
r1kh=04:f0:21:69:91:03 04:f0:21:69:91:03 00000000000066666666000000000000
r1kh=04:f0:21:33:28:06 04:f0:21:33:28:06 00000000000099999999000000000000
```

vap0: full hostapd configuration file
vap1: full hostapd configuration file
vap2: full hostapd configuration file
vap3: full hostapd configuration file

For more information see Two WiFi Access Point Network with 802.11r

3. Create four bridge devices, one for each virtual access point.
   A. Go to the port manager tab, select Create, then select Bridge and enter Quantity 4 and a Bridge Name, then Apply to create the bridges.
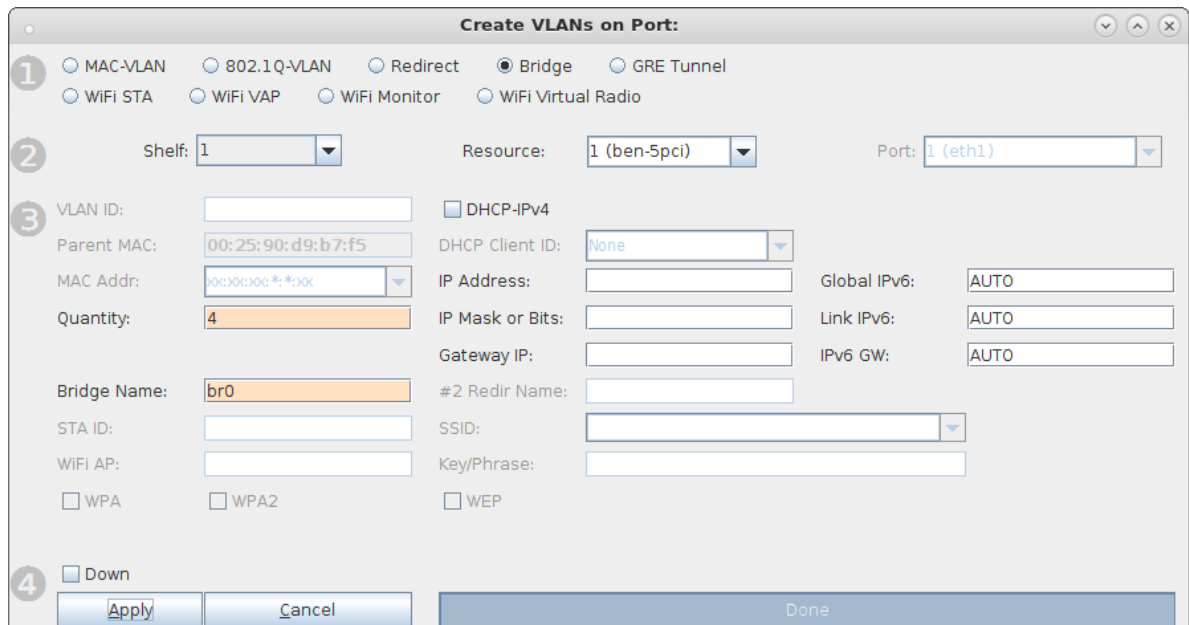
B. Modify each bridge device to add a vap. Netsmith will show a purple line when each vap has been added as bridge member.
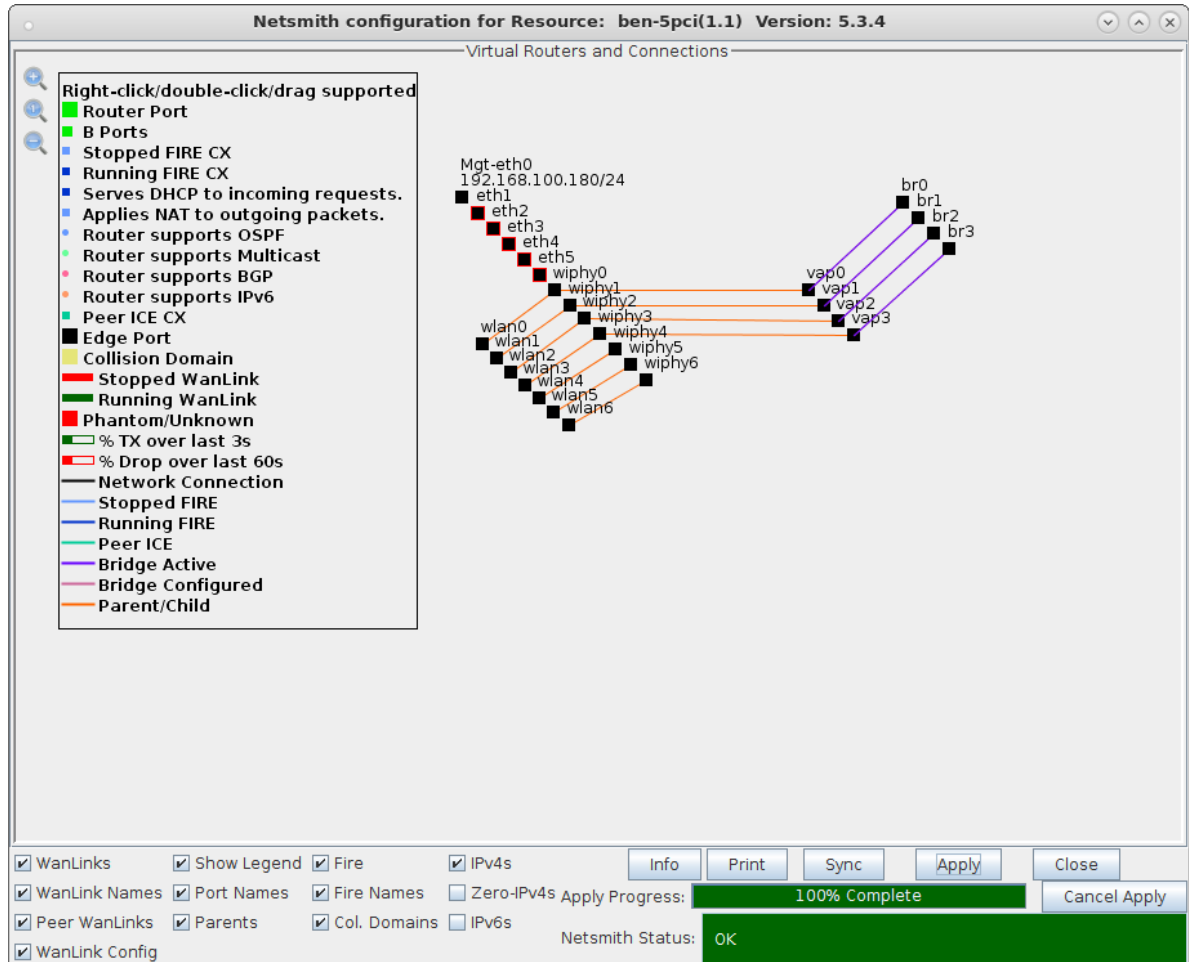
C. Add a single virtual router, drag br0 into the router, then give it an IP address and make it a DHCP server.
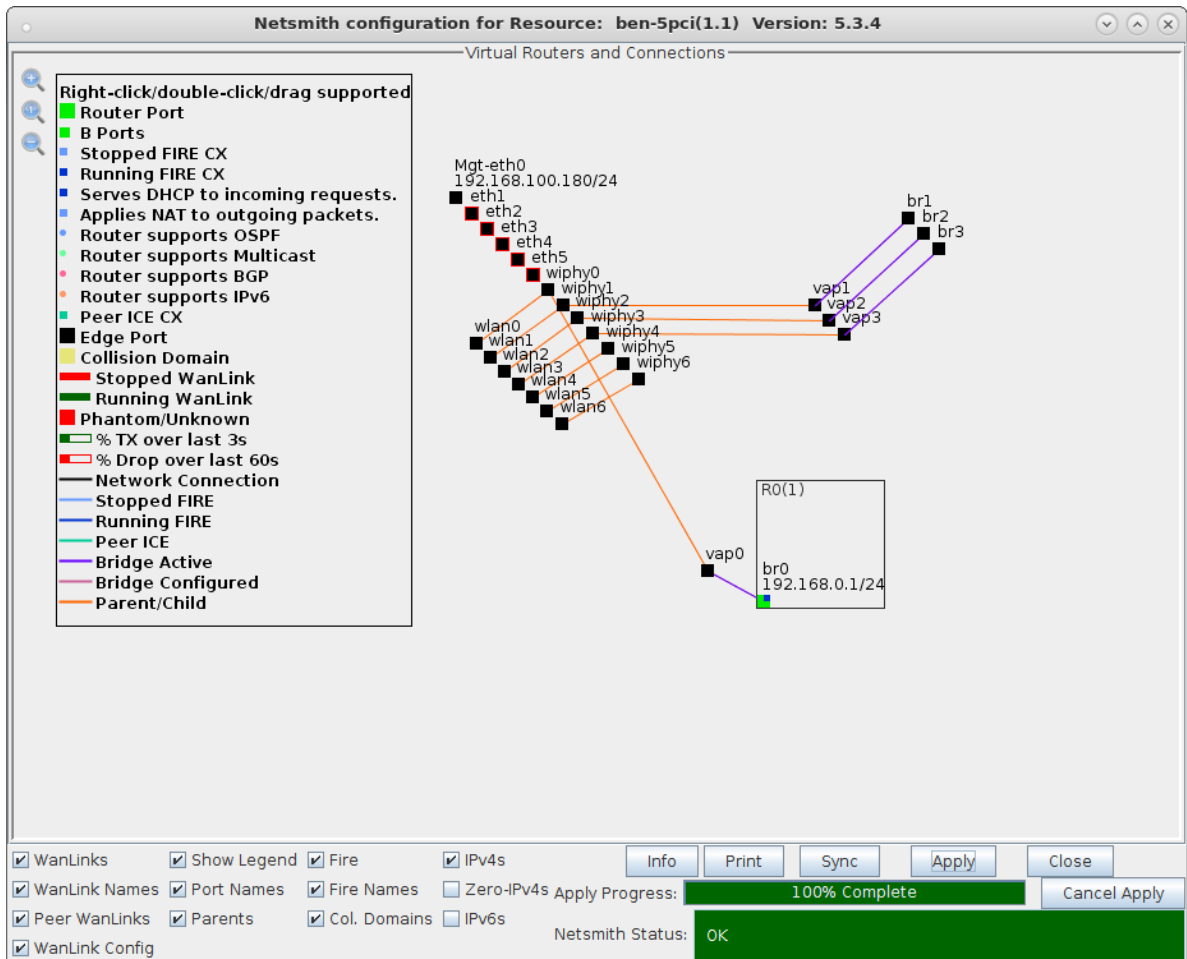
For more information see Virtual Router with DHCP Cookbook (skip the wanlink portion)

4. Each bridge will share a connection to a redirect device (rdd) pair so that FT messages can be sent and received.

A. In Netsmith, right-click in a free area and select New Connection to create an rdd pair. Select **Skip** for Port 1-B, WanLink and Port 2-B then select OK. Select Netsmith Apply after creating the new connection.

B. Right-click and select Modify Port br0, then add rddVR0 to br0. Your rddVRX numbering may differ depending on what other Netsmith objects are created.
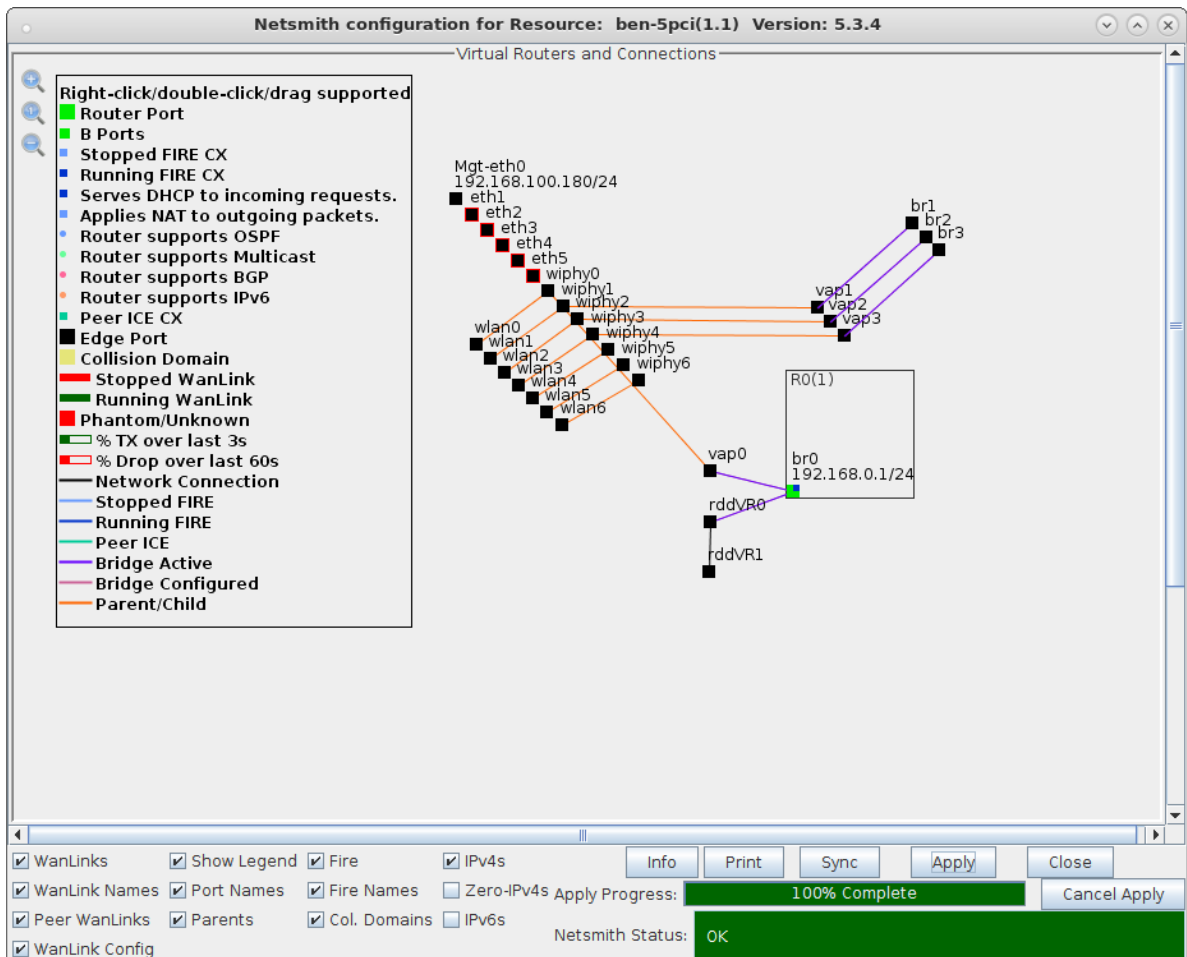
C. Right-click and select Modify Port br1, then add rddVR1 to br1. Your rddVRX numbering may differ depending on what other Netsmith objects are created.
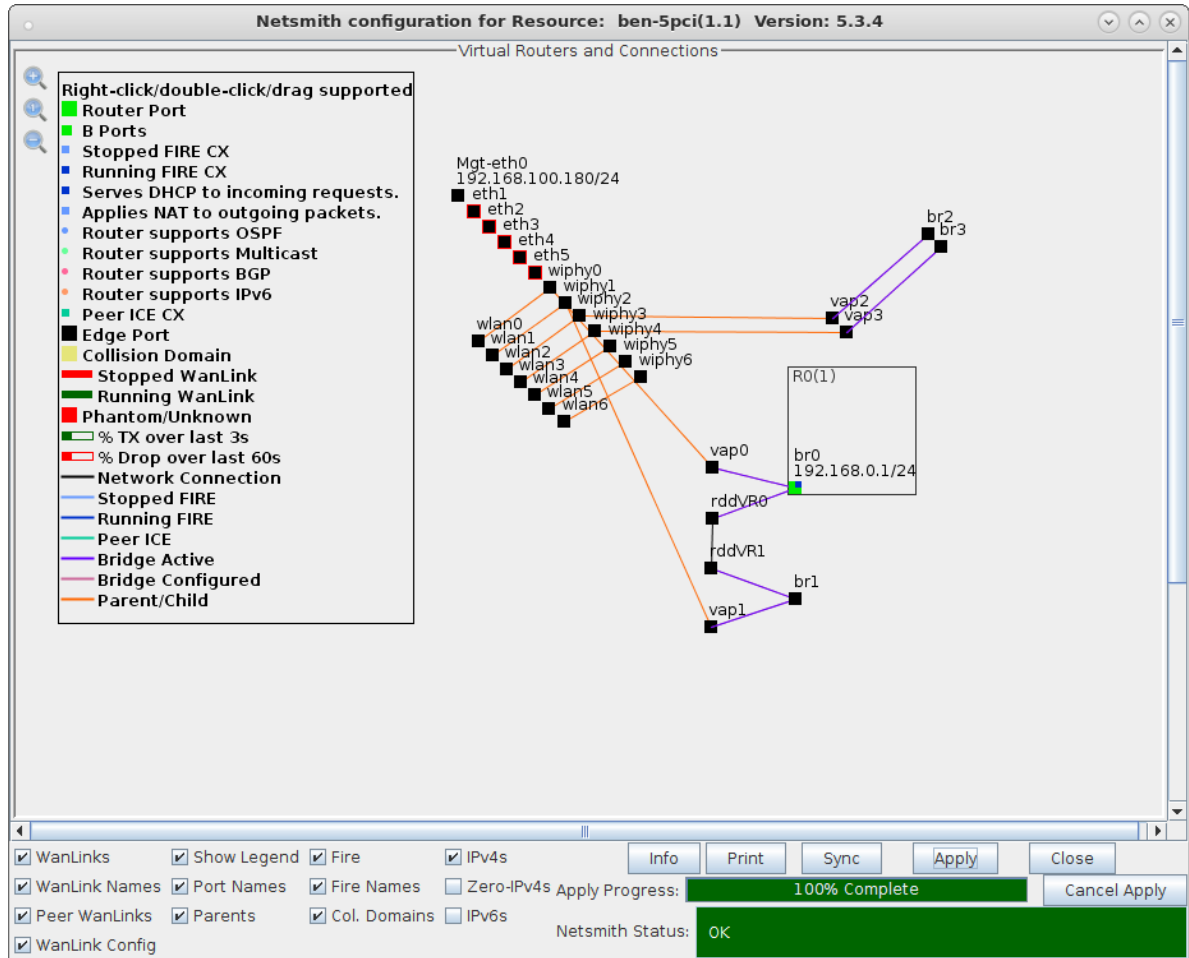
D. Create two more rdd pairs for bridges br2 and br3.
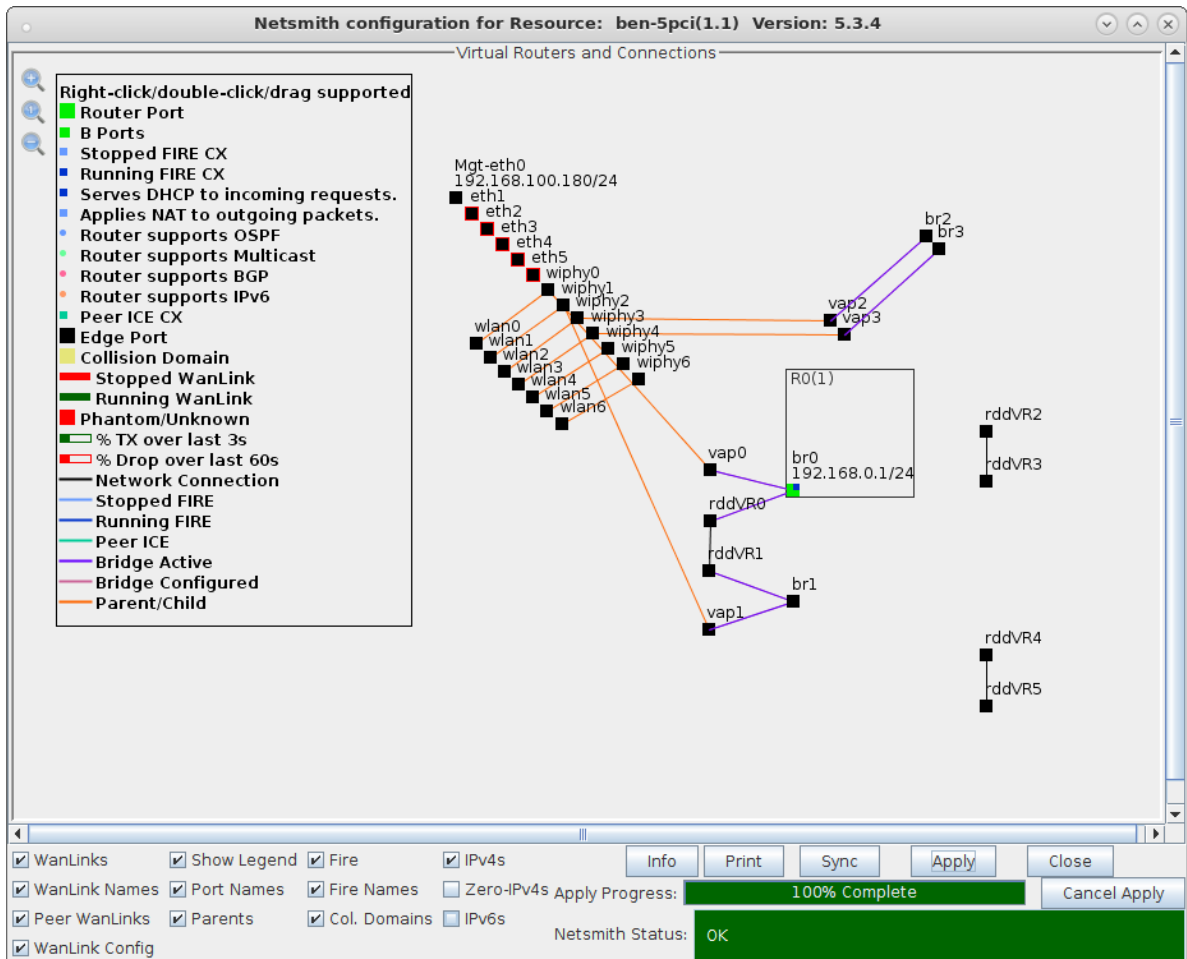
E. Add rddVR2 and rddVR3 to bridge br0.
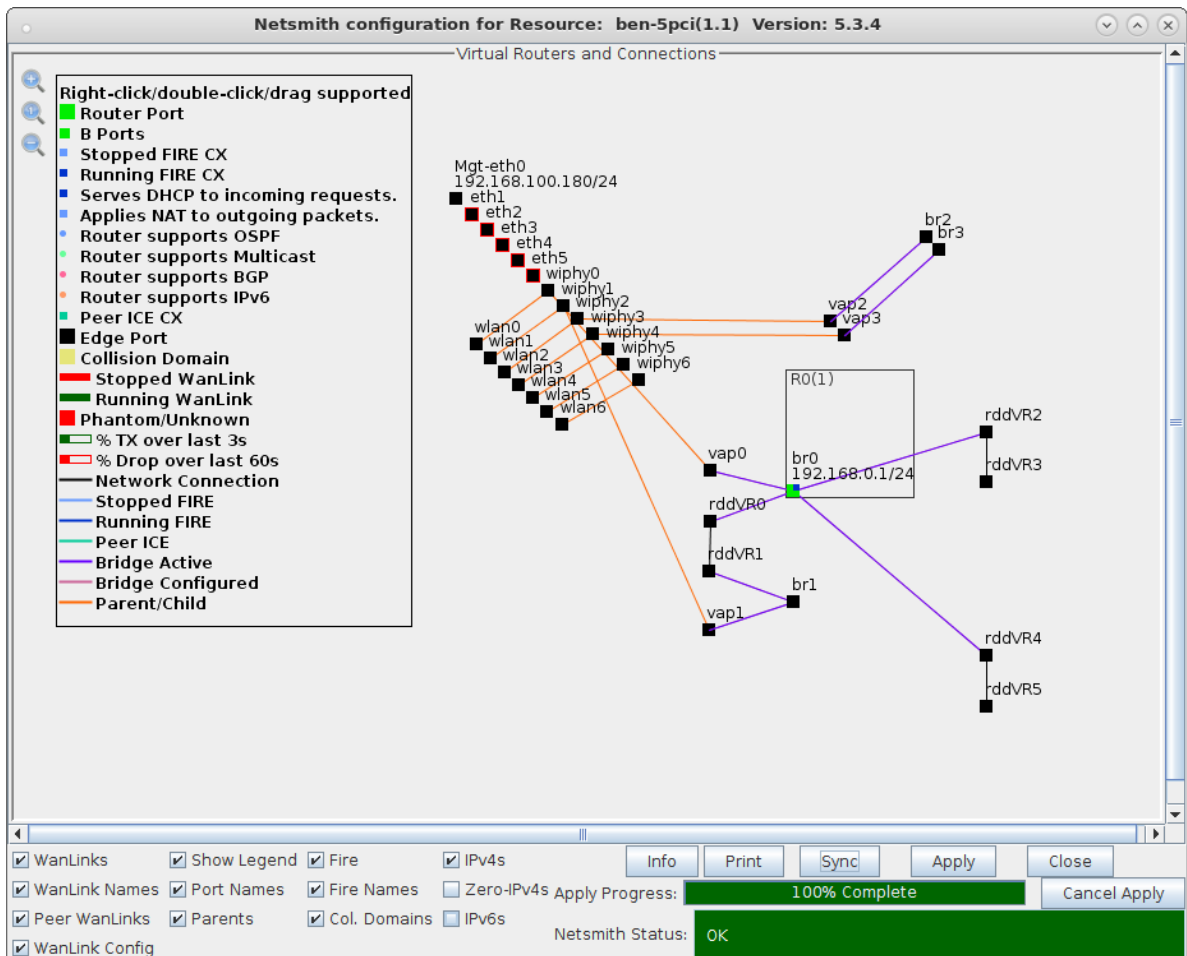
F. The objects vap2/br2 and vap3/br3 can be moved so that their logical relationships can be visualized. Add rddVR3 to br2, then add rddVR5 to br3.
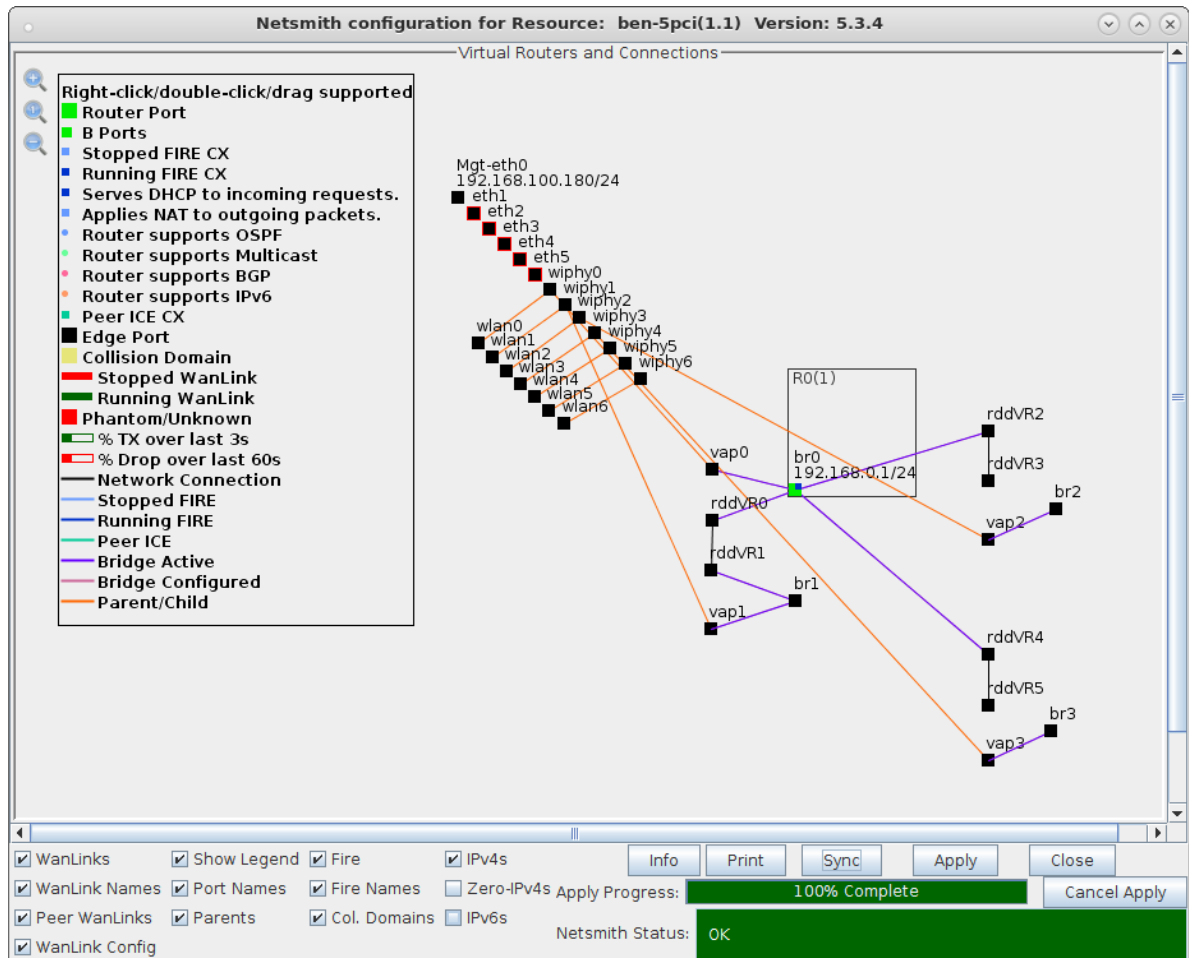
G. The final Netsmith display should show all four of the bridged virtual access points connected by a rdd pair, with br0 as the central bridge.
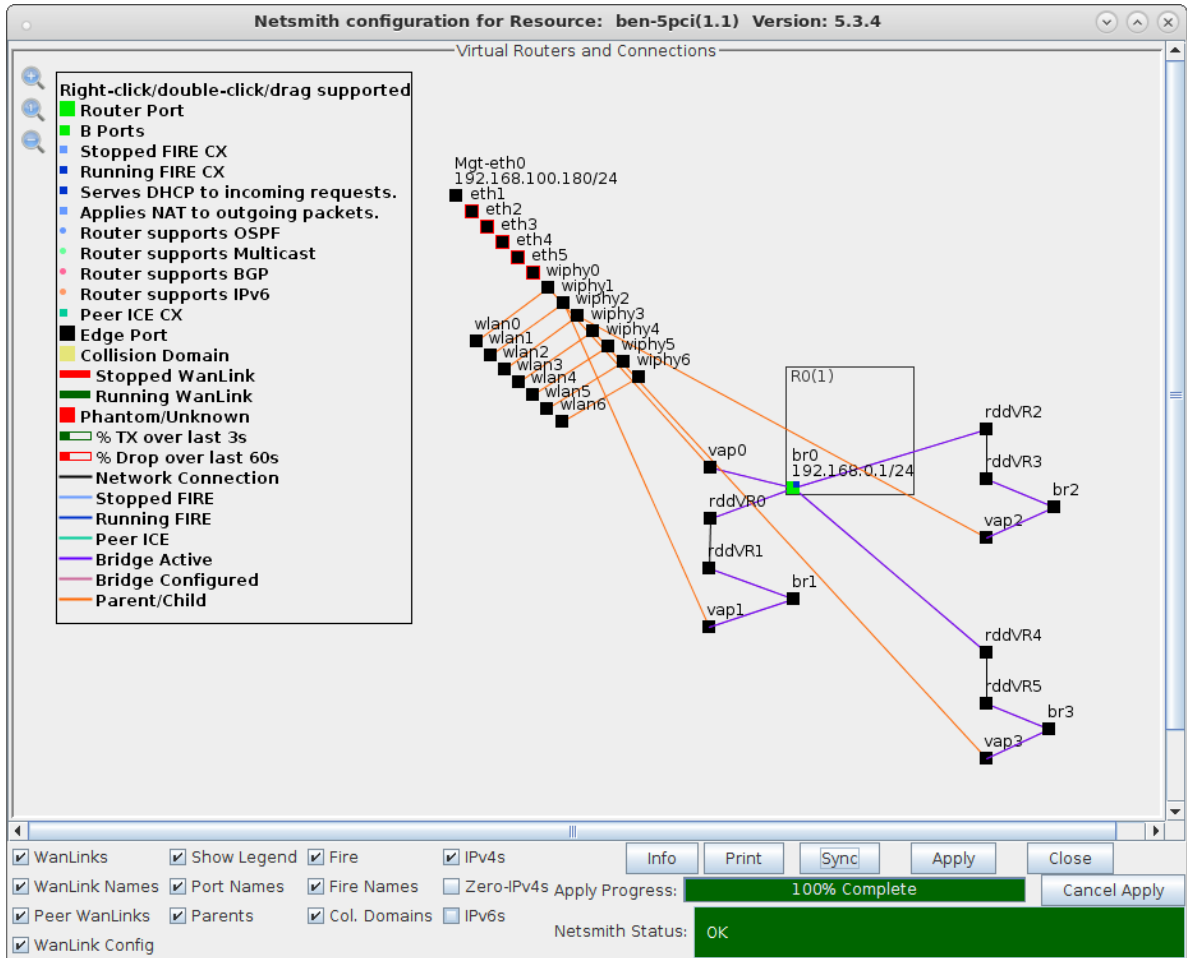
5. Connect LANforge clients and force them to roam from vap to vap. This can be accomplished with a wpa_cli command for one or two clients or the Mobility Plugin Script for many clients.

A. Client connected to vap0 **04:f0:21:b9:8f:00**.

B. Client roams to vap1 **04:f0:21:69:91:03**.


```
                              root@ben-5pci:~
File  Edit  View  Search  Terminal  Help
[root@ben-5pci ~]# wpa_cli -i wlan4 scan
OK
[root@ben-5pci ~]# wpa_cli -i wlan4 roam 04:f0:21:69:91:03 DS
OK
[root@ben-5pci ~]# iwconfig wlan4
wlan4     IEEE 802.11abgn  ESSID:"roamer"
          Mode:Managed  Frequency:5.745 GHz  Access Point: 04:F0:21:69:91:03
          Bit Rate=6 Mb/s   Tx-Power=19 dBm
          Retry short limit:7   RTS thr:off    Fragment thr=2346 B
          Encryption key:off
          Power Management:off
          Link Quality=70/70  Signal level=0 dBm
          Rx invalid nwid:0  Rx invalid crypt:0  Rx invalid frag:0
          Tx excessive retries:0  Invalid misc:0   Missed beacon:0

[root@ben-5pci ~]# █
```


LANforge Manager Version(5.3.4)

Control Reporting Tear-Off Info Plugins

Stop All | Restart Manager | Refresh | HELP

Layer-4 | Generic | Test Mgr | Test Group | Resource Mgr | Event Log | Alerts | Port Mgr | vAP Stations | Messages
Status | Layer-3 | L3 Endps | VoIP/RTP | VoIP/RTP Endps | Armageddon | WanLinks | Attenuators | File-IO

Disp: 127.0.0.1:1.0 | Sniff Packets | ▲ | Clear Counters | Reset Port | Delete
Rpt Timer: medium (8 s) ▼ | Apply | ▼ | View Details | Create | Modify | Batch Modify

All Ethernet Interfaces (Ports) for all Resources.

I	bps TX LL	Bytes TX LL	bps RX LL	Bytes RX...	Reset	TX-Rate	RX-Rate	Status	AP	Activity	Signal	Noise
0	70	12,528	331	601,603	Complete		0 bps			101		
0	554	195,854	581	18,066,...	Complete		0 bps			101		
0	492	191,858	503	23,417,...	Complete		0 bps			101		
0	571	233,623	63	16,333,...	Complete		0 bps			101		
0	51	24,715	7,341	20,645,...	Complete		0 bps			2.562		
0	0	0	0	0	Complete		0 bps			0		
0	0	0	0	0	Complete		0 bps			0		
0	0	12,211	0	27,071	Complete	6 Mbps	6 Mbps	Authorized	04:F0:21:69:91:03	2.544	-27 dBm	-84 dBm
0	0	0	0	0	Complete	0 Mbps	0 bps	NONE	Not-Associated	0	0 dBm	-1 dBm
0	0	0	0	0	Complete	0 Mbps	0 bps	NONE	Not-Associated	0	0 dBm	-1 dBm
0	0	0	0	0	Complete	0 Mbps	0 bps	NONE	Not-Associated	0	0 dBm	-1 dBm
0	0	0	0	0	Complete	0 Mbps	0 bps	NONE	Not-Associated	0	0 dBm	-1 dBm
0	0	0	0	0	Complete	0 Mbps	0 bps	NONE	Not-Associated	0	0 dBm	-1 dBm
0	0	0	0	0	Complete	0 Mbps	0 bps	NONE	Not-Associated	0	0 dBm	-1 dBm
0	0	0	0	856	Complete					0		
0	0	0	0	1,252	Complete					0		
0	0	1,200	0	856	Complete					0		
0	0	2,520	0	8,274	Complete					0		
0	0	2,460	2	80	Complete					0		
0	2	80	0	2,460	Complete					0		
0	2	9,520	0	3,204	Complete					0		
0	0	3,204	1	9,520	Complete					0		

Logged in to: localhost:4002 as: Admin

C. Client roams to vap2 **04:f0:21:33:28:06**.


```
                              root@ben-5pci:~
  File  Edit  View  Search  Terminal  Help
[root@ben-5pci ~]# wpa_cli -i wlan4 scan
OK
[root@ben-5pci ~]# wpa_cli -i wlan4 roam 04:f0:21:33:28:06 DS
OK
[root@ben-5pci ~]# iwconfig wlan4
wlan4     IEEE 802.11abgn  ESSID:"roamer"
          Mode:Managed  Frequency:5.745 GHz  Access Point: 04:F0:21:33:28:06
          Bit Rate=6 Mb/s    Tx-Power=19 dBm
          Retry short limit:7   RTS thr:off    Fragment thr=2346 B
          Encryption key:off
          Power Management:off
          Link Quality=70/70  Signal level=2 dBm
          Rx invalid nwid:0  Rx invalid crypt:0  Rx invalid frag:0
          Tx excessive retries:0  Invalid misc:0   Missed beacon:0

[root@ben-5pci ~]#
```


LANforge Manager   Version(5.3.4)

Control Reporting Tear-Off Info Plugins

Stop All | Restart Manager | Refresh | HELP

Layer-4 | Generic | Test Mgr | Test Group | Resource Mgr | Event Log | Alerts | Port Mgr | vAP Stations | Messages
Status | Layer-3 | L3 Endps | VoIP/RTP | VoIP/RTP Endps | Armageddon | WanLinks | Attenuators | File-IO

Disp: 127.0.0.1:1.0 | Sniff Packets | ▲ | Clear Counters | Reset Port | Delete

Rpt Timer: medium (8 s) ▼ | Apply | ▼ | View Details | Create | Modify | Batch Modify

All Ethernet Interfaces (Ports) for all Resources.

I	bps TX LL	Bytes TX LL	bps RX LL	Bytes RX...	Reset	TX-Rate	RX-Rate	Status	AP	Activity	Signal	Noise
0	42	12,972	63	602,269	Complete		0 bps			0		
0	430	201,473	264	18,070,...	Complete		0 bps			101		
0	486	197,814	148	23,419,...	Complete		0 bps			101		
0	444	239,212	0	16,333,...	Complete		0 bps			0		
0	68	25,443	7,327	20,742,...	Complete		0 bps			2.481		
0	0	0	0	0	Complete		0 bps			0		
0	0	0	0	0	Complete		0 bps			0		
0	0	12,211	0	27,071	Complete	6 Mbps	6 Mbps	Authorized	04:F0:21:33:28:06	2.466	-14 dBm	-84 dBm
0	0	0	0	0	Complete	0 Mbps	0 bps	NONE	Not-Associated	0	0 dBm	-1 dBm
0	0	0	0	0	Complete	0 Mbps	0 bps	NONE	Not-Associated	101	0 dBm	-1 dBm
0	0	0	0	0	Complete	0 Mbps	0 bps	NONE	Not-Associated	0	0 dBm	-1 dBm
0	0	0	0	0	Complete	0 Mbps	0 bps	NONE	Not-Associated	101	0 dBm	-1 dBm
0	0	0	0	0	Complete	0 Mbps	0 bps	NONE	Not-Associated	0	0 dBm	-1 dBm
0	0	0	0	0	Complete	0 Mbps	0 bps	NONE	Not-Associated	0	0 dBm	-1 dBm
0	0	0	0	862	Complete					0		
0	0	0	0	1,258	Complete					0		
0	0	1,200	0	862	Complete					0		
0	0	2,520	0	8,280	Complete					0		
0	1	2,480	0	80	Complete					0		
0	0	80	1	2,480	Complete					0		
0	0	9,520	1	3,224	Complete					0		
0	2	3,224	0	9,520	Complete					0		

Logged in to: localhost:4002 as: Admin

D. Client roams to vap3 **04:f0:21:b1:d7:0b**.


```
                          root@ben-5pci:~

File  Edit  View  Search  Terminal  Help
[root@ben-5pci ~]# wpa_cli -i wlan4 scan
OK
[root@ben-5pci ~]# wpa_cli -i wlan4 roam 04:f0:21:b1:d7:0b DS
OK
[root@ben-5pci ~]# iwconfig wlan4
wlan4     IEEE 802.11abgn  ESSID:"roamer"
          Mode:Managed  Frequency:5.745 GHz  Access Point: 04:F0:21:B1:D7:0B
          Bit Rate=6 Mb/s   Tx-Power=19 dBm
          Retry short limit:7   RTS thr:off    Fragment thr=2346 B
          Encryption key:off
          Power Management:off
          Link Quality=70/70  Signal level=-8 dBm
          Rx invalid nwid:0  Rx invalid crypt:0  Rx invalid frag:0
          Tx excessive retries:1  Invalid misc:0   Missed beacon:0

[root@ben-5pci ~]#
```


LANforge Manager   Version(5.3.4)

Control Reporting Tear-Off Info Plugins

| Stop All | | Restart Manager | | Refresh | HELP |

Layer-4 | Generic | Test Mgr | Test Group | Resource Mgr | Event Log | Alerts | Port Mgr | vAP Stations | Messages
Status | Layer-3 | L3 Endps | VoIP/RTP | VoIP/RTP Endps | Armageddon | WanLinks | Attenuators | File-IO

Disp: 127.0.0.1:1.0   Sniff Packets   ▲   Clear Counters   Reset Port   Delete

Rpt Timer: medium (8 s) ▼   Apply   ▼   View Details   Create   Modify   Batch Modify

All Ethernet Interfaces (Ports) for all Resources.

I	bps TX LL	Bytes TX LL	bps RX LL	Bytes RX...	Reset	TX-Rate	RX-Rate	Status	AP	Activity	Signal	Noise
0	18	13,239	123	603,379	Complete		0 bps			101		
0	331	204,845	218	18,072,...	Complete		0 bps			101		
0	362	201,600	146	23,421,...	Complete		0 bps			0		
0	463	244,547	45	16,333,...	Complete		0 bps			101		
0	43	26,074	4,455	20,785,...	Complete		0 bps			2.464		
0	0	0	0	0	Complete		0 bps			0		
0	0	0	0	0	Complete		0 bps			0		
0	0	12,211	0	27,071	Complete	6 Mbps	6 Mbps	Authorized	04:F0:21:B1:D7:0B	2.445	-41 dBm	-85 dBm
0	0	0	0	0	Complete	0 Mbps	0 bps	NONE	Not-Associated	0	0 dBm	-1 dBm
0	0	0	0	0	Complete	0 Mbps	0 bps	NONE	Not-Associated	0	0 dBm	-1 dBm
0	0	0	0	0	Complete	0 Mbps	0 bps	NONE	Not-Associated	0	0 dBm	-1 dBm
0	0	0	0	0	Complete	0 Mbps	0 bps	NONE	Not-Associated	0	0 dBm	-1 dBm
0	0	0	0	0	Complete	0 Mbps	0 bps	NONE	Not-Associated	0	0 dBm	-1 dBm
0	0	0	1	874	Complete					0		
0	0	0	1	1,270	Complete					0		
0	0	1,200	1	874	Complete					0		
0	0	2,520	1	8,292	Complete					0		
0	4	2,520	0	80	Complete					0		
0	0	80	4	2,520	Complete					0		
0	4	9,560	0	3,224	Complete					0		
0	0	3,224	3	9,560	Complete					0		

Logged in to: localhost:4002 as: Admin

E. Client roams back to vap0 **04:f0:21:b9:8f:00**.

For more information see Two WiFi Access Point Network with 802.11r