



XR Solution Technical Certification Training

Session 1:

Training | Knowledge Check | Lab exercise

This Workbook

Use this workbook to follow along with the technical training and take notes. This workbook only applies to session 1 of the XRSA certification.

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XR Series Hardware

Model Overview

The XR Series has 5 basic models that includes the XR80 and XR90 with the following variations.

Model	NAM	Global
XR90 5G Wi-Fi	•	•
XR80 5G Wi-Fi	•	•
XR80 LTE Wi-Fi	•	•
XR80 5G	•	•
XR80 LTE	•	•



Model Differences

An overview of the differences between models can be seen in this table:

Model	Internal Cell	Wi-Fi	Precision Time	Bluetooth	Expansion	Max Ethernet
XR90	--	(2) 5GHz 4x4 (1) 2.4GHz 4x4*	--	BT 4.1**	Up to 2 XP	1 x 5 GbE 4 x 1 GbE
XR80 5G	5G Sub-6 (4G Cat20 fallback)	--	1 x Precision Time Protocol IEEE 1588**	--	Up to 1 XP	1 x 5 GbE 3 x 1 GbE
XR80 5G Wi-Fi		(1) 5GHz 4x4 (1) 5GHz 1x1 (1) 2.4GHz 4x4*				
XR80 LTE Wi-Fi	4G Cat20	--				
XR80 LTE		--				

*2.4GHz Wi-Fi share 5GHz antennas

**Hardware is present, future software support

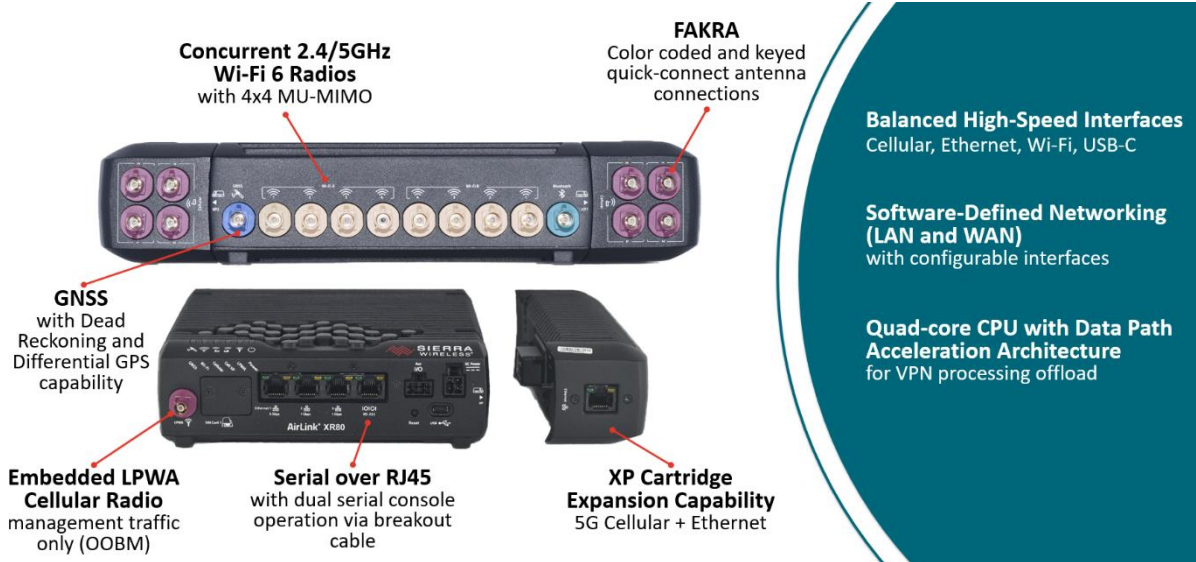
You will see from the table that there are minimal differences between models. For instance, the only difference between the XR80 5G and its XR80 LTE equivalent is the cellular radio module itself. Also, the XP module is the same for any XR series router, anywhere in the world.

From a build perspective, there are differences in both the AirLink OS behavior and also the LPWA/Out-of-band management radio use based on region (NAM vs Global SKUs) but the differences between the different models within each region are very minor.

For the XR80 5G and XR80 LTE Cat 20 models, the LTE capability is identical across the two models: both support the same level of carrier aggregation, both are 4-antenna MIMO with exactly the same bands supported for 4G usage.

Common Features

Building on Sierra Wireless' tradition of rugged, purpose-built routers, the XR Series have the following common features.



Other common features include:

- 7-36V power supply with transient protection from -600vDC to +200vDC
- Two configurable SIM slots which are 2FF/Mini-SIM form factor
- Rugged gasketed design (IP64 rating even with XP's expansion cartridges)
- -30°C to +70°C / -22°F to +158°F operating range
- 1-year standard warranty
- Up to 5 years extended warranty with current Services subscription
- Unrestricted critical firmware updates for product life (downloadable from Source)
- Certifications:
 - RoHS2, REACH, WEEE, Class 1 Div 2
 - E-Mark (72/245/EEC, 2009/19/EC)
 - ISO7637- 2
 - SAE J1455 (Shock & Vibration)
 - EN50155 (Rolling Stock)
 - MIL-STD-810G conformance to shock, vibration, thermal shock, and humidity

Balancing Interface Speeds

To use the exceptional speed available from the newest cellular networks, there must be other interfaces that can deliver the same speed to feed the WAN links. The XR series routers have been designed from the ground up as next-generation routers with a variety of high-speed wired and wireless interfaces, and hardware acceleration (Data Path Acceleration Architecture, DPAA) built into the processor and bus.

The XR Series boasts high-speed 5G Cellular plus WAN and LAN-capable wired and wireless. Check out these speeds:

Cellular (based on dual radio):

- Peak 5G DL of up to 4.1 Gbps
- UL of 660 Mbps
- Peak 4G DL of 2 Gbps, UL of 210 Mbps

Wired: One 5 Gbps Ethernet plus one USB-C 3.2 Gen 1

Wireless: 4x4 MU-MIMO Wi-Fi 6 up to 2.4 Gbps

Some 5G cellular devices on the market have inserted a 5G cellular radio into a legacy device with wired connections limited to only 1Gbps and Wi-Fi limited to 802.11ac 2x2, with a single radio capable of shared mode operation. This design creates bottlenecks within the router itself and gets in the way of making full use of the 5G or even gigabit 4G cellular throughput.

Interfaces and Behaviors

Network

- Full IPv4 and IPv6 support with transitional tools
- Default IPv4 LAN is set to 192.168.1.0/24
- Default Gateway is 192.168.1.1 and DHCP range is 100-200
- SDN allows multiple LAN segments assignable to any network interface
- Various options for IP Passthrough
- SDN allows dynamic WAN assignment
- DHCP Reservation and Named Networks and Hosts
- Zone-based firewall; all out, all between, none in by default
- **Default priority (based on WAN zone)**
- Ethernet (any) > 5 GHz client > 2.4 GHz client > Cell 1 > Cell 2

This course is focused on IPv4, but AirLink OS and the XR series routers are the first products in the AirLink line with complete support for IPv6, and just like IPv4 can be managed from addressing, firewall, and routing perspectives.

The default LAN addressing is different from previous AirLink routers, and can be changed very easily and also augmented with additional LAN segments (bridges). There is only one default LAN configured, and all LAN interfaces will provide access to it out of the box.

The addressing is:

- Default gateway 192.168.1.1
- Net mask 255.255.255.0 (C class, /24 network)
- DHCP range 192.168.1.100-200

NOTE If you connect to a local network (lab, corporate) to provide an Ethernet-based WAN link for initial setup and the WAN network addressing is the same as the Default LAN, it will appear that you are not getting an uplink. This is due to routing confusion.

NOTE AirLink OS features a full DNS server, and the hostname “airlink.” Including the trailing period will be mapped to the default LAN default gateway address. When connecting to AirLink OS locally, it is recommended that you use <https://airlink.> to connect.

All interfaces support software-defined networking in that they can be individually assigned functionality and addressing as well as routing and firewall, and can be quickly changed from the AirLink Management Service cloud management platform. Changes take effect right away and do not require reboots, and network clients benefit from address change functionality that does away with traditional requirements around disconnecting media and waiting for new addressing to be recognized and implemented.

AirLink OS provides IP Passthrough capability to a single host device on the LAN, along with many controls for managing port forwarding and outbound masquerade (effectively network address translation) functionality, and there will be additional features added in upcoming AirLink OS releases.

All previous AirLink multi-WAN routers had an implicit default priority of interfaces, but the XR Series of routers with AirLink OS takes Default Priority to a new level.

While there are many ways to shape the routing with advanced features, it is worth understanding the default WAN priority out of the box. Doing so will let you set up the device in a manner that requires the least reconfiguration.

Any Ethernet being used for WAN will be selected first to support any available routing, such as IPv4, IPv6 or both.

After the Ethernet interfaces, in order, the 5GHz Wi-Fi WAN connection will be used followed by the 2.4GHz Wi-Fi WAN.

To this point, preference is given based on perceived lowest cost and highest speed.

If none of those interfaces are available, the first cellular radio will be used (physical or virtual, in the case of multi-APN) followed by the second cellular radio. Based on this order, the primary cellular SIM should be used in the top slot if there is a preferred carrier.

You will see in the Multi-WAN table that the LPWA is listed as the final interface for IPv4 outbound traffic, but other system firewall rules prevent any user traffic from traversing the LPWA network connection; it is reserved for management traffic only.

Wired Interfaces



Ethernet

All Ethernet ports are configurable for LAN or WAN use

Dynamic WAN Auto-detect is default for all Ethernet ports (base and XP)

All Ethernet ports provide access to Default LAN, out of the box

The left port is 5 Gbps, all other ports are 1 Gbps



USB-C

USB-C port is on Default LAN and is LAN-configurable

Windows: requires driver install (auto update, optional); OS/X: autodetect

Theoretical max throughput is 5 Gbps

Industry-standard screw-lock support

Previous AirLink routers either had to be attached to an uplink prior to powering on, or had to be configured for WAN use only in order to connect and recognize a WAN link via Ethernet. XR series with AirLink OS is nimble and dynamic, and can have a single Ethernet port change back and forth between LAN and WAN use multiple times with no reboots or reconfiguration required.

Also, changing addressing of a segment is more seamless than ever before, as a client host device will be able to resolve addressing changes without having to remove the physical cable and waiting for the cached address to expire.

On the XR80, the 5Gbps port will in the future support Precision Time Protocol IEEE 1588. This is available only on the XR80, and when PTP is enabled, the throughput capability of the port will be limited to 1 Gbps because of the overhead and processing required to support PTP.

The USB-C port is the evolution of the Micro-USB port on ALEOS devices. It is by default on the same network address segment as the Ethernet ports, which is a change from ALEOS where it was its own LAN segment but was bridged to the default LAN.

It is capable of both Network and Serial use and is USB 3.2 Gen 1 hardware.

Cellular




SIM Slots

Top slot is for radio 1 (INT/XP1),
bottom slot is for radio 2 (XP/XP2)

SIMs read only at boot time

Slot assignments are configurable

Automated SIM failover supported for
single-cellular routers (3.0)



APN Modes

Automatic: Look-up based on carrier, uses
most common (Default)

Manual: APN specified

Manual: Blank (network assignment if
network supports)

Multi: up to 5 per radio; presents each
entry as virtual cell

SIM slots accommodate mini-SIM or 2FF SIM cards, and the use of adapters is not recommended.

Newly installed SIM cards are read only at boot-up time, but if SIM cards are present in both slots at boot time you can reassign the SIMs to different cellular radios without rebooting the router.

Radio configurations are in Automatic APN mode by default, which identifies the carrier and then applies the most commonly used APN for that carrier. In some cases, if supported by the network provider, the network will provide a different APN to use if the radio is in either Auto or Manual [blank] mode. This will be clearly marked as a network-assigned APN.

Wi-Fi 6 and RS232 Serial



DBDC Wi-Fi 6

Dual-band dual-concurrent radios; all disabled, set to 20MHz channel width

DFS disabled; enabling gives more 80MHz bands but has delay in AP broadcast

Locked to outdoor channels only based on region (changing in 4.0)

Up to 3 SSIDs available per access point



RS232 Serial

RJ45 port providing single or dual RS232

Compatible with standard Cisco-compatible light blue console/rollover cable

Proprietary cable available for dual-serial (one 4-wire, one 2-wire)

Pinout available in Hardware guide for building customer dual-serial cables as needed

Wi-Fi is the single greatest differentiator between the XR Series models, with the dual-radio XR80 and three-radio XR90 both providing dual-band dual-concurrent Wi-Fi radios with slightly different capabilities based on the resources available and the use cases they are designed to support.

Both support multi-mode operation, but with slightly different characteristics

Wi-Fi 6 Details by Model



XR90

5 GHz are two independent 4x4 radios, each configurable for client or AP (not shared)

2.4 GHz: can operate in “repeater” mode (same channel as 2.4GHz STA) or “timeslice” mode (different channels)

2.4 GHz: map each operation (STA/AP) to specific antenna bank



XR80

Dual concurrent 2.4/5 GHz use 4 streams

Both radios support shared operation; channel is based on STA/client (“repeater” mode)

Discrete configuration of one each 2.4 and 5 GHz radio

If you are using 5GHz STA mode, you **must** connect an antenna to Wi-Fi 5 connection

The XR90 has two independent 5GHz 4x4 radios each capable of either AP or client, but not both at the same time. The XR80 has one 5GHz radio that can be used in STA + AP mode, but can be set up to disable the AP when the STA is connected. That feature coupled with the Wi-Fi 5 scanning channel means that you can get uncompromising 4x4 throughput and performance by operating in either STA or AP mode if both are not required at the same time.

LPWA Radio: Management Traffic Only





Each XR Series router has an internal LPWA radio with 1x1 antenna

- Data is limited to LWM2M management traffic to ALMS
- Not configurable for user traffic
- Limited to low throughput Cat-M1, NB-IoT
- Not capable of supporting AirLink OS updates OTA
- Must receive initial activation from ALMS (via another WAN link such as Ethernet)
- Requires registration and active Services status
- Supported by SW connectivity, regional offering details may differ
- Internal SIM (not customer accessible)
- LPWA antenna included in router box
- Provides Out-of-band management in case of total WAN loss

The embedded LPWA radio supports management traffic to ALMS only, and requires a link capable of connecting to ALMS in order to become provisioned. The LPWA radio cannot provide the initial connection to ALMS, nor will it facilitate software upgrades. It is limited to low bandwidth protocols, but is ideal to support the regular small amounts of data from the router to ALMS.

The airtime/data for the LPWA radio is covered by the AirLink Service subscription, and the user will not have to pay for any overage that may occur due to more use than expected. The LPWA connectivity uses Sierra Wireless MVNO capabilities and may be set up differently for different parts of the world. This currently requires the North American XR Series routers must be registered in the North American data center, and Global XR Series routers must be registered in the EMEA data center. This is expected to change over time.

Antenna Requirements

Antenna Requirements	
 Cellular	4x4 MIMO each, 600-6000 MHz per cell Cables must support high frequencies Use of adapters not supported (interference + cable spec)
 Wi-Fi	XR80: requires 4x4 MIMO 2.4/5 GHz plus 1x1 5GHz (5 total) XR90: requires two 4x4 MIMO 2.4/5 GHz (8 total)
 GNSS	FAKRA Signal Blue C Plug (requires HC 9003 jack on cable) Cables must be low-loss
 Bluetooth	XR90 only: 2.4 GHz element with FAKRA Water Blue Z unkeyed (any FAKRA jack) Can use any 2.4GHz Wi-Fi antenna

Sierra Wireless has a number of solution-based antennas available which can be viewed in the catalog on the Sierra Wireless website. There will be additional antennas available in the future and several other reputable manufacturers have antennas suitable for use with the XR series.

As with any antenna, the number of connection points and characteristics of the cabling and elements within the array are of critical importance. The use of SMA to FAKRA adapters is strongly discouraged due to the inherent signal loss and susceptibility to noise from unshielded connection points.

If you are pressed to use less than all the recommended antenna elements, be aware that both configuration changes and possibly terminators may be required to prevent inefficient operation or damage to the hardware.

FAKRA Connector Summary



Antenna	FAKRA Color	Key	Requires jack	XR90	XR80	XP
Cellular	Claret-Violet	D	HA9004 jack	-	4	4
Wi-Fi	Beige	I	HV 1001 jack	8	5	-
GNSS	Signal Blue	C	HC 9003 jack	1	1	-
Bluetooth	Water Blue	Z	RAL 5021 jack	1	-	-

Not including LPWA antenna, which has same connector as other Cellular but is provided with base unit

If you are working with third-party antennas, the summary table above provides a reliable reference of the FAKRA color/keying. The plugs are mounted on the back of the router, and the jack is required on the cable connection.

As stated earlier, the use of FAKRA to SMA adapters is strongly discouraged and not supported in case of sub-optimal performance, due to the frequency response of legacy antennas coupled with the cable unsuitability for high frequency data and lack of shielding which will lead to higher interference.

Using non-standard or legacy antennas

When can I get by with less antennas?

My customer wants to use existing antennas, or use less than all the available connections to save money if they don't need all the speed

Cellular	Wi-Fi XR80	Wi-Fi XR90
<p>You can't</p> <p>It's not just about throughput; some channels use 3+4 as primary connections</p>	<p>If never using 5GHz STA (Client) mode, you can skip Wi-Fi 5</p> <p>If not max throughput requirement</p>	<p>You can't</p> <p>2.4 and 5GHz are shared, but MIMO order is reversed so even dual-band 2x2 requires all 4</p>

In a real-life scenario, you will be faced with customers wanting to use third-party or legacy antennas that are not ideally suited to the XR Series. They may be able to achieve reasonable results with the Wi-Fi on the XR80, but cellular and XR90 Wi-Fi should not be compromised.

For cellular, some bands rely on connections 3-4 as their primary downlink and uplink. For instance, band n41 requires two antennas but they are 3-4 and not 1-2 because of interference properties of the frequency. If the only antennas in use are connections 1-2, then these bands will not be able to connect at all.

For Wi-Fi, MIMO 1-2-3-4 are shared between 2.4 and 5GHz on the XR80, but on the XR90 the order for 2.4GHz MIMO is inverse from 5GHz, which is what the rear labelling shows. So for each bank, Wi-Fi 1 for 2.4GHz connects to the port labeled Wi-Fi 4. Four antennas are required for dual-band 2x2 MIMO operation so customers will need to provide the same number of antennas for dual-band 2x2 as dual-band 4x4.

The following table shows the XR80 connections based on band and mode requirements.

XR80 Modes	Number of Wi-Fi antennas available				
	1	2	3	4	5
Dual band STA+AP	Not Supported	1+5	1+2+5	1+2+3+5	1+2+3+4+5
5GHz STA+AP		1x1 MIMO	2x2 MIMO	3x3 MIMO	4x4 MIMO
5GHz STA only		1x1 Scan	1x1 Scan	1x1 Scan	1x1 Scan
2.4GHz AP only AND 5GHz STA+AP					
2.4GHz STA+AP AND 5GHz AP Only	1 1x1 MIMO	1+2	1+2+3	1+2+3+4	1+2+3+4
2.4GHz STA+AP		2x2 MIMO	3x3 MIMO	4x4 MIMO	4x4 MIMO*
2.4GHz AP only					
5GHz AP only					
2.4GHz STA only					

AirLink® OS



Key features of AirLink OS include:

- Reboots only required for SIM-related changes
- Dynamic WAN auto-detect
- Full software-defined networking (SDN): LAN and WAN
- Multi-APN support
- Full IPv6 support and typical controls and tools
- Enhanced troubleshooting tools and logging
- Enhanced reporting behavior to ALMS cloud management
- User management and audit log
- Improved upgrade behavior and new backout capability
- Quarterly feature release schedule

AirLink OS has been in development for over two years, and represents a modern operating environment built from the ground up. Many of its functions and capabilities are based on the other environments that Sierra Wireless has had in previous generations of products, but AirLink OS represents a complete refresh on how the products operate.

Navigating the User Interface

The new layout and operation does so much more!

Menu panels

Search bar

Quickly find settings and values, navigate to sections

Status and Monitoring first, including the Dashboard

Communication section

Device systems and management section

The screenshot shows the following interface elements:

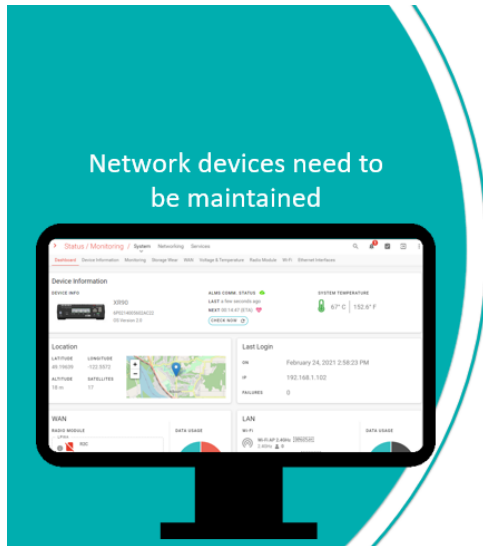
- Top Navigation:** Status / Monitoring / System | Networking | Services
- Sub-headers:** Dashboard, Device Information, Monitoring, Storage Wear, WAN, Voltage & Temperature, Radio Module, Wi-Fi, Ethernet Interfaces
- Device Information:** XR90, IPQ214005602AC22, OS Version 2.0, ALMS COMM. STATUS (green), LAST a few seconds ago, NEXT 00:14:47 (ETA), CHECK NOW button, SYSTEM TEMPERATURE: 67° C | 152.6° F
- Location:** LATITUDE: 49.19659, LONGITUDE: -122.5572, ALTITUDE: 18 m, SATELLITES: 17, Map of Albron.
- Last Login:** ON: February 24, 2021 2:58:23 PM, IP: 192.168.1.102, FAILURES: 0
- WAN Section:** RADIO MODULE (RDC), XP1 Cellular (Top SLOT), XP2 Cellular (Bottom SLOT), XP2 Cellular-1, XP2 Cellular-2, Wi-Fi (Wi-Fi Client 2.4GHz, Wi-Fi B 5GHz), ETHERNET PORT(S) (Ethernet 2).
- LAN Section:** Wi-Fi (Wi-Fi AP 2.4GHz, Wi-Fi 2.4GHz SSID 1, Wi-Fi 2.4GHz SSID 2, XR90-1, Wi-Fi A 5GHz SSID 1, Wi-Fi A 5GHz SSID 2, Wi-Fi B 5GHz SSID 1, Wi-Fi B 5GHz SSID 2), ETHERNET PORT(S) (Ethernet 1 (3G), Ethernet 2, XP2 Ethernet, XP1 Ethernet), USB PORT(S) (USBNet).
- Device systems and management section:** Cartridge (XR90), SLOT (XP1, XP2), STATUS (OK, OK), CPU Load (average) graph (Critical, Warning), Memory & Storage bar chart (RAM, SYSTEM, USER).

Some of the tools available in AirLink OS include:

- The new Search mechanism
- A dynamic left menu broken into logical segments
- Clickable breadcrumbs across the top of the window which update dynamically as you move around the interface
- Ability to scroll within the segments

AirLink® Services and ALMS

End-to-End Security



Subscription-based maintenance model ensures no device is left behind



Product solution includes the first year of AirLink Services



Regulatory landscape and customer dedication to security; carrier pressure



Many organizations and certification authorities mandate devices updates



Secure cloud-based service is the right tool



Sierra Wireless prioritizes security in the cloud and data residency

We have taken the approach of including the initial year of support, cloud-based management, and out-of-band management communication as part of the initial cost of the units and it is important that all of our customers and users understand the capabilities and value offered by the solution.

Tokens and Subscriptions

ALMS used to use tokens for accounting, and as long as there were enough tokens in the account, all devices would be covered. It has now changed with the new ALMS account and AirLink Services model to a device subscription model. As a result, the entitlement is connected to a specific device rather than simply having enough tokens in the account.

Product Solution for First Year Included

As with the latest ALEOS devices with AirLink Complete, the XR Series routers include the first year of subscription to AirLink Services is included, but the router must be registered in order to make use of the cloud management and out-of-band management portions or for access to direct support from Sierra Wireless. There will more discussion in the next session regarding the details of the Service offerings.

Regulatory Landscape

Certification authorities like FirstNet and the Transportation Security Administration in the USA are now requiring the critical communications infrastructure devices must be maintained with current firmware and software updates in order to protect against threats and malware. Sierra is the only company in its class with the responsibility for and capability to enumerate vulnerabilities, and we monitor as many as

1,000 newly reported vulnerabilities per hour to determine whether our products may be susceptible to attack and whether updates are warranted, and at what level of risk and criticality.

AirLink Services Registration Code

The router label information is continuing to evolve



The QR Code is:

Is on bottom label of the router

Unique, even more than before

One way to access Service registration information

When you scan the QR code, there is a specific order to the entries, separated by semicolons. The sequence on this label only includes what is in the specific device chassis, so for instance the XR80 will include an additional radio module IMEI that the XR90 does not contain.

The order if items is:

- Serial number
- LPWA IMEI
- Internal 4G/5G radio IMEI (XR80 only)
- Model number
- UPC
- Registration code



What's Next

As part of the certification program, you are required to demonstrate that you have mastered the knowledge requirements of working with the XR Series of routers. This assessment must be passed with at least 80% prior to the start of the next session.



You do not need to complete the lab exercise prior to taking the quiz, as it is based on the presentation content.

Log in to the Training Portal and {need instructions}

Here's what you should know:

- Differences between XR80 5G and XR80 LTE models
- Differences between XR80 5G Wi-Fi and XR90 5G Wi-Fi
- Antenna requirements are for each XR Series router
- Ethernet ports capabilities
- Requirements for Out-of-Band Management functionality
- LPWA radio capability and restrictions
- AirLink OS responsiveness compared to ALEOS
- Product label information



This lab exercise will cover:

- Guided inquiry into confirming device status
- Examining link quality indicators
- Examining link capability indicators
- New and improved troubleshooting tools
- Reconfiguring some key and basic device parameters

Also:

- Creating an ALMS "Gen 2" account (if not already done)
- Registering your XR Series router for AirLink Premium/Complete for XR80 (including ALMS)