ONOS:

ONOS (Open Network Operating System) is an operating system (OS) designed to help network service providers build carrier-grade software-defined networks architected for high scalability, availability and performance. Although specifically designed to address the needs of service providers, ONOS can also act as a software-defined networking (SDN) control plane for enterprise campus local area networks (LANs) and data center networks.

How ONOS works:

The ONOS core is based on a modular architecture, as opposed to an integrated system that blurs the division between its components. This modularity keeps north-south workflows separated from east-west workflows while also permitting easier customization for the entire system. Because service providers require the ability to scale their networks, the ONOS controller can scale out to accommodate a physically distributed system of devices. This allows service providers to add new switches or components without disturbing the rest of the system. Additionally, the distributed architecture reduces network failure, as identical instances can pick up where another fails. This, in turn, results in high availability.

While the ONOS core is distributed to provide reachability to each network switching device, the ONOS controller remains logically centralized and the separate subdivisions or instances in the complete ONOS architecture can be viewed and accessed as a single system. For overall system visibility and management, ONOS provides a relatively straightforward GUI.

ODL:

Hosted by the Linux Foundation, OpenDaylight Project (ODL) is an open source SDN project aimed at enhancing software-defined networking (SDN) by offering a community-led and industry-supported framework for the OpenDaylight Controller, which has been renamed the OpenDaylight Platform. It is open to anyone, including end users and customers, and it provides a shared platform for those with SDN goals to work together to find new solutions.

Since the OpenDaylight platform is both multiprotocol and modular, users can build an SDN controller to fit their specific needs. This modular and multiprotocol approach gives IT admins the ability to pick a singular protocol or to select multiple protocols to resolve complex problems as they crop up. The platform includes support for all SDN platforms, including OpenFlow, OVSDB, NETCONF, and BGP.

The OpenFlow protocol, considered the first SDN standard, defines the open communications protocol that allows the SDN Controller to work with the forwarding plane and make changes to the network. This gives businesses the ability to better adapt to their changing needs and have greater control over their networks.
The OpenDaylight Controller is implemented solely in software and is kept within its own Java Virtual Machine (JVM). This means it can be deployed on hardware and any operating system platforms that support Java. The controller uses these tools:

i. Maven for build automation.
ii. OSGi for dynamically loading bundles and packaging JAR files.
iii. JAVA interfaces for event listening, specifications, and forming patterns.
iv. REST APIs such as topology manager, host tracker, flow programmer, and static routing.

ONOS vs. OpenDaylight:

OpenDaylight (ODL) is a similar open source project created by the Linux Foundation. Both ONOS and ODL have modular designs and similar goals to advance SDN. The two projects take separate approaches, however, and have different backers and partners. While ONOS is primarily for service provider networks, ODL focuses on data center networks. Also, the goal of ONOS is to provide better overall network performance, while ODL is designed to merge legacy networks with SDN.

ONOS and ODL are major contenders that need to be considered side by side. ONOS vs. ODL– Cloud provider vs. Carrier-grade networks – Legacy vs. “Pure SDN – Corporate initiated vs. Academic initiated.

Both ONOS and ODL are written in Java and designed for modular use with a customizable infrastructure–and it is important to note that every ONOS partner is also an ODL member. Beyond that, there are some key features that set them apart:

- **Licensing**: ONOS has an Apache 2.0 license, while ODL uses the Eclipse Public License. ONOS is a little more Service Provider / Cloud Provider focused.

- **Structure**: Though some of its aspects are still developing, ONOS consists of a complex series of subsystems, as well as scalable functions for telecom systems. ODL, by contrast, uses a model-view-control platform and operates off a strong central abstraction layer.

- **Target clients:** The ONF also said that ODL and ONOS both have hybrid commercial strategies, but there are differences when it comes to which company is appealing to which vendors. While the Whole Stack connected ONOS to telecoms, it said ODL was more focused on data centers.

- **Focus**: ODL focuses on bringing legacy (BGP, SNMP etc) and NGN (Next generation Networks OpenFlow and SDN) together. ONOS focuses more on performance aspects and clustering to increase the availability and scalability naturally making it of more interest typically to Carriers. As a result, ONOS focuses more on Carrier-grade networks and telcos are involved with their projects. ODL has more vendors like Cisco, Juniper, and NES than ONOS.

- **Northbound Abstractions (Intent):** ONOS features 2 Northbound interface layers: Intent Framework and Global Network View. The Intent Framework shields the complexity of service operations, allowing applications to request network services abstracted from the specific details of service operations. Application developers can do their jobs and only need to raise operational intents. ODL is headed in the same direction with the Network Intent Composition project, which will enable developers to easily describe their own intents. ODL hopes to create a uniform intent platform to integrate many users intent Northbound Interfaces. At this point ODL lags behind ONOS in this regard.

Ultimately, today, ONOS boasts the better pedigree and will be the stronger choice for companies that want to radically upgrade their network access mode (give or take limitations in real-world experiences). Contact CloudSmartz for products and guidance that take you directly through network function virtualization and software-defined networking technologies.

Q) How you will select a router and what attributes of a router you will check / access when purchasing a router. Check and read the parameters sheet of 3 routers and select 1 from 3.

1. **Figure out your Internet's top speed.** This is doable by contacting your Internet Service Provider (ISP), or by looking at your account details. Internet speed, which is typically measured in megabits per second (Mbps), will dictate your router's bare minimum speed. For example: if your Internet's top speed is 100 Mbps, you'll need a router that can handle at least 100 Mbps.

2. **Make a note of each device that your router will support.** Writing down a list of devices that will be connected to the router (e.g., phones, computers, consoles, etc.) will help determine the router's size, since you'll need a large router to support several active devices at once and vice versa. A small, average-power router can typically take care of a group of standard computers performing low-bandwidth operations, while you'll need a stronger router to handle high-bandwidth operations and other devices (e.g., printers). Also consider how you'll be using the Internet, since casual browsing and light work will take significantly less processing than gaming or constant file transfers (e.g., uploading and downloading).

3. **Make sure your router supports WPA2 encryption.** There are many different security types, but WPA2 is the most recent--and, therefore, most secure--version of encryption. Any router with the "AC" designation should support WPA2 encryption. Avoid WEP and WPA, since both are outdated as of 2006. If you can't find a WPA2 certification on the router's packaging or features page, contact the manufacturer or customer service department and ask about the router's supported encryption.

4. **Single-band vs. dual-band**. Devices that can use only the 2.4GHz band are called single-band devices, while dual-band devices can use the 2.4GHz and 5GHz bands. Whereas the lower-frequency band has a lower speed limit and is narrower, the 5GHz band is much wider and has a much higher speed limit.

   There are drawbacks to the 5GHz band. Higher frequency means the signal loses more of its strength as it deals with walls, furniture, and other obstacles, though AC routers have something called beamforming that will send a signal in the direction of a device, rather than just spraying a signal in a sphere around it. Still, the increased speed and wider road mean it's perfect for streaming high-def video and gaming.

5. **Determine how much area you need to cover.** Living in a large home can cause problems when it comes to serving Wi-Fi to all of your devices, especially when using the 5GHz band. For smaller apartments or homes, a single router with a strong set of antennas will no doubt get the job done, and it doesn't hurt to test things out before buying something too expensive. Reading reviews is a great way to get an idea of how much range a router has. You can also always check out Wi-Fi extenders that pick up a router's signal and rebroadcast it somewhere else in your home.

6. **Do you need MU-MIMO?** To complicate things even further, some new routers have something called multi-user, multiple-input, multiple-output (MU-MIMO) tech baked right in. Whereas more traditional single-user, multiple-input, multiple-output (SU-MIMO) tech delivers data to one device at a time on a rotating basis, MU-MIMO allows for simultaneous data delivery.

   SU-MIMO is fine for most purposes, and the rotating delivery happens so fast you usually won't notice. If, however, someone in the home is streaming video and you're trying to game online, MU-MIMO can come in handy by offering uninterrupted data flows to both devices.

7. **Consider software and security features.** If you need to be in full control of everything that goes through your router, go for one with advanced firmware that includes a decent firewall and offers any additional features you may require, or supports the installation of third-party advanced firmware like DD-WRT that can offer those features. If you are concerned about your children being exposed to inappropriate information on the internet, choosing a router with built-in parental controls can be useful. Some routers even let you allow and restrict internet access for your children

based on time slots and offer guest access for your visitors so that you won't need to provide them with your primary Wi-Fi password.

8. **AC naming conventions don't matter. However, don't go below AC1200!**
   Wireless routers brag about their total maximum bandwidth in their name. You have AC1200, AC1900 or even AC5400 routers. This naming convention is meaningless in real-life, and it doesn't tell you the real speed you get from a wireless router.

   However, DO NOT BUY A ROUTER BELOW AC1200. If you see a router with AC750, AC900 or anything lower than AC1200, it means that you are dealing with an old router, with dated technology and you should not buy it. That router is not a good choice for a modern smart home where you need speed, stability, and security, for an increasing number of connected devices.

9. **Fast processor and plenty of RAM.** Manufacturers of wireless routers don't tell you this, but the hardware inside your router matters a lot, especially the processor and the quantity of RAM. Smart homes have many devices that require wireless connectivity. Now we do a lot of video streaming, online gaming and other activities during which lots of data is transferred through the network. To cope with everything, wireless routers need a lot more processing power than they used to.

   When choosing a wireless router, you must know whether it has a single-core, dual-core, or quad-core processor and its operating frequency. Naturally, a dual-core processor can deal with more data and more clients than a single-core processor. Also, a processor running at 900 MHz is less powerful than one at 1.2 GHz. The same rules apply as is the case with computers, smartphones, and other computing devices.

   When buying a wireless router, the processor should not be lower than a single-core running at 800MHz. For modern standards, this is the minimum required to deal with the load you get in a small smart-home. If you could afford to buy a router with a dual-core or quad-core (usually reserved for expensive routers) processor, the better.

   Also, your router should not have less than 128MB of RAM. This is to make sure that it can process everything as fast as possible. If money is not a big issue, you should seek for a wireless router with 256MB of RAM or more.

10. **USB (preferably USB 3.0).** Having at least one USB port available is a must in modern homes. We have all kinds of USB devices that we need to connect to our wireless router: external hard disks, printers, USB modems, etc. Your newly purchased router should have at least one USB port, preferably one that it is USB 3.0.

JUNIPER:

	MX960
Rack units	16
Systems per rack	3
Slots	11 MPCs
Per slot capacity	1.5 Tbps
Maximum system throughput	12 Tbps
PDH	Yes
Sonet/SDH	Yes

Specifications

		MX960
Layout	System capacity	12 Tbps
	Slot orientation	Vertical
	Mounting	Front or center
Physical Specification	Dimensions (W x H x D)	17.37 x 27.75 x 23 in (44.11 x 70.49 x 58.42 cm)
	Weight fully loaded	334 lb/ 151.6 kg
	Weight unloaded	150 lbs/ 68.1 kg
Routing Engine	Default memory	2x16 MB NOR flash storage; 64 GB of DDR4 RAM; 2x50 GB SSD
	Number of cores	6 cores
Redundancy	Components	Power supplies, REs, fans
Power	Power input [AC]	200 to 240 V AC
	Power input [DC]	-40 to -72 V DC
	Typical power draw (AC)	6520 W
Redundancy	Components	Power supplies, REs, fans
Power	Power input [AC]	200 to 240 V AC
	Power input [DC]	-40 to -72 V DC
	Typical power draw (AC)	6520 W
	Typical power draw (DC)	6670 W

		MX960
Environmental	Air flow	Front to back
	Operating temperature	32° to 115° F (0° to 46° C) at sea level
	Operating humidity	5% to 90%
	Operating altitude	10,000 ft (3048 m)
Certifications	NEBS	- GR-1089-Core EMC and Electrical Safety - Common Bonding Network (CBN) - National Electrical Code (NEC) - GR-63-Core Physical Protection

MX Series Platform/Feature Matrix

		MX960
Security	Firewall filters/ACLs	✓
	DDoS—control plane	✓
	DDoS—FlowSpec	✓
	Stateless filters L2-L4	✓
	Stateful services	✓
Inline Services	GRE reassembly	✓
	1:1 NAT	✓
	Flow monitoring	✓
	Video monitoring	✓
	Lawful intercept	✓
	Mirroring	✓
Service Card Supported Services[5]	Deep packet inspection	✓
	CGNAT	✓
	Flow monitoring	✓
	Server traffic load balancing[6]	✓
	IPsec	✓
	Stateful firewall	✓
	HTTP header manipulation	✓
Resiliency	Redundant RE	✓
	Unified ISSU	✓
	Nonstop active routing (NSR)	✓
	Fast restoration	✓
	Operation, Administration, and Maintenance (OAM)	✓
System Virtualization	Enhanced SLA and queuing	✓
	Junos Fusion Edge (AD)	✓
	Logical systems	✓
	Virtual router/switch	✓
	Path Computation Element Protocol (PCEP)	✓
	OpenConfig	✓
	YANG data modeling	✓
	Juniper Extension Toolkit	✓

CISCO:

PRODUCT SPECIFICATIONS OF CISCO 4000

Technical Specifications	Cisco 4461	Cisco 4451
Aggregate Throughput	1.5Gbps	1 Gbps to 2 Gbps
Total onboard WAN or LAN 10/100/1000 ports	4	4
RJ-45-based ports	4	4
SFP-based ports	4	4
Dimensions (H x W x D)	3.5 x 17.25 x 18.5 in	3.5 x 17.25 x 18.5 in (88.9 x
Technical Specifications	Cisco 4461	Cisco 4451
Enhanced service-module slots	3	2
Doublewide service-module slots	2	1 (assumes no singlewide SM-X modules installed)
NIM slots	3	3
OIR (all I/O modules)	Yes	Yes
Onboard ISC slot	1	1
Maximum memory DDR3 ECC DRAM (control/service s plane)	32 GB	16 GB

HUAWEI:

Technical Specifications

Item	AR2204-27GE
Hardware	
WAN Speed with Services***	200 Mbit/s
Firewall Performance (large packets)	1.2 Gbit/s
Number of Recommended Users	150
Fixed WAN Ports	3 x GE (1 x Combo port)
Fixed LAN Ports	24 x GE
SIC Slots	4
USB 2.0 Ports	1
Console Port	1
Memory	512 MB
Flash (default/max**)	512 MB
Maximum Power	60W
Redundant Power Supply	-
AC Power	100V to 240V
Frequency	50 Hz/60 Hz
Dimensions (H x W x D)	44.5 mm x 442 mm x 420 mm
Weight	4.95 kg (without power module and interface card)
Ambient Temperature	0°C to 45°C
Relative Humidity	5% to 95% (non-condensing)

	Temperature	-40 to 158ºF (-40 to 70ºC)	-40º to 158ºF (-40º to 70ºC)
	Relative humidity	5% to 95%	5% to 95%
	Altitude	15,584 ft (4750m)	15,584 ft (4750m)