



**NANOG®**

## **Request For Proposal Curriculum Development**

NANOG is a professional association for Internet engineering and architecture organized as a 501(c)3 non-profit membership organization whose mission is to provide forums in the North American and Caribbean regions for education and for the Internet operations community. NANOG focuses on technologies and systems that make the Internet function: core routing and switching; Internet inter-domain routing; the domain name system; peering and interconnection; and Internet core security. We also cover associated areas with a direct impact on Internet architecture, such as data centers, optical networking, software development, and automation.

NANOG (North America Network Operators Group) is requesting proposals from qualified consulting firms or individuals to assist in developing a curriculum.

### **CONTACT INFORMATION**

ORGANIZATION	NANOG (North American Network Operators Group)
NANOG CONTACT	
TITLE	
EMAIL ADDRESS	

### **DECISION MAKING PROCESS**

RFP Distribution Date	
Proposal Deadline	
NANOG Proposal Review Dates	
Tentative Decision Date	
Decision Notification Method	Email

### **Attendee Demographic**

NANOG has a robust community that began in 1987. We service the continuing education needs of the network operator community. Our community consists of seasoned professionals, junior engineers, students, and those exploring career changes.

## REQUIREMENTS

Statement of Need:

The NANOG Education Committee is seeking proposals from experienced consulting firms or individuals to develop a NANOG proprietary technology-based program that will be offered to the NANOG community in continuing education. All developed courses will become the sole property of NANOG and shall not be used without the written permission and consent of the NANOG organization.

Respondents may bid on one or more of the courses detailed below.

SERVICE REQUIREMENTS:

### **NANOG courses to be developed (Spring 2022) \***

- Fundamentals of Finance for the Network Engineer
- Routing Fundamentals
- IPv6 and its current and future role in Networking
- Network Automation
- BGP

\*Course descriptions, student takeaways, and logistic details can be found in the addendum at the end of this document.

### **Deliverables:**

- Course slides
- Pre-reads/pre-work
- Any homework assignments between Day 1 and Day 2 of the course (if applicable)
- Lab setup
- LMS version of the course in cartridge format (optional)

## PROPOSAL CONTENT

**In response to the RFP, each proposal must include the following information:**

- Company Information
  - Company name, mailing address, website
- Primary Contact information
  - Full name, phone number, email address

- Experience
  - How many years of experience?
- In addition to material for an in-person course, do you plan to also include the course in cartridge format (LMS version of course)?

## COURSE DEVELOPMENT TIMELINE

Our goal is to have courses available throughout 2022. If you want your proposal to be considered for early evaluation, please submit your proposal by 30 Nov 2021. Below you will find our desired course development cycle.

### Finished curriculum and deliverables due:

- Routing Fundamentals: 06 Jan 2022
- IPv6 and its current and future role in Networking: 06 Jan 2022
- Fundamentals of Finance for the Network Engineer: 06 Jan 2022
- Network Automation: 04 Apr 2022
- BGP: 04 Apr 2022

## REFERENCES

Provide three references that have used your services of similar scope as outlined above

	Reference 1	Reference 2	Reference 3
Organization Name			
Contact Name			
Contact Title			
Phone			
Email			
Type of service performed			

## CONFIDENTIALITY

NANOG expects that all work will be performed in a professional manner. All information in this RFP is proprietary and confidential. Information cannot be released without written permission from NANOG. In addition, this Request for Proposal or any resulting contract shall not be copied, reprinted, quoted, or in any way transmitted or displayed, except where required by law, without the written permission of NANOG.

## COURSE DETAILS:

### Routing Fundamentals

**Description:** *A beginning-level course* designed for those new to the field of network engineering. Routing (the act of getting packets where they need to go) is fundamental to the operation of the Internet, and a robust service that **needs** to be fully understood to initially configure, then operate and troubleshoot the network. **This course includes labs to gain hands-on experience.**

### Topics Covered:

- Network Addressing (IPv4)
- Concepts of Routing
- Dynamic vs. Static Routing
- Interior Gateway Protocols (IGP) vs Exterior Gateway Protocols (EGP)
- Subnetting, VLSM
- Address Aggregation (NAT)
- Troubleshooting Tools, *TCPtrace, NMAP, Ping, and Traceroute*
- Routing Services, *ARP, DHCP*
- Routing protocols and their respective roles
  - OSPF
  - BGP
  - ISIS
- Routing security concepts (MANRS Actions)

### Student Take-Away:

- Key routing protocols and where to use each protocol
- How to use key configuration tools like subnetting and NATing
- Hands-on experience for network elements configuration and troubleshooting
- Key components of routing security and MANRS actions.
- **Duration:** Two days, 6 hours per day
- **Prerequisites:** N/A
- **Modality:** Face to Face at Conference
- **Hands-On:** laboratory component will be used
- **Other:** the student should expect homework and prerequisite work to be done
- **Metric of Completion:** Certificate

## IPv6 and its Current and Future Role in Networking

**Description:** *A beginning level class that explores the purpose, use, and moving parts of IPv6 in the networking domain. We have all heard of IPv6, but what is it? Why is it important? What do we do with it? This class will explore these questions and also give a fundamental working knowledge of IPv6.*

### Topics Covered:

- Why IPv6
  - Design shortcomings of IPv4 (available address space, fixed header, etc.)
  - Downsides of IPv4 NAT
  - Market Drivers
- IPv6 Header Format
  - Header fields
  - IPv6 Extension Headers
  - Routing, Fragment headers
- IPv6 addressing architecture
  - Address format and prefixes
  - Address Types
    - Unicast Address
    - Global Unicast Addresses
    - Link-Local Unicast Addresses
    - Anycast Addresses
    - Multicast Addresses
- IPv6 Address Assignment
  - DHCPv6 and DHCP-PD
  - SLAAC
  - History of self-assigned IPv6 addresses and the temporary IPv6 address
  - Duplicate Address Detection
  - Lab - Enable IPv6 on students' laptop
- IPv6 neighbor discovery
  - Comparison of ARP vs. NDP
  - Neighbor solicitation
  - neighbor advertisement
  - router discovery
  - router advertisement
  - router solicitation
  - redirect message
- ICMPv6
  - Path MTU discovery
  - other
- IPv6-enabled routing protocols

- RIPng
- OSPFv3
- Integrated IS-IS
- MP-BGP
- PBR
- FHRP for IPv6
- Route Redistribution
- IPv6 Security
  - ACLs
  - IPsec, IKE
  - best practices for IPv6 security
- IPv6 Transition mechanisms
  - Dual-stack
  - IPv6 over IPv4 tunnels
    - Tunneling requirements
    - Tunneling and security
    - Tunneling mechanisms
    - IPv6 over IPv4 GRE
    - 6to4 tunnel
    - 6RD tunnel
    - Lab - set up a tunnel to Hurricane Electric
  - IPv6-only configurations
    - 6to4 NAT / CGNAT
- IPv6 Deployment considerations
  - Considerations for address allocation/assignment architecture
  - Understanding multihoming in IPv6
  - Deployment in the home network
  - Deployment in the enterprise
  - deployment in the service provider
    - with MPLS
    - with 6PE
  - Lab - design an address allocation for a medium-sized enterprise
- Case Studies
  - Example deployment and implementation plan in an enterprise
  - example deployment and implementation in a network service provider
  - example deployment and implementation in a broadband service provider
  - example deployment in a hyper-scaler
- On-going protocol development in the IETF

**Student Take-Away:**

- A thorough understanding of the enhancements made in IPv6 over IPv4

- Establish a comfort level with IPv6 addresses and an ability to readily distinguish between the different types of addresses
- An understanding of how to implement IPv6 in their home network, with or without native ISP support
- A basic understanding of deployment practices in enterprises and service providers

### Logistic Details:

- **Duration:** Two days, 6 hours per day
- **Prerequisites:** a working knowledge of IPv4 addressing, subnetting, and routing, and a working knowledge of the MS Windows or macOS operating systems.
- **Modality:** In-person at a conference
- **Hands-On:** a lab infrastructure will be provided for students to build out simple but informative/useful/challenging network topologies. Students should have a laptop for the class, loaded with Windows, macOS, or Linux
- **Other:** the student should expect homework and prerequisite work to be done
- **Metric of Completion:** Certificate

### Fundamentals of Finance for the Network Engineer

**Description:** *A beginner finance course* for network engineers, engineering managers, or director-level managers. Students will learn how to use the business case as an invaluable business planning tool instead of just a hurdle that your finance department wants you to jump through to get funding. Students will understand the motivations of financial-based decision-making in a company, and how financial tools, such as “discounted cash flow,” are used for calculating common metrics such as NPV, ROI, and IRR. **In this class, you will learn how to build financial models, revise and hone them, and build a vocabulary with which to talk to your finance team.**

### Topics Covered:

- **Financial Statement Analysis and Forecasting**
  - review of basic accounting concepts
  - making sense of income statements and balance sheets
  - projecting future funding needs
  - the concept of sustainable growth
  - case study: TBD
- **Methodology - Project Valuation**
  - the DCF approach to valuation
  - DCF vs. other methods

- Discounting methodology
- constructing cash flows
- lab exercises - investment evaluation
  - buying a new router vs. upgrading an existing one
  - building new computer vs. renting in the cloud
- **More Methodology - Project Valuation**
  - cost of capital, *how it is calculated, and it influences a company's financial decisions*
  - terminal values
  - economic value added
  - real options
  - case study: TBD
- **Application of Project Valuation**
  - approaches to determining cash flows
  - using DCF analysis to compare competing projects
  - sensitivity and scenario analysis
  - lab exercise: building a network to peer vs. buying IP transit

## Network Automation

**Description:** A system is well-designed if it scales, and the way we operate systems at scale is through automation. This *is an introductory course* in network automation, **no coding experience is required**. This course is intended to be useful to new people in the industry, as well as tenured engineers who are looking to add to their expertise.

### Topics Covered:

- Network-automation-friendly programming languages like Python or Go
- Templating libraries
- Sources of truth systems like NetBox or Nautobot
- Orchestration frameworks like Ansible or Nornir
- Network telemetry using gNMI and SNMP
- Containerization
- Relational and time-series databases
- Modeling network data

### Student Take-Away:

- Write simple scripts
- Interact with RESTful and gRPC APIs
- Package software in containers
- Apply best practices to their work, such as sources or truth for network data and modeling the data



- Identify when and where automation is most appropriately applied to typical networking problems
- Evaluate build vs buy and understand various software offerings in several spaces (e.g., orchestration, containerization, observability)

### **Logistic Details:**

- Duration – Two days, 6 hours per day, split up as the instructor sees fit between instruction and hands-on
- Prerequisites – None
- Modality – Face to Face at Conference
- Hands-On – A laboratory component will be used
- Other – The student should expect homework and prerequisite work to be done
- Completion – Certificate

### **BGP**

**Description:** BGP is the de facto routing protocol between networks, thereby making it quite literally *the routing protocol of the internet*. Because of the extensibility of its design, it is also used for virtualization within networks, including the data center. This course is intended for people with a solid understanding of network fundamentals who wish to begin to work with interdomain routing and other advanced routing concepts.

### **Topics Covered:**

- Autonomous Systems
- eBGP and iBGP
- IPv4 and IPv6
- Path selection
- Routing policy (communities, MEDs, prepends)
- BGP scaling (route reflectors)
- Multihoming
- Transit and peering - Internet Exchange Points (IXPs)
- MP-BGP with emphasis on EVPN and L3VPN
- Routing Security (MANRS)

### **Student Take-Away:**

- Be able to set up BGP sessions
- Be able to affect routing changes
- Understand peering relationships
- Use MP-BGP

- Secure routing announcements

**Logistic Details:**

- **Duration:** two days (6 hours per day) split up as the instructor sees fit between instruction and hands-on
- **Prerequisites:** Routing Fundamentals
- **Modality:** In-person at a conference
- **Hands-On:** a laboratory component will be used
- **Other:** the student should expect homework and prerequisite work to be done
- **Metric of Completion:** Certificate