Managing Personal Disruption: The Next Generation Network Engineer

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Scott Robohn Intro

- Husband, Dad to 4, Bestefar (Grandpa) to 6
- 30+ years in the networking industry
- Technology Auditor, Network Operator, Instructor, TAC Engineer, SE, SE Leader, and now…
- Consultant focused Elevating Operations, AI, Automation
- My socials:
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Introduction to NGNE

- NGNE: Next Generation Network Engineer
  - Where does NGNE come from?
    - Career
    - NAF and TNOps
    - Learning the Hard Way
- What is NGNE?
- Where is it going?

NGNE Primordial Soup

SOLUTIONAL

NETWORK AUTOMATION FORUM

From TNOps to NGNE: Big Ideas from 30+ years

- Think Broadly – Systems Thinking
  - Your Ops Stack is more interconnected than you think
- Develop discipline around proactive evaluation of new tools and technologies
- Org Disruption: Total Network Operations seeks to take new tools and tech and figure out the NetOps org needs to adjust to the new stuff
- Personal Disruption: NGNE provides a framework for ICs to personally adopt new tools and tech

Managing Personal Disruption:
The Next Generation Network Engineer (NGNE)

Becoming a Next Generation Network Engineer

Modern NetOps Needs More from Network Engineers

TNOps
606 followers

January 21, 2020

Introduction

Network Engineering and what it takes to thrive in this new reality is undergoing a massive shift. We need to understand how we got here, and how we can adapt and thrive in this new environment.

Introduction to the NGNE

- Disruption is real
- Big idea: increasing literacy in software development processes and models means the process and tooling knowledge (and the tooling itself) is becoming more common in NetOps (and more)
- AI and other new tech keep coming at us
- As a result, we need more than subnets and spanning tree (and pcaps): the NGNE

NGNE Development: Pre-reqs

- Networking basics absolutely STILL MATTER
  - CCNA / JNCIA / Arista L1 / etc.
  - Equivalent experience
- On theoretical programs
- Don't assume – people coming into networking with all the advanced skills
  - Give them a chance to catch up

NGNE 100 Level

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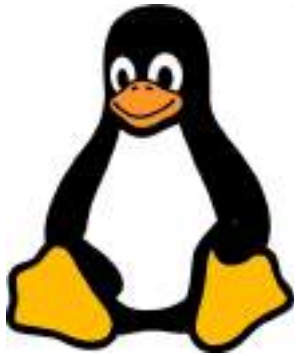
NGNE Development: 100 Level

- Linux the OG OS
- Python (or another language suited for automation (Go))
- GitHub (or another SCCS)
- Containers, Docker, and Virtual Machines
- Intro cloud platform experience
- Virtual Lab Environments
- APIs
- Intro to LLM chat tools
- AI-enhanced learning of all 100/200/300/400 level topics
- Vendor skills: driven by product decisions, add to your learning plan accordingly

NGNE 100: Linux

- Underlying operating system for many production applications and systems
- Underlying OS in many Network Operating Systems ("NOS") – and *nix variants
- Junos, SRLinux, and others
- Learning Linux will get you familiar with OS concepts such as navigating file systems, Linux networking, and viewing, creating, editing files
- Pro tip: learning Linux shell scripting and other constructs in Linux (e.g., bash scripts, crontab) will also introduce you to the basics of automation



CentOS Ubuntu debian

NGNE 100: Python

- By far the most popular language used to automate network operations tasks
- Used in many other technical disciplines (e.g., Data Science)
- Can broaden your skill set and expose you to other areas for future career growth
- Substitute Python for another language suited for automation (e.g., Go is rising in popularity for Network Automation)
- The goal is not to make you a full-fledged Python programmer - rather, you should start here to understand the basics of automation for NetOps


```
def read(telnet_conn, sleep=1.5):
    time.sleep(sleep)
    data = telnet_conn.read_very_eager().decode()
    return data

def write(telnet_conn, data):
    byte_data = data.encode()
    telnet_conn.write(byte_data)

def login(telnet_conn, username, password):
    debug = False
    prompt_terminator = r"#"

    data = read(telnet_conn)
```

NGNE 100: GitHub

- Source code control system (SCCS) that allows teams of people creating software, documents, scripts, etc. to contribute to and edit a codebase, as well as check each others' code

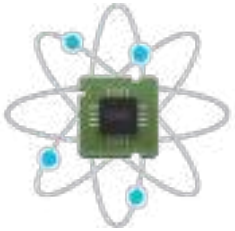
- GitHub is widely used in software development projects and increasingly used in network operations

NGNE 100: Containers

- Containers, Docker, and Virtual Machines
- Containers have been around in Linux for a long time
- Software processes delivered via containers and created and managed with Docker are key tools to understand
- Many of the software and automation tools noted above are delivered in containers
- Virtual Machines (VMs): a predecessor to Containers
  - More resource-intensive and less graceful way to deliver software
  - You should be aware of VM concepts and know how VMs and Containers operate differently

NGNE 100: Virtual Labs

- There are a growing number of tools (sometimes free or low cost) that let you set up virtual environments for networks
- Critical environments to learn and test specifics of different types of network elements
  - For learning
  - As pre-production/dev and test environments
- Examples:
  - Containerlab
  - EVE-NG
  - Cisco Modeling Labs (CML)



NGNE 100: Intro to Chat LLM Tools

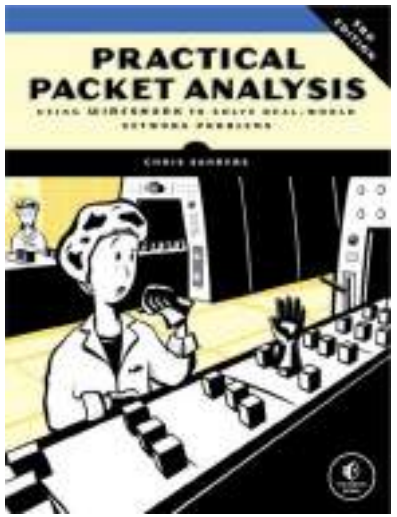
- AI is definitely a large and growing class of tools you need to understand
- Lots hype around AI - this is not an attempt to jump on the bandwagon
- Burn through the hype haze and understand what AI tools and use cases provide real utility in NetOps
- You absolutely can use AI as a key differentiator to springboard your career
- AI can both help you learn about many of these NGNE topics (the Patient Tutor) and allow you to automate many NetOps tasks and operations
- Start playing with chat-based AI tools today (ChatGPT, Grok, Gemini, Claude, and many others) to help you learn about these NGNE topics
- Watch it become more and more of a feature of tools

NGNE 100: APIs - Application Program Interfaces

- May be the most thrown-around term in networking today
- Few understand APIs beyond the conceptual and how to use them in the most basic ways
- As a network engineer, you understand a device's CLI, which is essentially a human interface - the "human API" - into a device config
- As we increase the use of automation and employ software processes (applications) to help us configure, operate, and even protect the network, we need to know intimately how to give that software the right APIs into network devices as well as other software
  - Recall example of telephony operators being replaced by code

NGNE 100: WireShark / PCAP Analysis

- Packets Don't Lie
- Fundamental to understanding protocol and system behaviors
- You probably do NOT need lots of convincing here



NGNE 200 Level

NGNE Development: 200 Level

- DevOps Concepts and Principles
- Automation Concepts
- Source of Truth (SoT)
- Ansible
- CI/CD Pipelines
  - Alignment with Git
- Orchestration Concepts
- Focused AI Experimentation

NGNE 200: DevOps Concepts and Principles

- DevOps was created originally created to improve software development and operations
- A movement and culture more than a technology
- NetDevOps developed as the application of DevOps principles to NetOps.
- The combination of cultural philosophies, practices, and tools that increases an organization's ability to deliver applications and services at high velocity

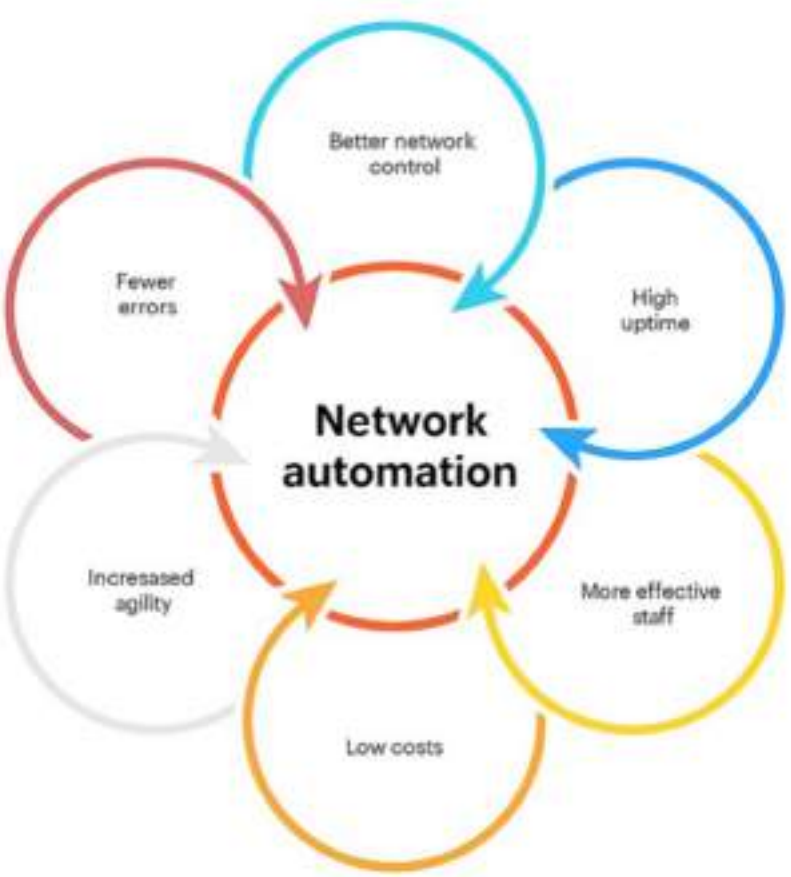
NGNE 200: NetDevOps

Configure	Build	Test	Deploy
• Use a version control system • Create network tests • Use software dev best practices	• Engage automation workflows • Kick off CI/CD pipeline • Programmatically generate network configurations	• Network modeling • Digital twins • Network sandboxes • Reference architectures	• Deploy config to devices • Merge PRs • Collect new network state • Monitor

(Continuous Monitoring)

NGNE 200: Automation Concepts

- Understand what, why and when tasks should be automated
- Choose high value automation initiatives
- Choose tasks that you do very often (not seldom)
- Fewer errors
- Increased stability
- Faster deployment

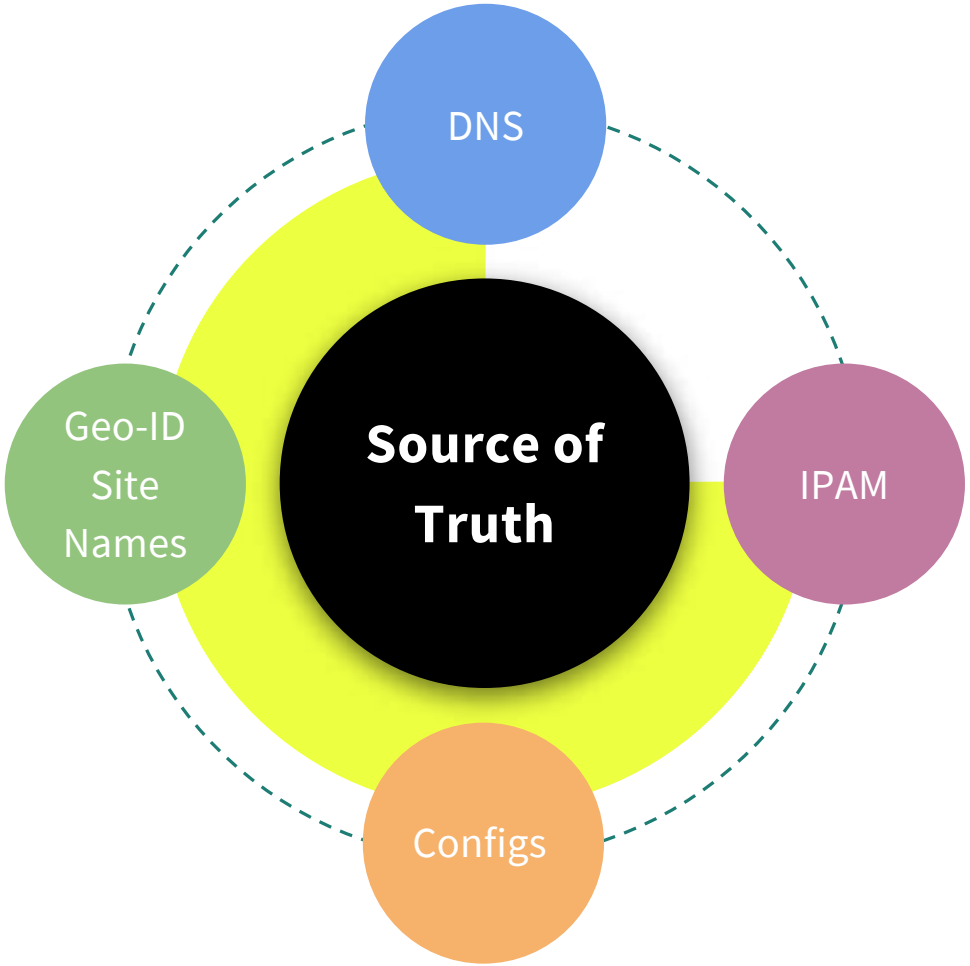


NGNE 200: Sources of Truth (SoT) / Source of Record (SoR)

- Centralized repository of accurate, up-to-date network information
- Routing tables, Security Policies
- DNS, IPAM, Geo-ID, Site Names
- Configurations, App IDs, Circuit IDs
- Reference Architecture (intended configs and state?

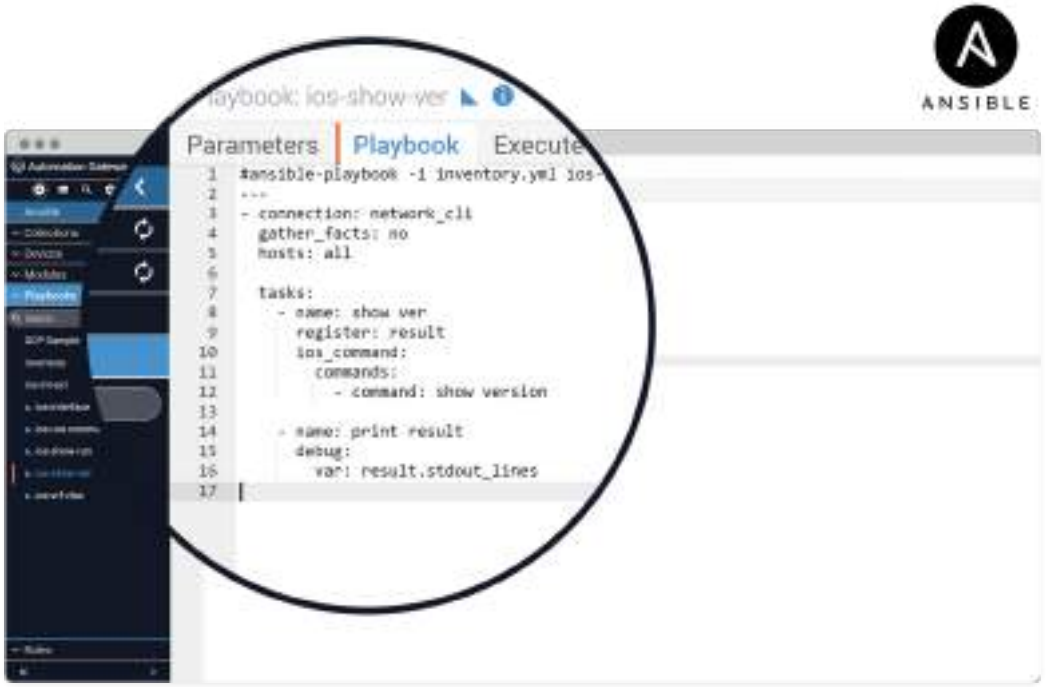
netbox >>> nautobot

servicenow BACKBOX



NGNE 200: Ansible

- Open-source IT automation engine
- Used to manage and automate IT processes
- Configure, provision, deploy and orchestrate networks
- Run playbooks to execute workflows
- Inventory files, configurations, configuration features
- Connect to devices over SSH



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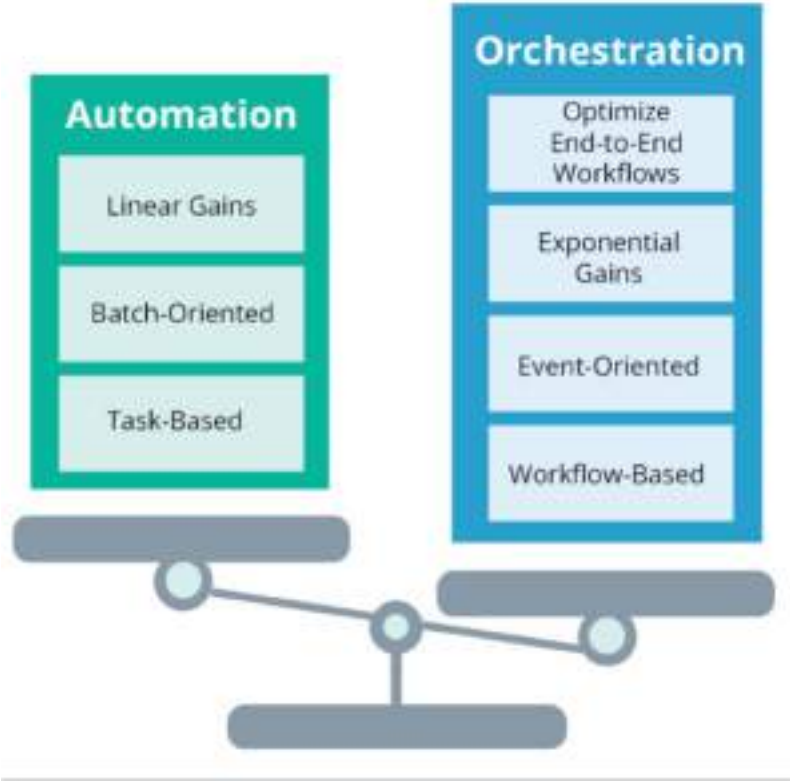
NGNE 200: CI/CD

- Continuous Integration / Continuous Deployment
- Automated process that helps software development teams streamline the writing, integrating, testing, deployment, and more testing of applications
- Separate coding environments for development, testing, and production
- Useful in cloud development to easily clone/copy dev to test and test to prod
- Enable management of configs and enable a separate dev/test network
- Automate tests for proposed config and network changes but adapt CI/CD to physical network environments

NGNE 200: Orchestration Concepts

- Automating many individual tasks as a process or flow
- Incorporates feedback loop
- Event-driven
- Orchestrate across IT domains in end-to-end workflow



NGNE 200: Focused AI Experimentation

- Happening so fast
- Developments in MCP, A2A
- Finding real use cases and problems to tackle in your environment
- Developing Agent Boss mindset
- Just Start Somewhere

NGNE 300 Level

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NGNE Development: 300 Level

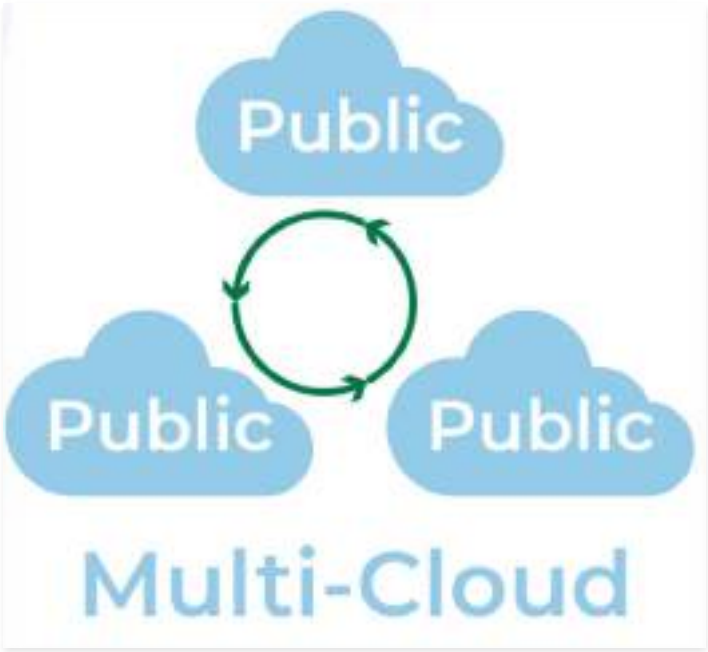
- Cloud networking Constructs
- Load Balancing
- Cloud Peering
- Hybrid Cloud Networking
- MCN: Multi-cloud Networking
- Cloud Observability and Telemetry

NGNE 300: Cloud Networking Constructs

- Networking between physical on-prem and cloud (and between clouds)
- AWS, Microsoft Azure, Google Cloud Platform, Oracle Cloud Infrastructure, and others
- Start with the one that your org is already committed to, or the one they are moving to
- Become familiar with the networking constructs
- Cloud networking is highly abstracted away from hardware
- Understand the definition and utility of the basic functions in the cloud such as compute, storage, firewall, and database

NGNE 300: Hybrid and Multi-Cloud Networking

- Networking between and among public cloud and SaaS providers
- Dealing with different features, constructs, SLAs, billing methods, etc
- Handling applications distributed across cloud providers (e.g. front in AWS, backend in Azure)
- Using tech like SD-WAN, cloud overlays, etc. to unify cloud experience



NGNE 300: Cloud Observability and Telemetry

- Cloud flow logs
  - AWS VPC Flow Logs
  - GPC FLow Logs
  - Azure NSG Flow Logs
  - Azure VNet Flow Logs
- Cloud metrics
- WAN Router, firewall, Load balancer, SD-WAN telemetry
- Service provider telemetry and path tracing
- eBPF metrics
- Application, billing, customer, app/security tag metadata enrichment
- Opportunity for AI - HUGE

NGNE 400 Level

NGNE Development: 400 Level

- Kubernetes
- Understanding Open Source
- Open Networking
- Web Assembly
- Digital Twins
- Security
- Other NetOps Stack Adjacencies (Optical, more)
- Continuous Tech and Tool Evaluation

NGNE 400: Kubernetes

- Really? Yep.
- Kubernetes (k8s) is a tool for managing and automating the deployment, scaling, and operation of containers
- While k8s also comes primarily from the software deployment world, there is a growing movement to leverage k8s constructs for network automation
- Worth learning some basics about k8s and see how it could be used for Network Automation and how networking is implemented in k8s

NGNE 400: Understanding Open Source

- Software has gone through significant transformation
  - Development models: Waterfall to Agile to CI/CD
  - Closed binaries to openly available source code
  - Main advantages: more developers, better visibility for security
- More and more can and is being done with open source software for NetOps
- Some understanding of how to use, contribute to, and get support for open source software is a useful area for study
- Tightly linked to use of GitHub as a means of contributing to open source projects

NGNE 400: Open Networking

- AKA “Disaggregated Networking” (some differences)
- NOS is purchased or obtained separately from the hardware, is also an increasingly-viable option for networks
- Some NOSs are open source, such as SONiC, and others are vendor-developed and supported
- Run on “merchant silicon” platforms, often based on network ASICs from Broadcom, but other manufacturers are gaining momentum (e.g., Marvell)
- Integrating and operating network elements in this mode requires a level of knowledge on how they are different from “shrink-wrapped” products
- More responsibility for making the hardware and software work together

NGNE 400: Web Assembly

- Computing and software evolved from monolithic programs, to virtualization via VMs, and most recently to Containers
- Web Assembly (Wasm) has potential for being the next step in delivery and operation of programs across disparate infrastructure
- Wasm is a binary instruction format for compiling and executing code in a client-side web browser
  - Can be used outside browsers as well
- An open standard intended to support any language on any operating system
  - Many of the most popular languages already have at least some level of support

NGNE 400: Digital and Operational Twins

- Network modeling has seen limited use over the past ~30 years, largely due to dependency on vendor-specific hardware
- Separation of control plane software from the hardware-focused forwarding plane, along with the increasingly-inexpensive access to compute resources, combine to enable emulation of network control planes at larger scale
- Combining the control plane with time-series database technology and observability tools, digital twin technology has emerged that can allow us to see the state of a network over time, and use observability data to predict future state of the network
  - Rewind to a previous state to see what happened
  - Predict into future and play out various scenarios

NGNE 400: Security

- Remember Security? Yep.
- It's not fair to just say "Security"
  - Incredibly broad and complex set of technologies
  - Constantly evolving due to the creative nature of bad actors continually trying to do new bad things in new and clever ways
- NetOps and SecOps have significant overlap
  - That overlap is always increasing
- In thinking as a system, there is great operational benefit to view them together and coordinate interaction of NetOps and SecOps

NGNE 400: Other Stack Adjacencies: Optical, WiFi, more

- Security isn't the only adjacent tech that can impact NetOps
- Optical networking
- WiFi
- Private 5G
- Collaboration tools
- Trouble ticketing software
- Procurement
- A systems view will lead to other efficiencies
- There will be more modules to add, dependent on you NetOps environment

NGNE Electives: Important Things Not Yet Placed

- Specialized wireless/radio technologies
  - 5G
  - ORAN
  - 6G
  - LoRa (Long Range, low power)

- Deming Primer: application of manufacturing engineering principles to NetOps

Now What?

Next Steps to Becoming a NGNE

- We're in a learning environment that we've never really seen before
  - WWW
  - AI as a Patient Tutor
- There is NOTHING in your way – except time as a scarce resource
- Tailor all these topics to your environment
- Consider vendors in place and on the horizon, as well priorities in your NetOps team and what interests you

Approaches to Using NGNE Learning Roadmap

- Go Deep on Topics in Order
  - Use the above learning roadmap laid out as-is
  - This works well with the topics listed in NGNE Levels 100-300
  - Option: cover a smaller number of subjects at a time
- Go Wider: Overviews of More Topics at a Time
  - Focus on overviews of the topics and come back to each one for more depth as needed or as interest dictates
- Triage: Do What You Need To Do
  - Dive into the things you need to know first in any of the levels, driven by your job or by your curiosity

Other Helps for NGNE Study

- Study Groups
  - Getting together with one or more other people with similar interests can be really helpful
  - Organizations, podcasts, and individuals that can help specifically with learning in groups
  - Reach out to people you know in similar circumstances – find Birds of a Feather
    - Orgs: WireShark, NAF, USNUA NUGs, NANOG, Wi-Co, Meetups
    - Podcasts: Packet Pushers (N is for Networking), AONE, Telemetry Now
    - Slack/Discord: see above
- Set Priorities and Start Somewhere
  - Work through the topics in a way that balances your work needs, the time you have to study, and what interests you the most

Continual NGNE Evolution

- A year from now, it's almost guaranteed that something in this list WILL change
- Recall the reality of tech disruption
  - Kubernetes may take over the world, WebAssembly could gain huge momentum, and other topics that aren't even on our radar yet will emerge
- TNOps discipline of continual evaluation will help you evaluate what's important as a NGNE
  - To your org
  - To your own skillset and career

Change Beyond Personal Skills: Org Evolution

- NGNE is all about Personal Focus on Skills Development
  - That's good and necessary (and awesome!), but not sufficient
- There needs to be engagement with NetOps org leaders to turn the ship
  - This is challenging
  - Complement and support grass roots efforts
  - This is what we want to do with TNOps

NGNE: To Sum it Up

- Disruption is here to stay
  - Personally and Organizationally
- We CAN Elevate NetOps
  - Personally and Organizationally
- You can learn anything you put your mind to
- TNOps can help!

What's Next for TNOps

- Keep Talking to and Learning From Operators
- Keep Talking to Vendors to cultivate Ops Focus
- Create and Curate Useful Materials and Resources
- Engage with companies that want to do NetOps Better
- Please send good people our way
- Please listen and provide feedback:
- https://packetpushers.net/podcast/total-network-operations/

Questions/Discussion?

NGNE Feedback – Thank You!

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