

Next Era of Network Management Operations (NEMOPS) Workshop

Summary and Next Steps

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IAB

Internet Architecture Board

- The IAB provides **long-range technical direction** for Internet development, ensuring the Internet continues to grow and evolve as a platform for global communication and innovation
- **Architectural oversight**
- Runs **workshops** to:
 - Address current challenges
 - Explore emerging technologies
 - **Create input for future work within the Internet Engineering Task Force (IETF) and Internet Research Task Force (IRTF)**
- Runs programs to address long term perspectives/issues
- Liaison management



Internet Architecture Board



Making the Internet work better

IAB

First IAB Workshop on Network Management

- 1990-2000
 - IETF Operations and Management Area (OPS) area collects **network management requirements**
 - Configuration, Monitoring and Security requirements
- April, 2001~ May 2002
 - OPS-NW **Roadshow** visited Operators at NANOG, RIPE (Réseaux IP Européens), and LISA (Large Installation System Administration) Conferences
 - Unusable configuration management
 - Network monitoring is complex with so many alternative protocols and tools
- June 2002
 - 3-day **IAB workshop** on Network Management in Reston, VA, USA

IAB Workshop Key Outcome



- Importantly, all IETF WGs work together to develop a cohesive collection of YANG data models, at both the element and service levels

NEMOPS Workshop
22 years later

IAB / IETF
Next Era of Network Management Operations
(NEMOPS) Workshop 2024

December 3-5
Virtual/Online



Making the Internet work better

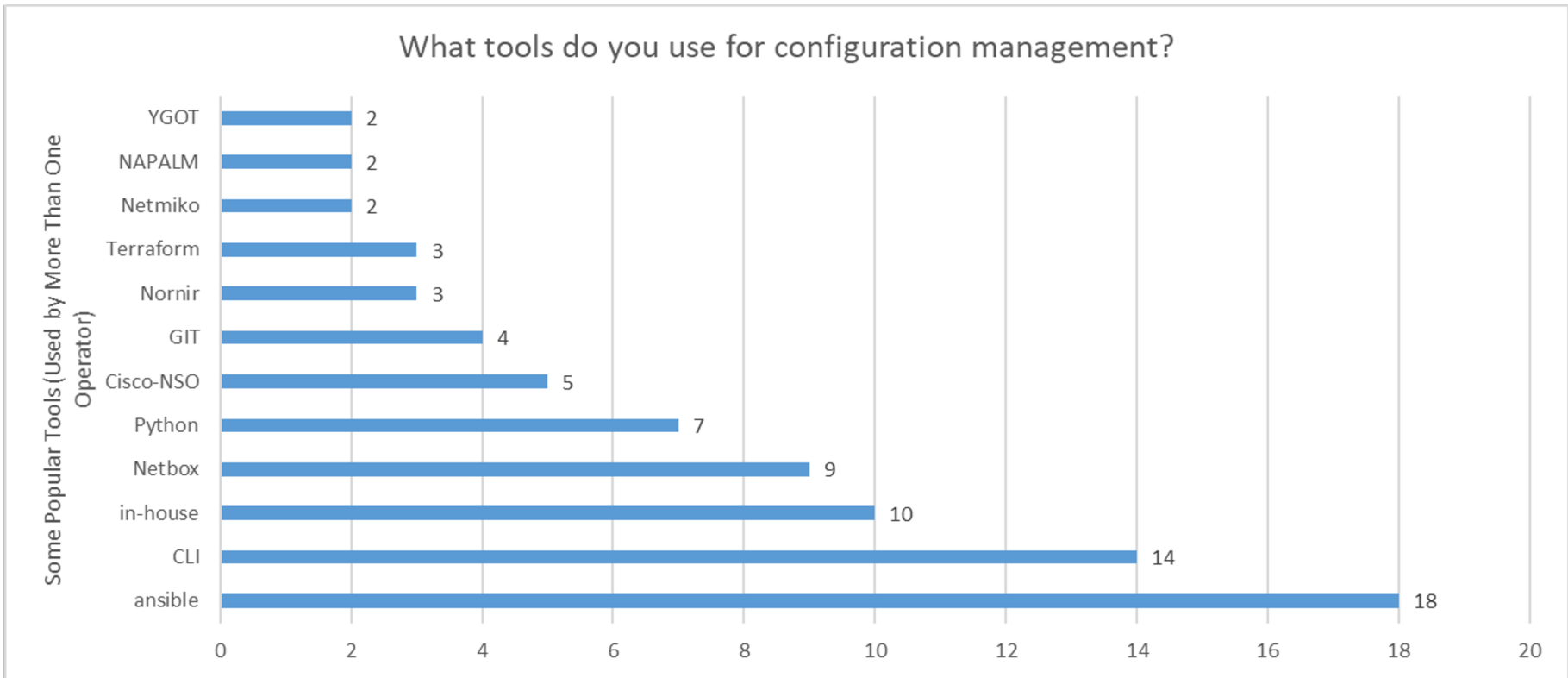
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Objectives

- **Review the outcomes** and results of the 2002 workshop (e.g., current deployments, state of the art) and **identify any operational barriers** that prevent these technologies from being widely implemented (limitations, hurdles)
- **Explore new requirements** for future network management operations in a collaborative manner with the industry, network operators, and protocol engineers
- Develop a **plan of action and recommendations** for the IETF
- More details at <https://datatracker.ietf.org/group/nemopsws/about/>

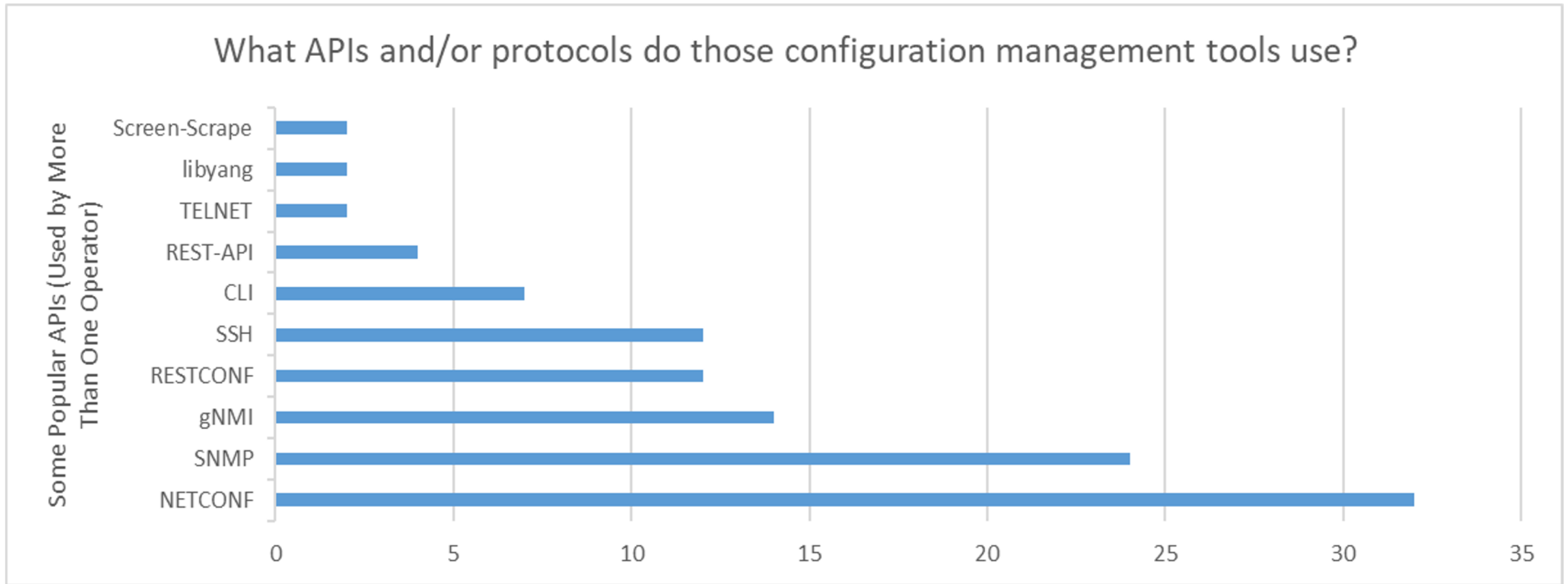
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Operator Survey



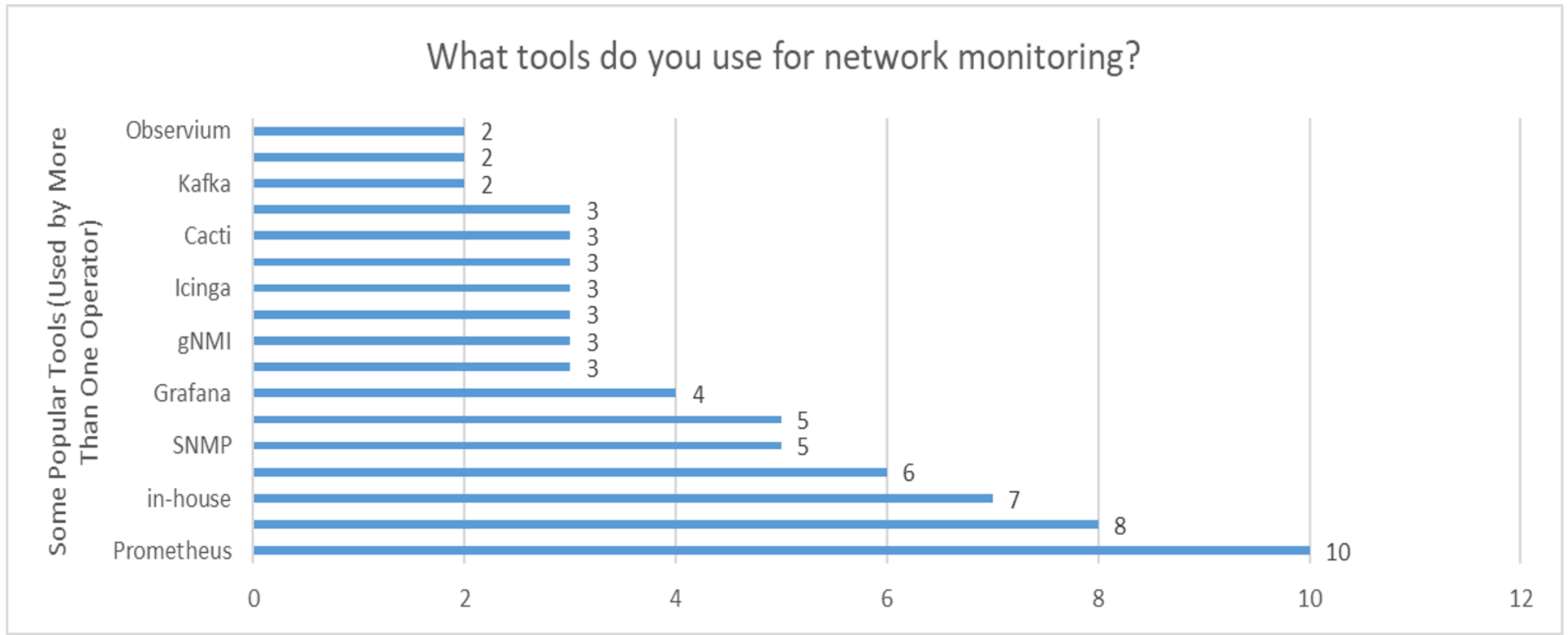
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Operator Survey



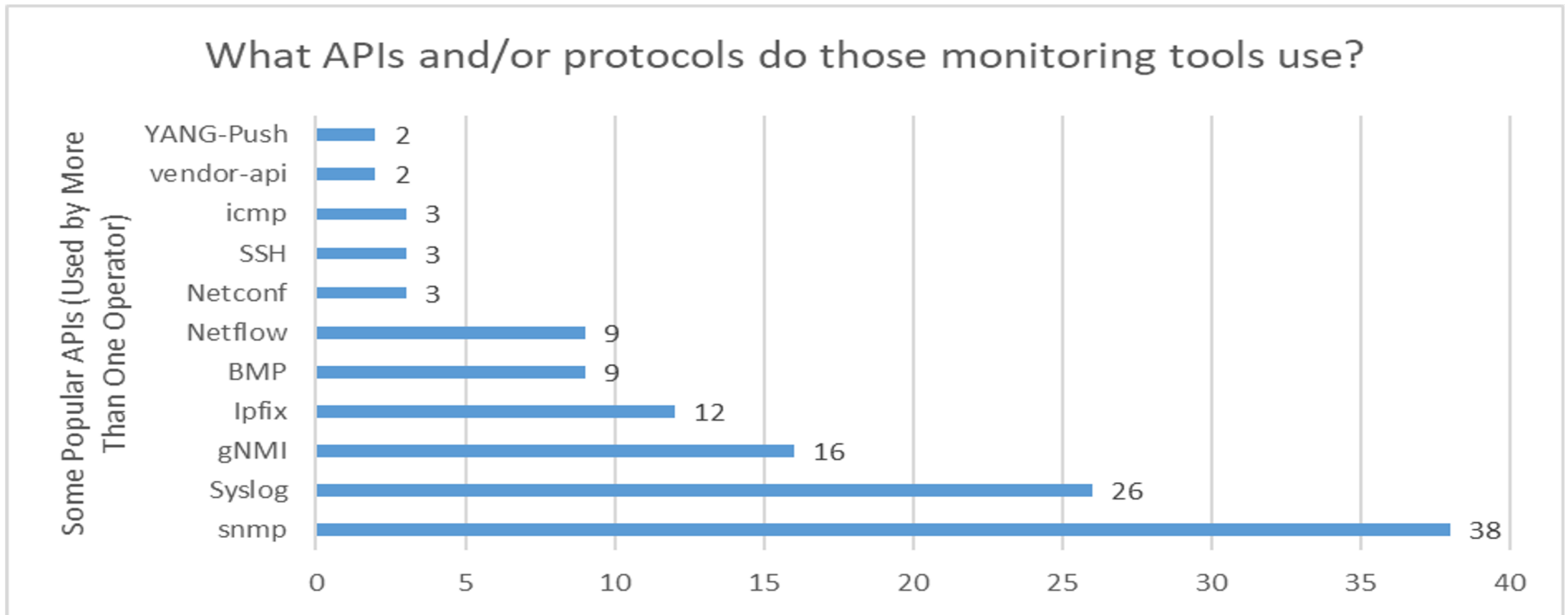
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Operator Survey



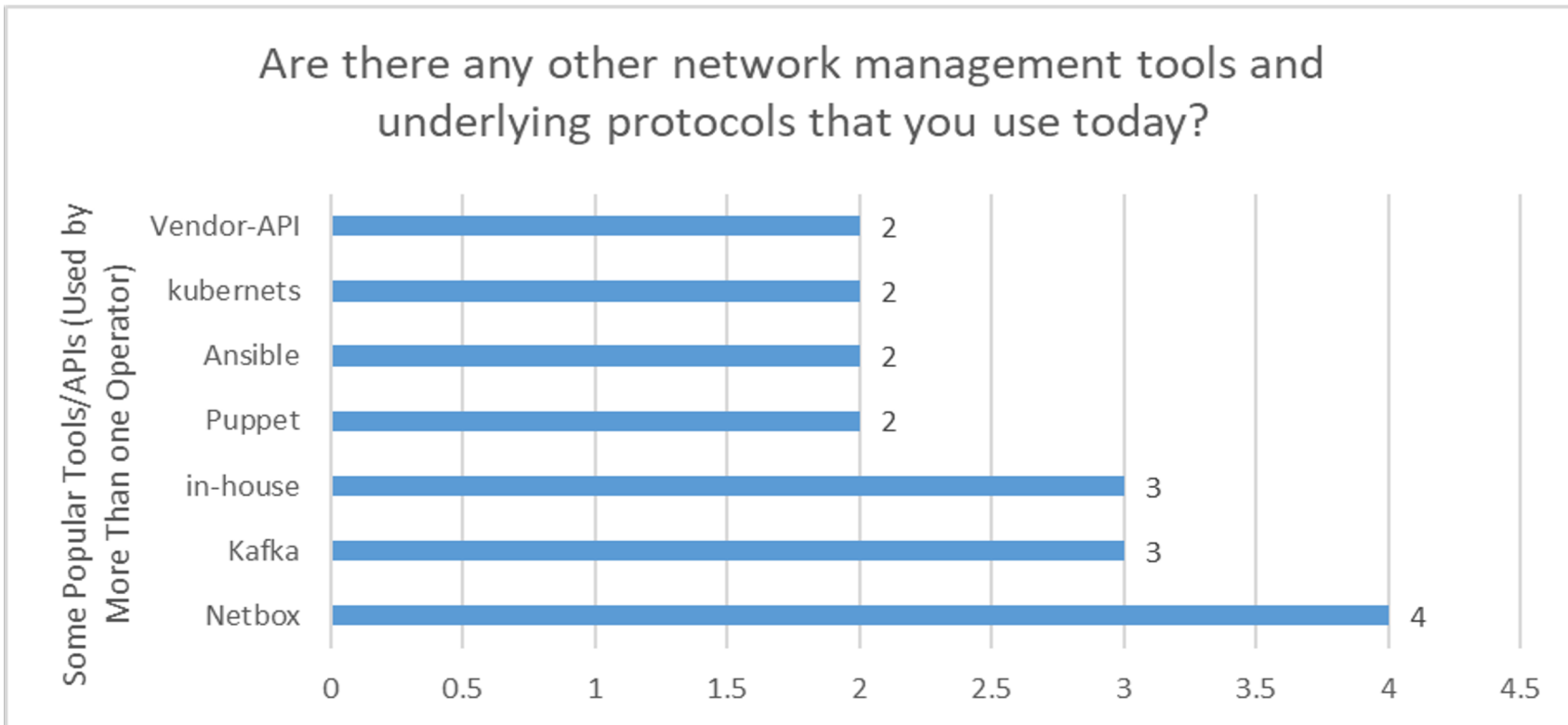
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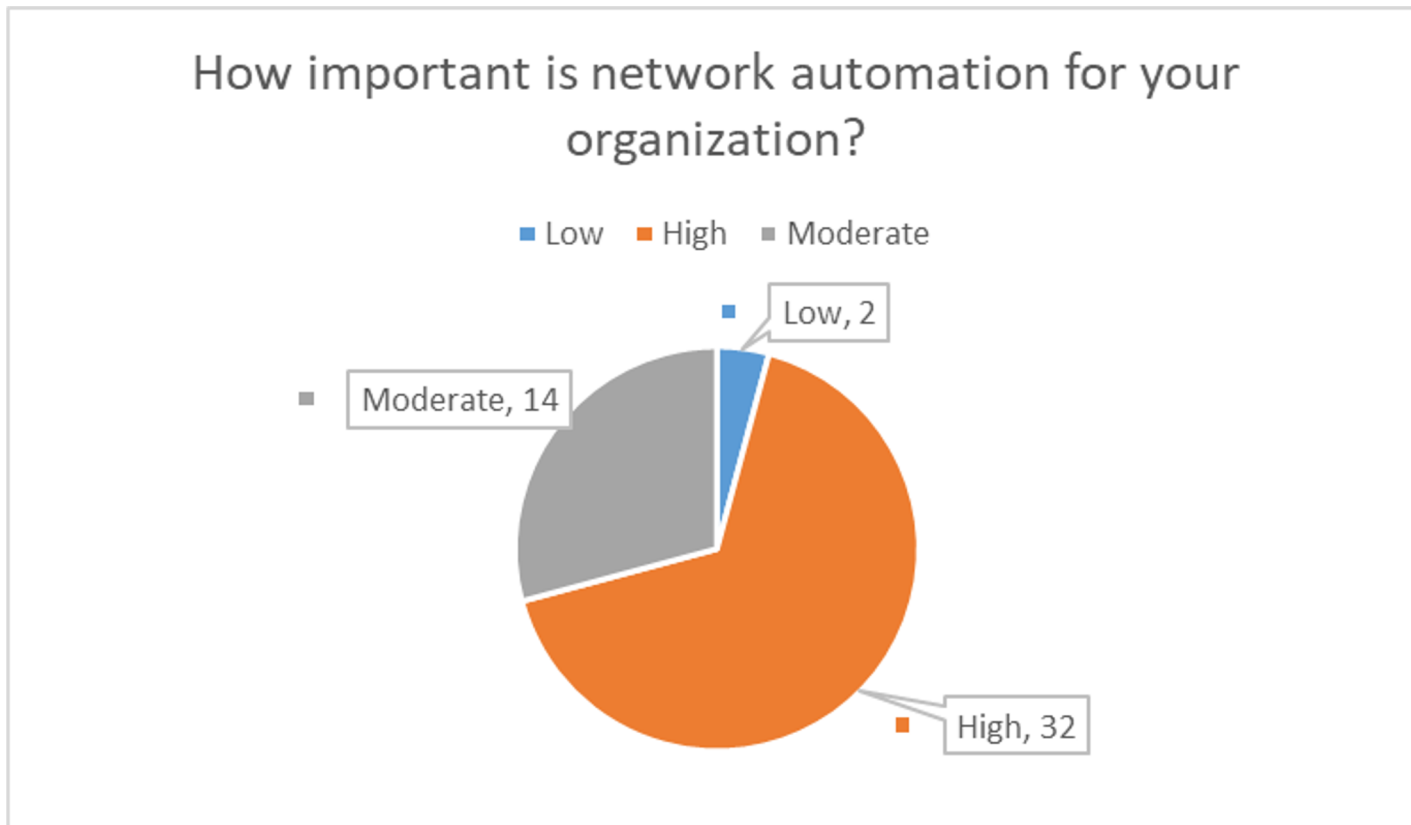


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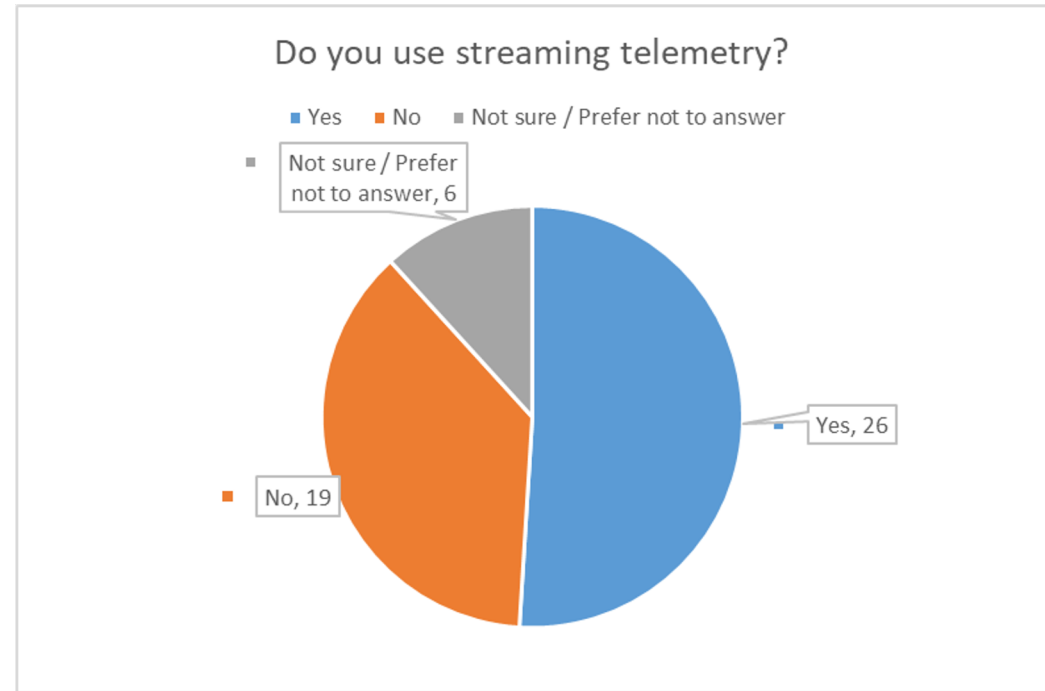
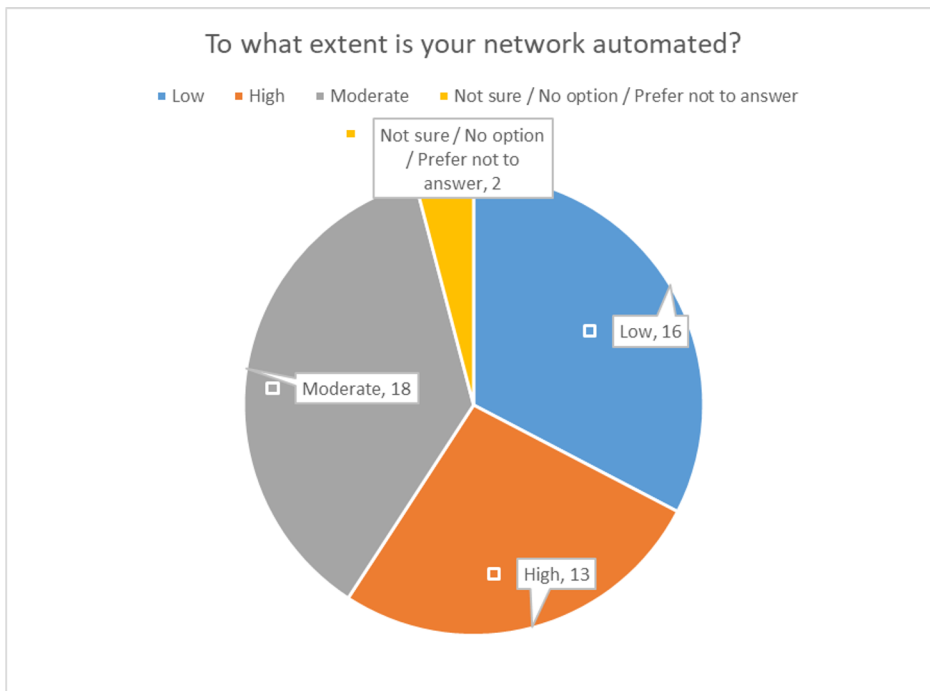
Operator Survey



NEMOPS Workshop Operator Survey



NEMOPS Workshop Operator Survey



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Agenda

- The workshop agenda was divided into
 - Session I: Past (**lookback, analysis**)
 - Session II: Present (**identified problems & requirements**)
 - Session III: Future (**possible solutions, recommendations and next steps**)
- At the end, Workshop PC collected
 - **Key takeaways**
 - **Requirements**
 - **Recommendations**
 - **Potential next steps**

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Past

- Jürgen Schönwälder (author of RFC 3535) went over the **experience from past** IAB workshop and laid out a direction for Network management to be - **Declarative, Composable, Reproducible, Verifiable**
- Ian Farrer (DT) provided an operator perspective on how YANG has been successful but there are **challenges in mapping** it to higher level orchestration systems and **lack of open-source** NMS and IETF device models

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Past

- Wes Hardaker (Net-SNMP) highlighted the need for **simplicity** and how the current solutions have largely failed the operator requirement #1 (Ease of use)
- Carsten Bormann gave an overview on how YANG ecosystem has been adapted for **managing IoT** Devices via CoAP (Constrained Application Protocol), CBOR (Concise Binary Object Representation), and CORECONF (CoAP Management Interface)
- Rob Shakir (Google/Openconfig) made a plea to **rethink** how we do standardization in network management space



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Past

- Some of the key discussion highlights
 - **Lack of full coverage** via YANG models (and thus going back to CLI, screen-scraping)
 - **Divergence** in implementation of both protocols and models
 - IETF should focus on **system** level instead of just API
 - Large learning curve with both models and protocols
 - What makes the current models/protocols/tools - **hard to use**?
 - Does the presence of many protocols, many encoding options, many models create a problem? Is there scope to converge?

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Present

- Holger Keller (DT) highlighted how configuration is working well but needs **monitoring** support to be able to **validate** it. There is a need to focus on enhancing observability!
- Jaime Jiménez talked about challenges and **complexity** in managing legacy and multi-vendor networks
- Luis M. Contreras (Telefonica) went over some of the collected **new requirements**
- Thomas Graf (Swisscom) highlighted the issues with **data transformation** in yang-based telemetry and how YANG-PUSH is being driven in an iterative agile manner.

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- Some of the key discussion highlights
 - The **complexity** of multiple models, mapping between them and difference in implementations
 - Need for **intent-driven** configurations
 - Need for **open-source** implementations, interop, compliance test in the space
 - Best practice for vendor specific knobs

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Future

- Benoit Claise shared the **Knowledge graph** framework via the Resource Description Framework (RDF) used by Semantic Web and it can be used to describe the YANG models
- Kent Watsen highlighted that the data model driven management is a success but recommended focusing on **RESTCONF**, JSON, Yang-Push-Lite, NMDA, **off-box data model and protocol adaptors**
- Rob Wilton stressed on minimizing unnecessary complexity, timely solutions, open engagement, simplicity

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Future

- Some of the key discussion highlights
 - Lack of **NMDA** (Network Management Datastore Architecture) in Openconfig models
 - History of **gNMI** (gRPC Network Management Interface) and its failed attempt at IETF
 - How to make **IETF process** of YANG model and protocols faster?
 - How to work closely with **open-source** implementations in this space



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Key Takeaways - Ecosystem

1. The current network management protocols/models/tools still fail the **'ease of use'** requirement
 - a. The tools may matter more than the protocols
2. The overall ecosystem is still **fragmented** for both protocols and data models
 - a. SNMP (for monitoring) and CLI is still the rule in many networks (this is a potential obstacle)
 - b. Transitions between frameworks is challenging (see IPv4 -> IPv6)
 - c. Fragments: SNMP, CLI, NETCONF, RESTCONF, gNMI, etc...
 - d. gNMI is popular for stream



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Key Takeaways - Ecosystem

3. **Model-driven** network management is generally a success
4. **Documentation** for how the network management ecosystem works is lacking
 - a. Could use architecture documentation, deployment guides, tutorials, training, getting started
5. Easily usable network management tools for the operators are needed
 - a. Lack of open-source **tools** are a barrier to adoption
 - b. We need more discussion about tooling success paths
 - c. Tools need good use cases / example use cases and flows

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Key Takeaways - Protocol

1. Netconf for configuration has been successful in some larger scale deployment
 - a. This was contested!
 - b. Service config?
2. **Netconf/YANG is not used much (yet?) for monitoring**
3. Full device control and configuration frequently requires **CLI and screen scraping**
 - a. This was contested!
4. Full coverage of NetConf support on devices is missing
5. Polling based solutions are still frequently deployed

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Key Takeaways - Modeling

1. YANG models can sometimes get **too complex** (not a fault of the language)
2. **Vendor-specific** features need to be exposed through network management protocols
3. More **service-level** modeling is needed
 - a. Device level modeling needs to be a building block but is not a complete service-level solution
4. Network configuration needs to be **verifiable**
5. Multi-vendor compatibility support is required
6. Full coverage of YANG models on all devices is missing
7. **Model translation adapters** may be the best path forward
 - a. Likely off-device



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Key Takeaways - Standardization

1. **More rapid model development** procedures are (still) needed
 - a. Faster than how the IETF produces (simple) results today (especially models)
 - b. New approaches/methods to make it live outside the RFCs should be explored
 - c. Need more predictable timelines
2. More focus is needed on **scalability** of all network management roles (monitoring, configuration, notifications)
3. We should **reduce complexity** for future changes to a minimal agreed set of core features
 - a. For both protocol and models
4. Network management enhancements needs to be **backed by operator use cases** and vendor buy-in
 - a. Vendors and operators should must work together
5. A rapid development **experiment** would be an interesting approach



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What's Next

- IAB Workshop acts as a **spark for in-depth discussions** and engagement that might otherwise be missing
 - Designed to improve the overall understanding of technical challenges in network management.
- **Not the Final Destination**: Workshops initiate conversations rather than conclude them
 - Particularly impactful in advancing discussions within the Network Management Operations (NMOP) Working Group at the IETF
 - Encouraging participation in NMOP WG to collaboratively shape the future of network management and Internet architecture
- Additional information at <https://notes.ietf.org/nemops-workshop-next-steps>

IETF

Call for Action

- Feedback on the outcome of the workshop at nemops-interest@iab.org
- The Program Committee is working on the workshop reports
- Reminder - workshop is not the end, it is just a trigger for further discussion!
- New requirements being finalized in NMOP WG
- IETF 122 meeting in Bangkok in March
 - Participate in-person or online



Thank you

04-February-2025



References

- CoAP: <https://datatracker.ietf.org/doc/rfc7252/>
- CBOR: <https://datatracker.ietf.org/doc/rfc8949/>
- CORECONF: <https://datatracker.ietf.org/doc/draft-ietf-core-comi/>
- gNMI: <https://openconfig.net/docs/gnmi/gnmi-specification/>
- NETCONF: <https://datatracker.ietf.org/doc/rfc6241/>
- NMDA: <https://datatracker.ietf.org/doc/rfc8342/>
- YANG: <https://datatracker.ietf.org/doc/rfc7950>
- RESTCONF: <https://datatracker.ietf.org/doc/rfc8040/>