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

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

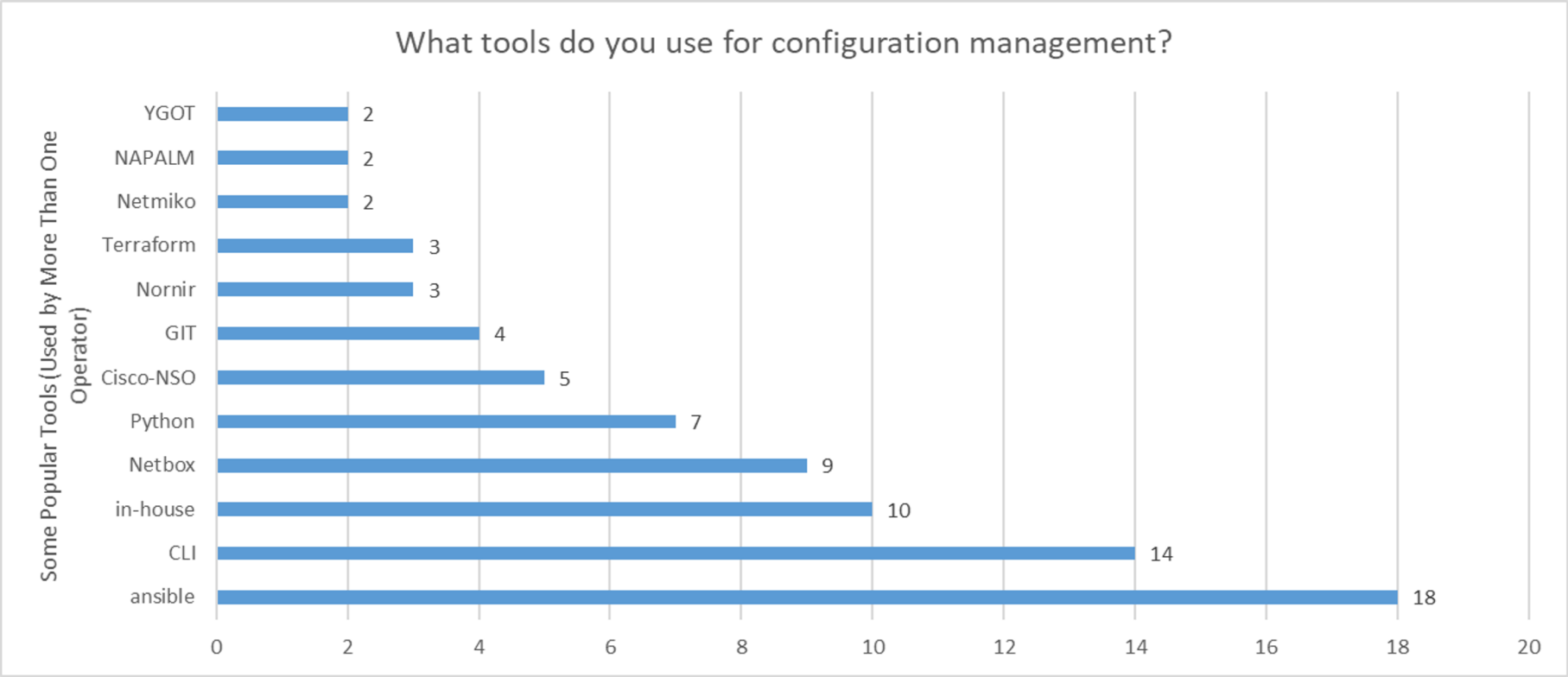
IAB / IETF
Next **E**ra of Network **M**anagement **Op**erations (NEMOPS) **Workshop 2024**

December 3-5
Virtual/Online

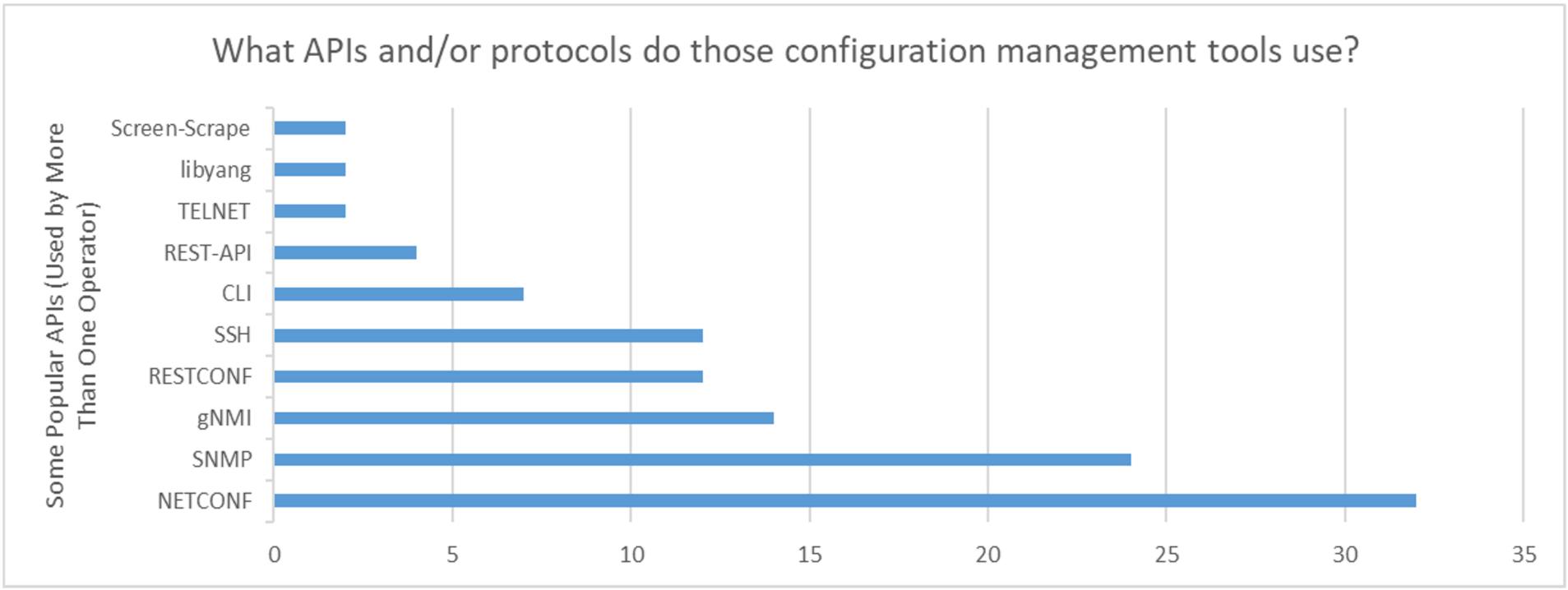
NEMOPS Workshop
Objectives

- **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/**

NEMOPS Workshop
Operator Survey



NEMOPS Workshop
Operator Survey



NEMOPS Workshop
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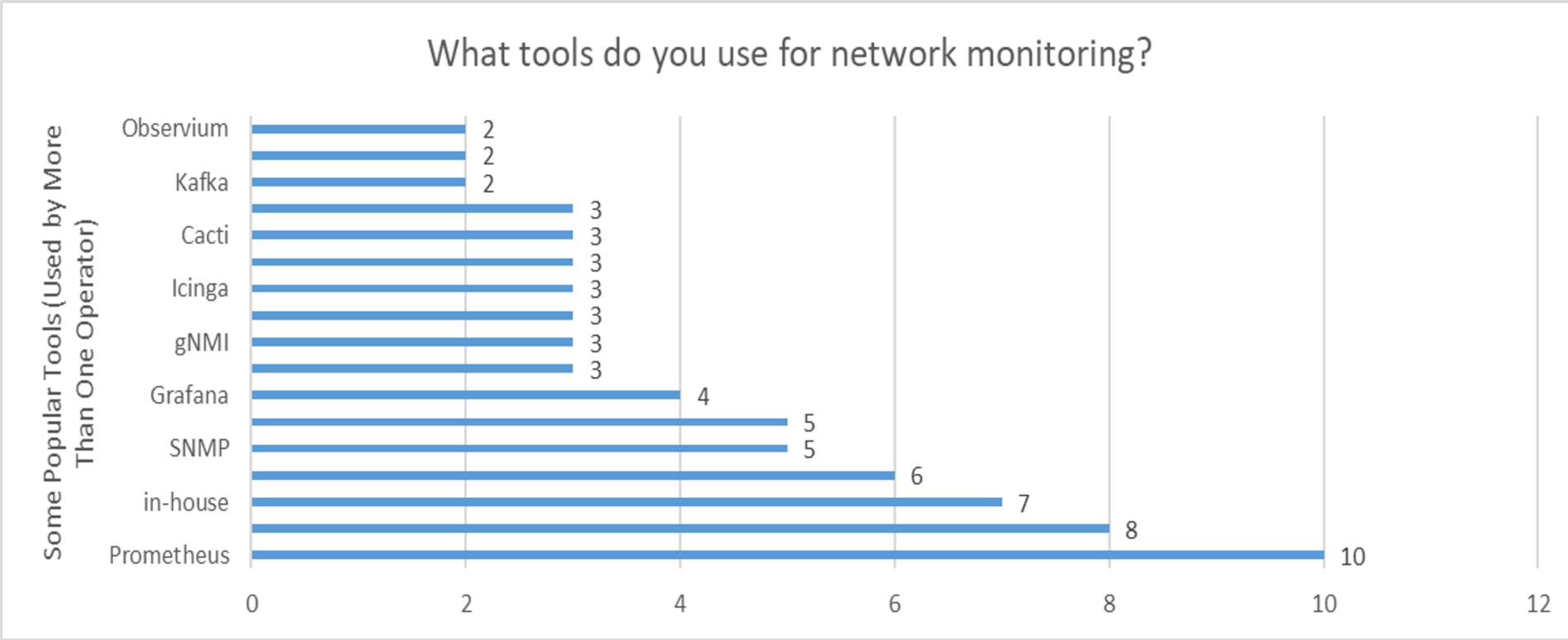

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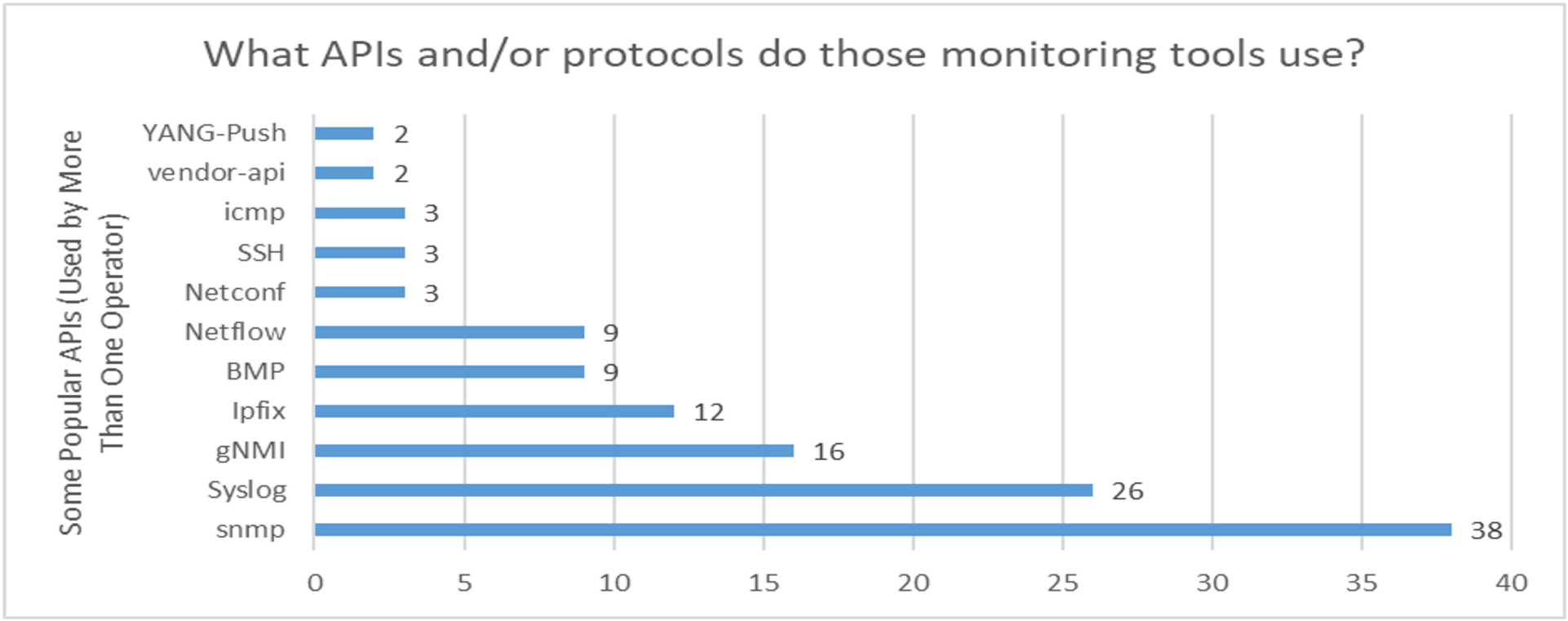

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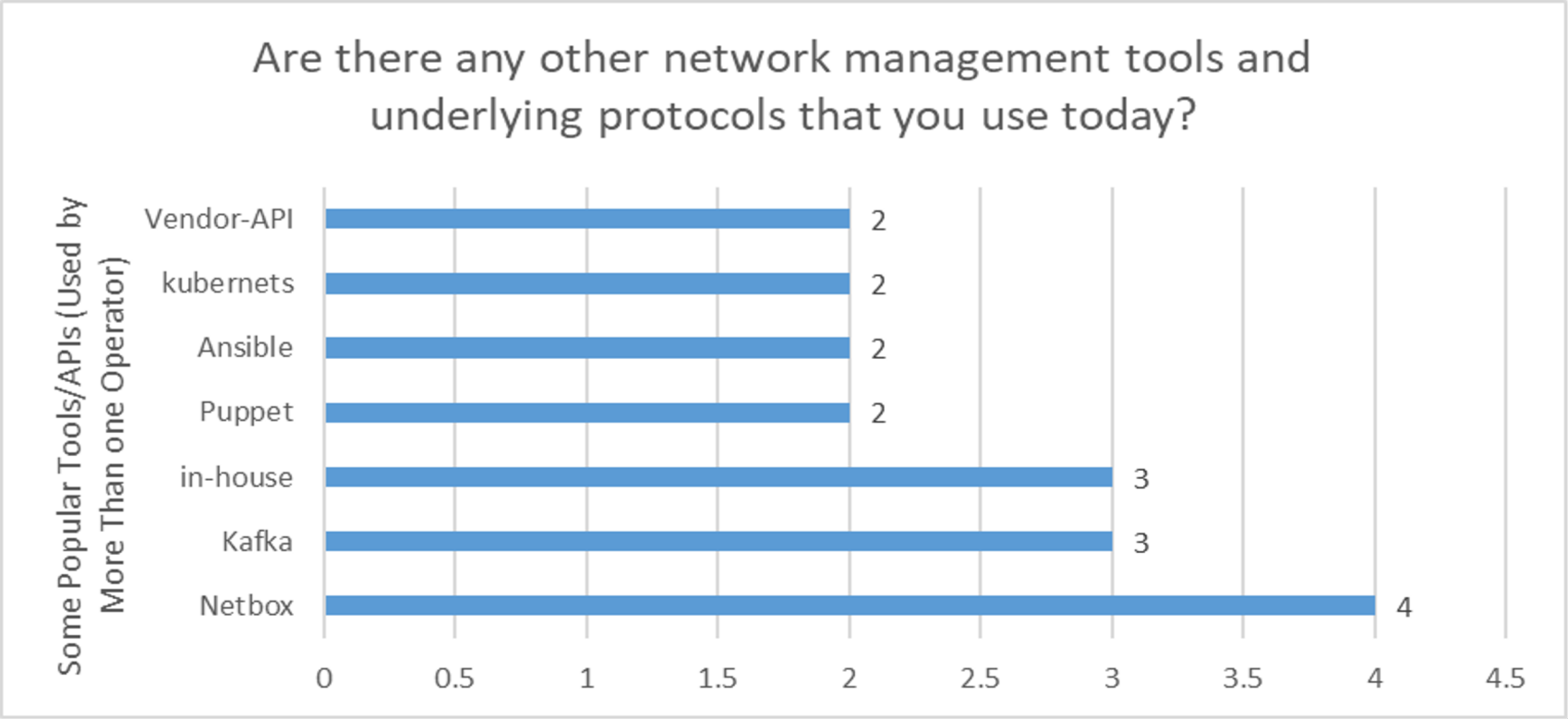

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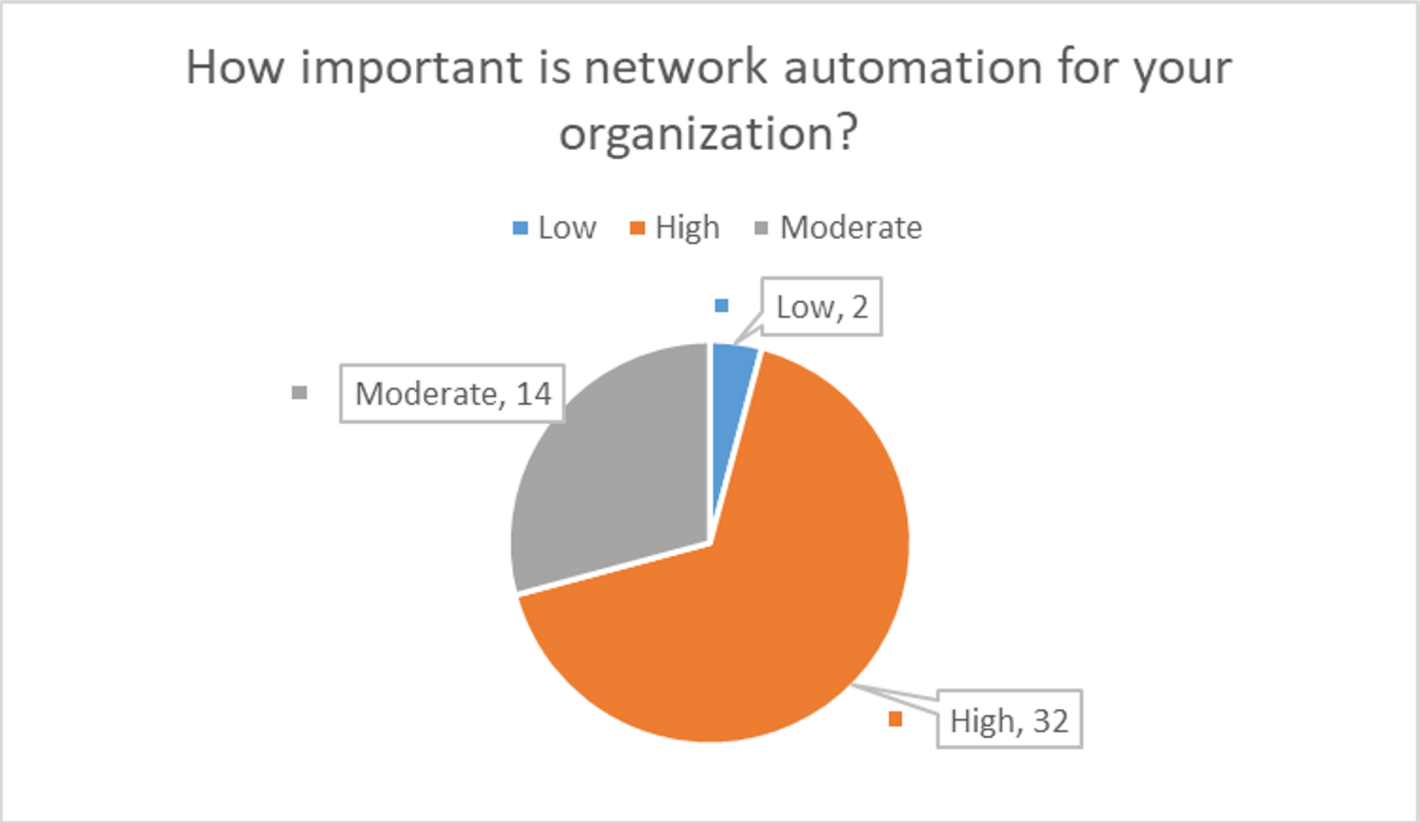

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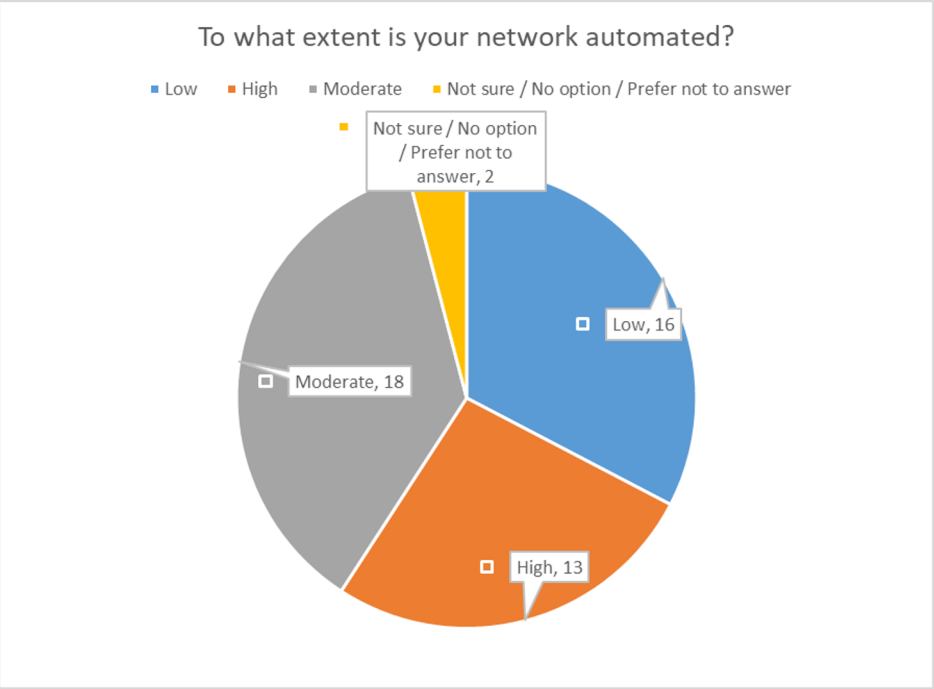

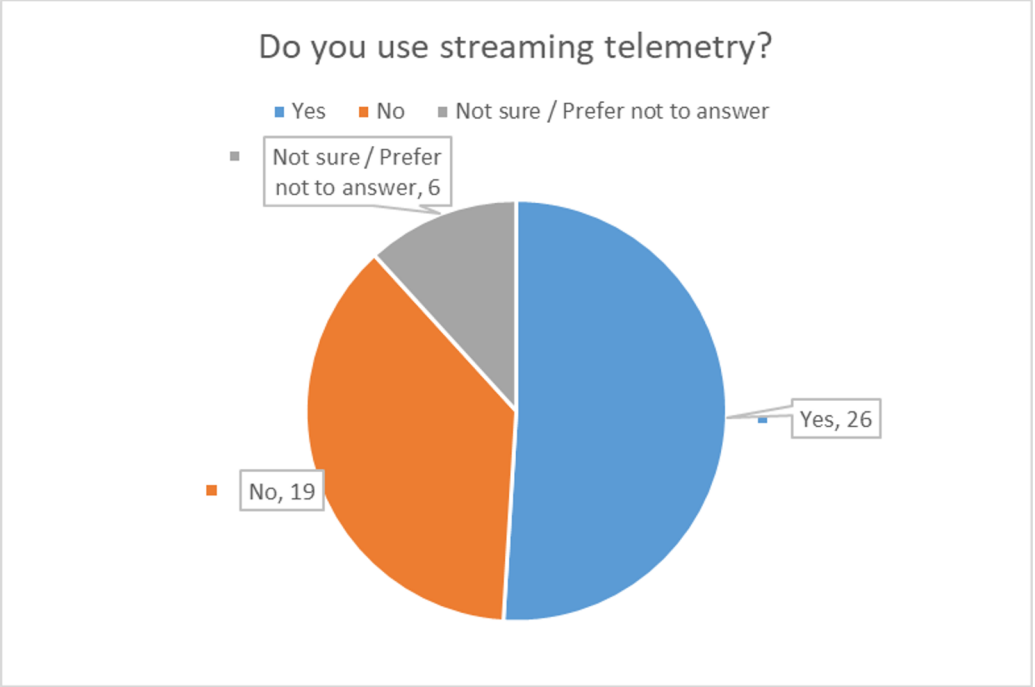

NEMOPS Workshop
Agenda

- 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**

NEMOPS Workshop
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

NEMOPS Workshop
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

NEMOPS Workshop
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?

NEMOPS Workshop
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.

NEMOPS Workshop
Present

- 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

NEMOPS Workshop
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

NEMOPS Workshop
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

NEMOPS Workshop
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

NEMOPS Workshop
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

NEMOPS Workshop
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

NEMOPS Workshop
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 adaptors** may be the best path forward
   a. Likely off-device

NEMOPS Workshop
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

NEMOPS Workshop
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

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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/