AI for Network Management and the IETF Network Management Research Group
October 9th, 2025

Jéferson Campos Nobre
Federal University of Rio Grande do Sull

Jérôme François
INRIA Research Center, France

Outline

- Figures
- Mode of operations
- Progress on research agenda
- Observations
- Present & future work
- Discussion

Network Management Research Group (NMRG)

- Research Group (RG) of the Internet Research Task Force (IRTF)
  - IRTF RGs encouraged to explore more than one alternative approach to the chartered problem area
  - No expectation that the RG will "come to consensus" on one approach
- Research link with IETF
  - Understanding of new concepts and approaches
  - “Landing zones” for NMRG outcome
    - E.g., ANIMA WG
- Good interactions between groups on specific topics (e.g. OPS)
- Support diversified research outcome e.g.
  - Via IETF documents publication
  - Via scientific and position papers
- Focused interim meetings to identify and progress on relevant work items or new topics
  - E.g., Agentic AI

NMRG mode of operation

- Collaboration and open forum
- Meetings during IETFs (3x per year)
  - 1 or 2 slots
  - Progress research agenda
  - Open and experiment with new topics (tech talks and research presentations)
  - Feedback from the IETF participants
- Interim meetings: monthly/bi-monthly meetings
  - Online or co-located with other events (e.g., network management conferences)
  - Can be hosted by a supporting institution
  - Presentations followed by intensive, detailed discussions
  - Focused topics to progress on a particular work item

NMRG figures

- Oldest IRTF RG in activity (26+ years…)
- Rechartered in 2020, new research agenda
- 7 RFCs published, 3 upcoming
- 70+ meetings, co-located with IETF and scientific conferences
- Interactions with the research community (IEEE/IFIP…)
- 400+ members on mailing list
- Well-attended meetings (avg. 70+)

IETF/IRTF Documents

- Internet-Drafts
  - Working documents of the IETF, its Areas, and its Working Groups
  - Individual documents
    - Anyone can author an Internet-Draft.
    - Opinions expressed in the drafts are the authors' alone
  - (adopted) Working/Research group documents
    - Managed by the group itself
    - Opinions expressed are the groups' position
- RFC
  - IETF/IRTF publishes its documentation as RFCs (historical acronym for "Requests for Comments")
  - Different statuses (in the context of IRTF)
    - Informational → published for the general information of the Internet community
    - Experimental → specification that is part of some research or development effort

Research agenda

- Details on research agenda available on NMRG page: Network Management (nmrg)
- **Artificial Intelligence in Network Management (AI-NM)**
  - Investigate, organize and document major research challenges in AI-NM
    - Goal: provide a reference document which defines the different forms and usages of AI in network management
  - Organize a series of practical AI-NM challenges/competitions
    - Goal: promote experimental research, practical knowledge and validation of AI techniques to solve network management problems
  - Support discussion and collaboration → dedicated meetings or sessions with invitations
    - Goal: offer a forum for the Network Management AI community to report on advances, developments and key results and introduce its efforts to the IETF

Current Documents - Adopted

- ~5 I-D
- Network Digital Twin: Concepts and Reference Architecture, draft-irtf-nmrg-network-digital-twin-arch-11
- Use Cases and Practices for Intent-Based Networking, draft-irtf-nmrg-ibn-usecases-00
- **Research Challenges in Coupling Artificial Intelligence and Network Management, draft-irtf-nmrg-ai-challenges-05**
- A Framework for LLM-Assisted Network Management with Human-in-the-Loop, draft-irtf-nmrg-llm-nm-00
- **Considerations of network/system for AI services, draft-irtf-nmrg-ai-deploy-01**

Current Documents - Adopted

- draft-irtf-nmrg-ai-challenges-05
  - Challenges to overcome when Network Management (NM) problems may require coupling with Artificial Intelligence (AI) solutions
    - Many difficult problems in NM that to this date have no good solutions, or where any solutions come with significant limitations and constraints
    - Distribution of AI tasks became primordial and expected that networks are operated efficiently to support those tasks
    - Method → evaluating the gap between NM problems and AI solutions
  - Sub-challenges
    - Suitable Approach for Given Input
    - Suitable Approach for Desired Output
    - Tailoring the AI Approach to the Given Problem
    -

Current Documents - Adopted

- draft-irtf-nmrg-ai-deploy-01
  - Considerations of network/system for AI services
    - Configuration of the network and system in terms of AI inference service to provide AI service in a distributed manner
    - Points to consider in the environment where a client connects to a cloud server and an edge device and requests an AI service

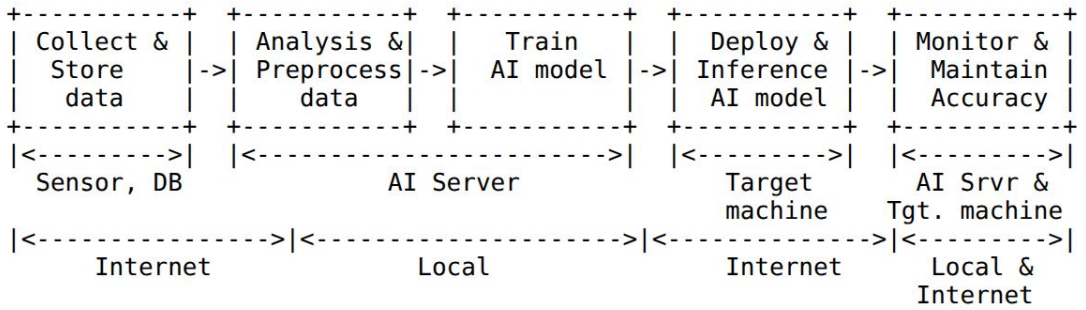

Figure 1: AI service workflow

Current Documents - Individual

- Semantic Inference Routing Protocol (SIRP), draft-chen-nmrg-semantic-inference-routing-00
- **Generative AI for Intent-Based Networking, draft-cgfabk-nmrg-ibn-generative-ai-00**
- **Large Model based Agents for Network Operation and Maintenance, draft-chuyi-nmrg-ai-agent-network-01**
- An Intent Translation Framework for IoT Networks, draft-gu-nmrg-intent-translator-01
- Data Generation and Optimization for Network Digital Twin, draft-li-nmrg-dtn-data-generation-optimization-04
- **Requirements Analysis of System and Network for Large Language Model Inference Service, draft-liu-nmrg-ai-llm-inference-requirements-01**
- **AI-Based Distributed Processing Automation in Network Digital Twin, draft-oh-nmrg-ai-adp-0**
- **A Protocol-agnostic Multiple Agents Interaction Model for Autonomous Network, draft-wang-nmrg-magent-im-00**
- **Applicability of A2A to the Network Management, draft-yang-nmrg-a2a-nm-00**
- **Framework and Automation Levels for AI-Assisted Network Protocol Testing, draft-cui-nmrg-auto-test-00**
- **Applicability of MCP for the Network Management, draft-yang-nmrg-mcp-nm-00**
- **Network Digital Twin based Architecture for AI driven Network Operations, draft-wmz-nmrg-agent-ndt-arch-00**
- **A Framework to Evaluate LLM Agents for Network Configuration, draft-cui-nmrg-llm-benchmark-00**
- Intent-Based Network Management Automation in 5G Networks, draft-jeong-nmrg-ibn-network-management-automation-06
- Resource Allocation Model for Hybrid Switching Networks, draft-sun-nmrg-hybrid-switching-12

Current Documents - Individual

- Network Digital Twin based Architecture for AI driven Network Operations
  - NM activities to take user intent or service requirements as input, automatically assess, model, and refine optimization strategies under realistic conditions but in a risk-free environment
- Generative AI for Intent-Based Networking
  - How to specialize AI models in order to creating highly targeted generative models for Intent-Based Networking
- Applicability of MCP for the Network Management
  - Operational aspect, key components, generic workflow and deployment scenarios in the multi-domain heterogeneous network environment
- A Framework to Evaluate LLM Agents for Network Configuration
  - Emulator-based interactive environment, a suite of representative tasks, and multi-dimensional metrics to assess properties

Discussion

- AI for NM and NM for AI but still a very large topic
- Avoid use case bias → a challenge document but a few individual initiatives
- Large gap between academia and industry (in terms of applied methods) → good fit regarding IRTF objectives
- Link with IETF
  - E.g., Network Management Operations (NMOP)
    - AI based Network Management Agent (NMA): Concepts and Architecture, draft-zhao-nmop-network-management-agent
- Challenges: beyond "ML hammer" to solve all "network nail problems"
- Network specific AI/ML

Final Remarks

- Networks and Network Management have changed a lot in 25 years
- NMRG adaptation over time to address the changes
- Difficult to "predict" what future networks will be… however, necessary to think about
- What networks are today / near future
- How they are designed, deployed, operated
- What are the key (research) problems / challenges

AI for Network Management and the IETF Network Management Research Group
October 9th, 2025

Jéferson Campos Nobre
Federal University of Rio Grande do Sull

Jérôme François
INRIA Research Center, France