

*IEEE Future Networks Webinar - 18 May 2022 - 11:00 am ET*

# Systems Optimization for Future Networks

Register today: [bit.ly/FNIWebinarMay2022](https://bit.ly/FNIWebinarMay2022)

Baw Chng, BAWMAN LLC  
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Lyndon Ong, Ciena



# International Network Generations Roadmap (INGR)

Future network technologies (5G, 6G, etc.) are expected to enable fundamentally new applications that will transform the way humanity lives, works, and engages with its environment. Be a part of this transformation today!

- The INGR is a semi-annual technical document highlighting network technology evolutions over 3-, 5- and 10-year horizons.
- Created by a group of 100+ international IEEE experts from industry, academia and prominent research labs, organized across 15 distinct working groups.
- Every 12-18 months, INGR will release a new multi-chapter document highlighting development needs, the challenges/roadblocks to achieving those needs, and potential solutions to those challenges.
- At least twice a year, INGR leadership will do outreach to industry and hold presentations highlighting the most crucial future technical roadblocks, to engage industry to solve or avoid those risks and roadblocks.
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# IEEE INGR Structure and Working Groups

CATEGORY	DESCRIPTION	INGR WORKING GROUP CHAPTERS
<b>Access</b>	Describes how the users are able to reach the network	<ul style="list-style-type: none"> <li>• <b>Massive MIMO</b></li> <li>• mmWave and Signal Processing</li> <li>• Hardware</li> <li>• Energy Efficiency</li> </ul>
<b>Networks</b>	Describes how the networks are interconnected	<ul style="list-style-type: none"> <li>• Edge Automation Platform</li> <li>• Satellites</li> <li>• Optics</li> </ul>
<b>System and Standards</b>	Describes system standards and testability	<ul style="list-style-type: none"> <li>• Standardization Building Blocks</li> <li>• Testbed</li> <li>• <b>Systems Optimization</b></li> </ul>
<b>Enablers and Users</b>	Represents all the elements that enable deployment, assure functionality and security and address impact on society and environment	<ul style="list-style-type: none"> <li>• Deployment</li> <li>• Applications and Services</li> <li>• Security and Privacy</li> <li>• Artificial Intelligence and Machine Learning (AI/ML)</li> <li>• Connecting the Unconnected (CTU)</li> </ul>

# Accessing INGR 2021 Chapters

1. Visit [FutureNetworks.ieee.org/roadmap](https://FutureNetworks.ieee.org/roadmap)
  2. Sign in as an FNI member (IEEE account)
  3. Download all chapters
- Not a member of Future Networks?
    - Add it to your IEEE account
    - Membership is free for IEEE Society members
    - USD \$5 - \$15 annually for others
    - URL to join: [bit.ly/fni-join](https://bit.ly/fni-join)



# SysOpt WG Scope

The Systems Optimization working group within the IEEE Future Networks Initiative addresses:

- modeling of control of complex networks of self-organizing systems
- identification of the key problems for control of such networks
- development of new solutions to achieve network self-organization, applying intelligence science concepts such as emergence
- demonstration of these features within the scientific community.
- collaboration with industry and standards community

Some of the INGR groups we work with:

- AI/ML, Energy Efficiency, Security, Standards Building Blocks and Testbed

# Webinar Agenda

- Overview of the Systems Optimization WG
  - Lyndon Ong, Ciena
- O-RAN Use Case for Systems Optimization
  - Dilip Krishnaswamy, Sterlite Technologies
- Federation Use Case for Systems Optimization
  - Baw Chng, Bawman Consulting
- Q&A

# Future Demands

- Service and Traffic Variance
  - mMTC: high latency/low individual traffic/many sources
  - eMBB: low to high latency/high traffic
  - URLLC: low latency/low traffic;
- Control Variance
  - Centralized: higher latency/lower cost/greater resources
  - Distributed: lower latency/higher cost/limited resources
  - Spread of intelligent systems capable of autonomous action



# Future Landscape

- Increasingly used for machine-to-machine applications
- More complex systems architecture/optimization

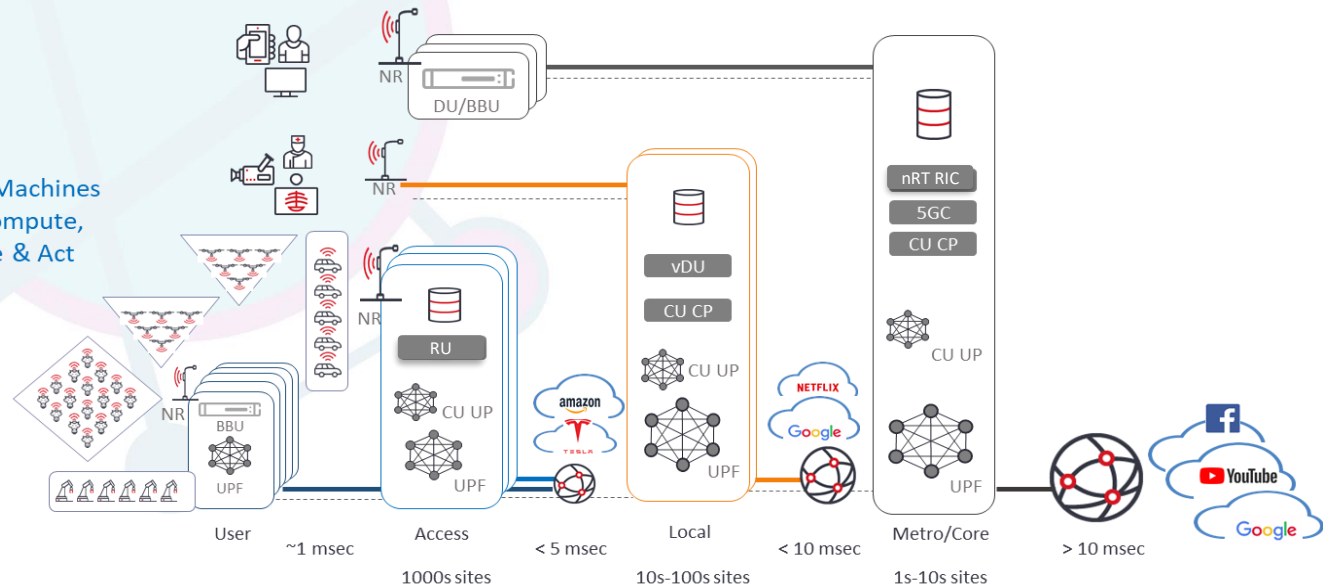
## Future

End User:

Humans & Machines

Value Elements:

Connect, Compute,  
Store, Sense & Act





# 10-year Vision

Future systems will be highly distributed fabrics of compute, intelligence and networking interconnected at multiple levels, making optimization an interesting challenge.

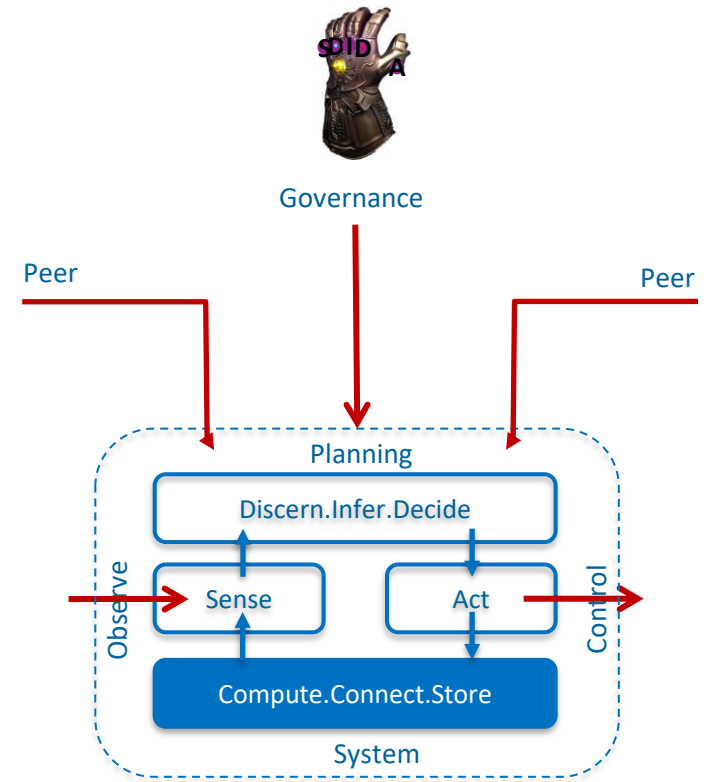
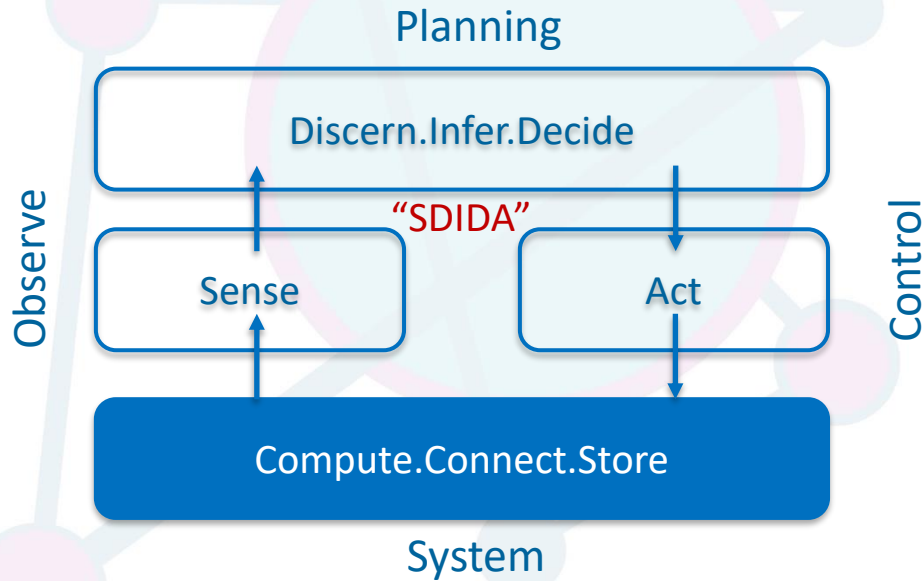
Key areas of need:

- Dynamic fabric allocation with (near) real time discovery and peering of heterogenous resources contributed by disparate providers
- Dynamic semantics discovery and negotiation at points of attachment between peer entities
- Distribution and federation of intelligence across disparate contributing entities
- Self-optimizing techniques for autonomic system behaviors

# Needs Identified in 10-year Vision

	Future State 10-years (2029)
Need #1	Dynamic discovery and peering between heterogeneous intelligent systems
Need #2	Distributed dynamic resource allocation, optimization and monetization across autonomic systems
Need #3	Self-organization of federated domains
Need #4	Federation/integration across public/private boundaries
Need #5	Modeling and tooling to identify dependencies, potential deadlocks and predict/optimize system performance
Need #6	Testbeds suitable for testing systems optimization strategies, especially interactions such as AI/ML governance and federation

# System Intelligence



# Standards Analysis and Directions

- ETSI GANA (Generic Autonomic Network Architecture)
  - Addresses similar model and governance needs
  - Looking into possible enhancements such as
    - Incorporation of the SDIDA model
    - development of mechanisms for auto-discovery and federation
    - development of brokers to support federation of domains
- TMF Multi-SDO Initiative
  - Development of Common Operational Principles for Autonomic/Autonomous Networks
    - Establishing requirements for interaction/governance by human operators and interaction between peer autonomous networks/systems

# Stakeholders

- Stakeholders include various verticals that are interested to improve efficiency, flexibility, and control latency for their operation during the deployment phase. These verticals could realistically include operators, enterprise networks, first responder, public safety, and tactical network community and app developers
- Involved SDOs include TMF, NGMN, 3GPP, ETSI, BBF, ITU-T and IETF and accompanying communities such as O-RAN

# Contributions from Working Group Members

- |  |   |   |
|--|---|---|
| <ul style="list-style-type: none"> <li>• Meryem Simsek</li> <li>• Lyndon Ong</li> <li>• Ashutosh Dutta</li> <li>• Aarne Mammela</li> <li>• Abdelaali Chaoub</li> </ul> | <ul style="list-style-type: none"> <li>• Ranganai Chaparadza</li> <li>• Muslim Elkotob</li> <li>• N. Kishor Narang</li> <li>• Dilip Krishnaswamy</li> </ul> | <ul style="list-style-type: none"> <li>• Baw Chng</li> <li>• Pedro Martinez-Julia</li> <li>• Nigel Davis</li> </ul> |
|--|---|---|

# SysOpt Details

- SysOpt Working Group Meetings
  - Biweekly Monday mornings at 11am US Eastern Time
  - For additional information, contact the Systems Optimization WG Co-Chairs
    - Meryem Simsek:simsek@icsi.Berkeley.edu
    - Lyndon Ong:lyong@ciena.com
  - To join the Working Group, send email to 5GRM-sysopt@ieee.org
- SysOpt Chapter of the INGR Roadmap 2022 document
  - [https://futurenetworks.ieee.org/images/files/pdf/INGR-2022-Edition/IEEE INGR SysOpt Chapter 2022-Edition-Preview.pdf](https://futurenetworks.ieee.org/images/files/pdf/INGR-2022-Edition/IEEE_INGR_SysOpt_Chapter_2022-Edition-Preview.pdf)

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