IEEE Future NETWORKS

Enabling 5G and Beyond

International Network Generations Roadmap (INGR)

Virtual Workshop

Systems Optimization

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IEEE

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

Scope

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

- 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

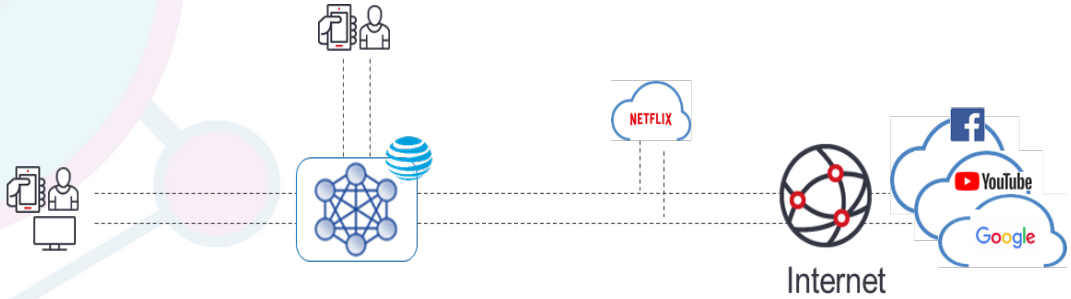
Today's Landscape

- Tailored for human end users
- Architecture optimized for access to content

Now

End User: Humans

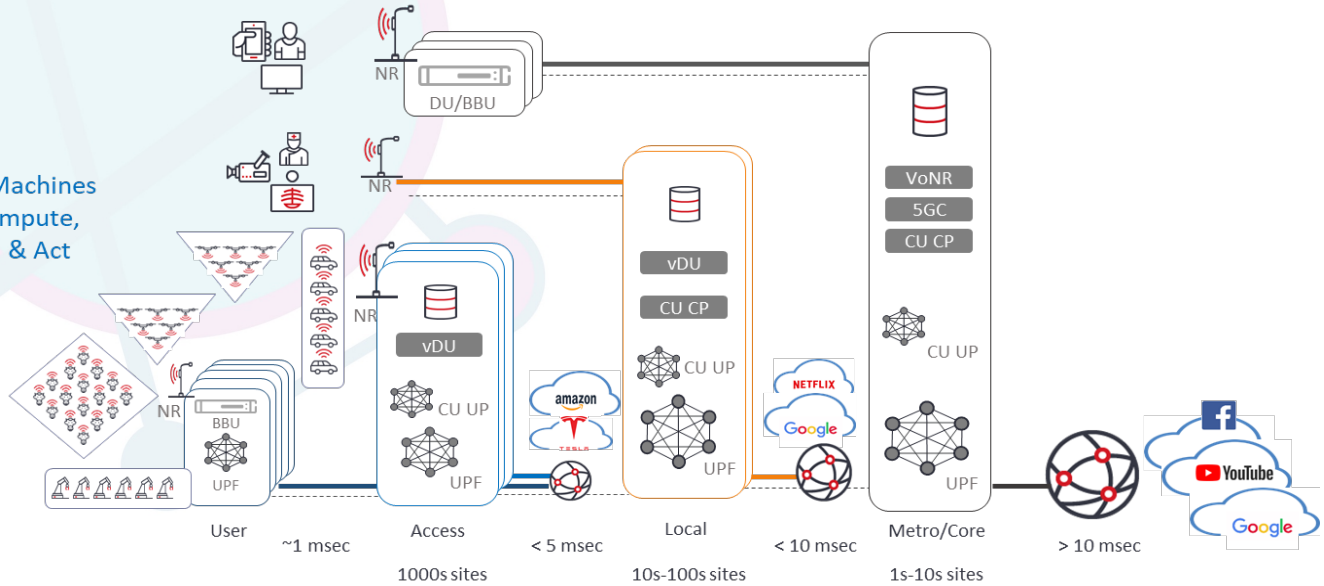
Value Elements: Connect, Compute, Store



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



Top Needs for 10-year Vision

	Current State (2019)	3 years (2022)	5 years (2024)	Future State 10-years (2029)
Need #1	Dynamic discovery and peering of heterogenous resources	ML-capable entities/fabrics	Architectural evolution for end-to-end autonomic management and control	Dynamic Semantics discovery and negotiation: self-learning protocols to be discovered at the point of attachment
Need #2	Static protocol and capability negotiation	ML driven dynamic capability discovery and negotiation	Autonomic system behaviors with self-optimized components that leverage any achievements in this area	Dynamic fabric allocation, optimization and monetization with resources contributed by multiple micro data centers
Need #3	Dynamic capability negotiation	ML driven policy federation across multiple jurisdictions	Autonomic policy negotiation and agreement	Self-determination of federated domains
Need #4	ISM, local (private) and national license holder with strict network & spectral resource allocation	ML driven resource federation and optimization	AI powered private network operation and integration with a federated network	Development of new-look internet technology with the federation of private networks
Need #5	Need to have a model that can model system dependency and deadlocks	Models that can predict the systems performance based on the schedules and available systems resources	Model should be able to study and detect behavioral properties such as system deadlocks, investigate the anomalies of specific schedules, and then compare various schedules, such as proactive, reactive, and concurrent schedules	Tools that search for application- or context-specific optimizations, such as caching, proactive, or cross-layer techniques
Need #6	Testbed that can be used to test various systems optimization techniques	Federation of Testbeds by connecting various testbeds at various parts of the world	Augment the testbed capabilities to demonstrate various types of applications including augmented reality and other low latency type applications	Integration of some of the advanced techniques and enablers including AI/ML in the testbed.

Challenges and Solutions to Meet Needs

	Current State (2019)	3 years (2022)	5 years (2024)	Future State 10-years (2029)
Need #1	Dynamic discovery and peering of heterogenous resources	ML-capable entities/fabrics	Architectural evolution for end-to-end autonomic management and control	Dynamic Semantics discovery and negotiation: self-learning protocols to be discovered at the point of attachment
Challenge(s) for Need 1	lack of entity as well as functionality for performing these tasks	computational complexity, lack of interfaces, lack of data and models	Revolutionary changes in existing architecture	stays in contrasts to today's protocols; requires radical changes in the systems
Possible Solution for Challenge	introduction of a fabric/multiple fabrics into the system	introduction of highly efficient entities/fabrics	self-optimized outer loop	

Challenges and Solutions to Meet Needs

	Current State (2019)	3 years (2022)	5 years (2024)	Future State 10-years (2029)
Need #2	Static protocol and capability negotiation	ML driven dynamic capability discovery and negotiation	Autonomic system behaviors with self-optimized components that leverage any achievements in this area	Dynamic fabric allocation, optimization and monetization with resources contributed by multiple micro data centers
Challenge(s) for Need 2	can be performed locally, but no end-to-end performance guarantee	Need for dynamics ML-driven solutions to guarantee end-to-end performance and adapt to the network dynamics	Definitions of autonomic systems, and abstractions layers for control-loops that close gaps in emerging standards for autonomic networking and autonomic management & control, identification/introduction of self-optimized components, modelling of complex systems,	lack of solutions for enabling and implementing fully-autonomous solutions; guarantee of stability
Possible Solution for Challenge	introduction of higher-level fabric to orchestrate/coordinate, additional interfaces/signaling	offline studies and model development and gradual integration	Emergent intelligence solutions	Enhanced emergent intelligence solutions

Stakeholders

- Stakeholders could 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 3GPP, ETSI, TMF, NGMN, BBF, ITU-T and IETF and accompanying communities such as O-RAN and LF

Contributions from Working Group Members

- Meryem Simsek
- Lyndon Ong
- Ashutosh Dutta
- Kaniz Mahdi
- Aarne Mammela
- Jens Voigt
- Ranganai Chaparadza
- Altran Capgemini
- Mohammad Patwary
- Pedro Martinez-Julia
- Muslim Elkotob
- Narang N. Kishor

Next Steps

- SysOpt Working Group Meetings
  - Biweekly Monday mornings at 8am PDT
  - Bring Your Research Ideas, Talks to discuss in the meeting
  - Initial talk from Aarne Mammela available at googledocs site
- Develop SysOpt white paper
  - Currently in draft with contributions from many members
- Sysopt Virtual Workshops and Tech Focus papers
- Industry and Standards Engagement

Cross Team Meeting Schedule for June 17 and 18

Please contact working group co-chairs for Webex link if you are interested to attend cross team meetings

Contacts: Sysopt Working Group Co-Chairs
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June 17

Start Time										
8:00 AM	9:00 AM	10:00 AM	11:00 AM	12:00 PM	1:00 PM	2:00 PM	3:00 PM	4:00 PM	5:00 PM	6:00 PM
Apps & Svcs AI ML				Apps & Svcs Deployment		EE Hardware	Apps & Svcs EE		EE Deployment	
			EAP Massive MIMO	EAP Security		EAP Standards	EAP Testbed			
	Satellite Standards	Satellite Testbed		Massive MIMO Hardware		Massive MIMO Deployment	Massive MIMO Standards			Deployment CTU
				Standards CTU	Sys Opt CTU		Security Sys Opt		CTU Testbed	Sys Opt Testbed
					Satellite Security	Satellite AI ML				
			Security AI ML							

June 18

Start Time										
8:00 AM	9:00 AM	10:00 AM	11:00 AM	12:00 PM	1:00 PM	2:00 PM	3:00 PM	4:00 PM	5:00 PM	6:00 PM
	Apps & Svcs Satellite			AI ML EAP	Apps & Svcs EAP			Apps & Svcs Security		Apps & Svcs Sys Opt
	AI ML Massive MIMO				AI ML CTU		EAP EE	EAP Deployment		
					Security Testbed	Standards Testbed	Standards Security		EE Sys Opt	
								AI ML Testbed		

Get involved!

Working Group Members

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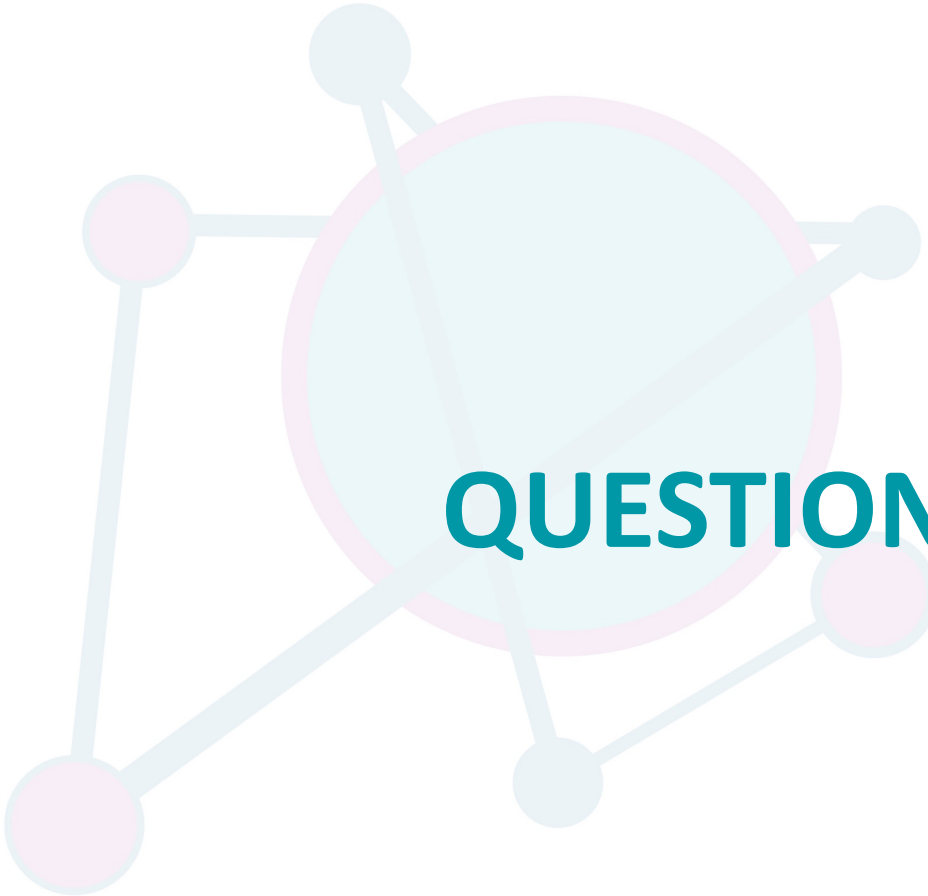
If you would like to join the working group please send mail to:

5GRM-sysopt@ieee.org



QUESTIONS?