Learning-Capable Communication Networks (LCCN)

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(Self-adaptive) Learning-based Control

Current situation: once configured, network systems follow explicitly pre-defined behavior, persistently decide and uniformly execute

=> Self-adaptive learning-based control

- Aware of their state, activity/behavior, and environment over time
- Capable to react and adapt to changing environment and running conditions over time
- Operate autonomously and when needed cooperatively (no global coordination or synchronization)



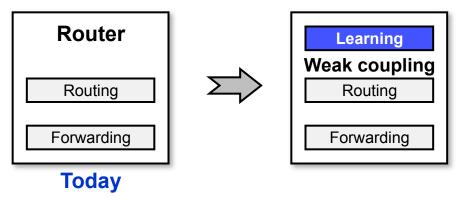
Learning to avoid need to iteratively re-design systems as they should adapt to their environment and running conditions

Role/challenges of learning

- WHAT/WHY: diagnose internal state, own activity, and network environment over time (detect -> identify -> analyze)
- HOW: adapt decisions and tune actions automatically and timely
- WHEN: determine when to operate autonomously and when to cooperate

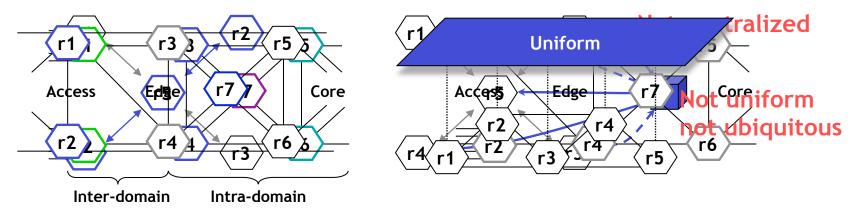
(Self-adaptive) Learning-based Control

Augment network systems (e.g. routers) with learning component

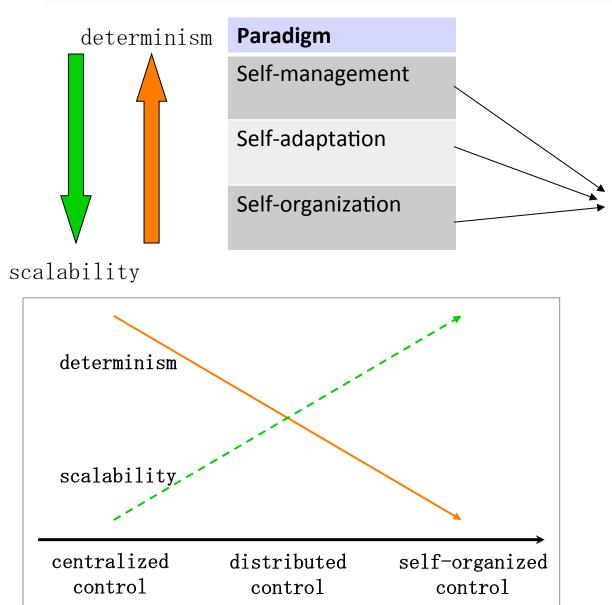


Guiding principles

- Local view and decision (no network global view or coordination): to ensure scalability and robustness
- Modular (no monolithic or unified framework): to ensure gradual development
- Distribution (no uniform or ubiquitous plane): to ensure organic deployment



Self-X paradigms vs functionality



Functionality

Self-configuration

Self-maintenance

Self-stabilization

Self-diagnosis

Self-protection

Self-healing

Self-repair

Self-optimization

LCCN Research Activity Positioning

Self-management **LCCN** Self-adaptive Self-organizing

<u>Self management</u>: capability to operate and maintain systems and devices depending on the current system parameters

<u>Properties</u>: Unified framework and global coordination (and re-evaluation)

<u>Technique</u>: e.g. policy-based management

<u>Self-adaptive</u>: ability of the system's components to adapt to changing environmental and running conditions over time

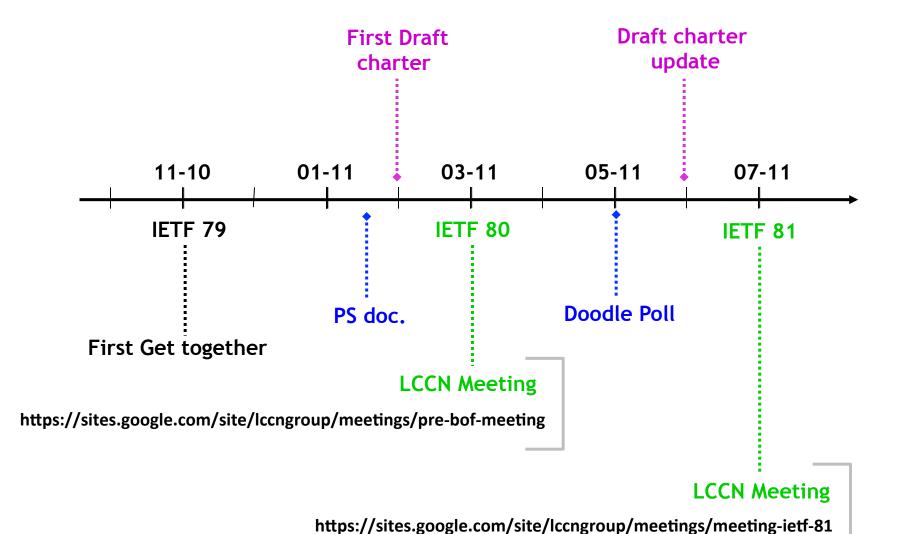
<u>Properties</u>: Distributed, modular, and local coordination (and re-evaluation)

Technique: e.g. learning

<u>Self-organize</u>: structure and functionality at the global level emerge solely from numerous interactions among lower-level components without any external or centralized control

Technique: e.g. biology, neuro-science

Activities Timeline



9/8/11 6

Research Space/Domains

Doodle poll (25, about 50% of participants)

	Network self- defense (incl. distributed intrusion/attack detection, distributed anomaly detection, etc.)	Routing (incl. traffic engineering, resiliency, stability, etc.)	Control of optical networks	Mobile/Ad-Hoc/ Sensor networks	Other Suggestion
Count	11	21	10	10	5

- Outcome: several people will present state-of-the-art/challenges in these selected experimental domains during LCCN meeting @ IETF 81
- Identify research challenges and potentials wrt application of various learning models and techniques inside each of these domains and between domains (specialization vs generalization)
- Architectural baseline (common principles, control model, etc.)

LCCN Initiative

- One-line abstract: learning-based control for network systems to automatically and timely adapt to network environment and running conditions over time
- Description: https://sites.google.com/site/lccngroup/
- LCCN Meeting: Wednesday July 27th from 1:00 to 3:00PM (303AB)
 Goals (of this meeting)
 - Identify research challenges & potentials when applying learning to i)
 Routing (incl. traffic engineering, resiliency, stability, etc.), ii) Network self-defense (incl. distributed intrusion/attack detection, distributed anomaly detection, etc.), iii) Mobile/ad-hoc/sensor networks.
 - Assess level of interest to initiate research on them
 - Determine if IRTF is the right place to conduct such research work
 - Estimate readiness for opening an IRTF Research Group by IETF 82
- Agenda: https://sites.google.com/site/lccngroup/bof-description-and-agenda
- Problem statement I-D: draft-tavernier-irtf-lccn-problem-statement-01
- Contact: <http://groups.google.com/group/lccn/>

LCCN Initiative

LCCN Mailing list countries (60+ members)

