KIRA – Scalable Zero-Touch Routing

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KIRA: Kademlia-directed ID-based Routing Architecture

R. Bless, M. Zitterbart, Z. Despotovic and A. Hecker, „KIRA: Distributed Scalable ID-based Routing with Fast Forwarding“, 2022 IFIP Networking Conference (IFIP Networking), 2022, https://s.kit.edu/KIRA

KIRA – Motivation

- Goals
  - resilient control plane connectivity → robust network operation
    - e.g., for SDN, NFV, VIM, AI-based Control, Intent-based NM, OAM, …
    - guarantee controllability of every networked device → IETF standard
  - no manual configuration, no dependencies (just link layer connectivity)

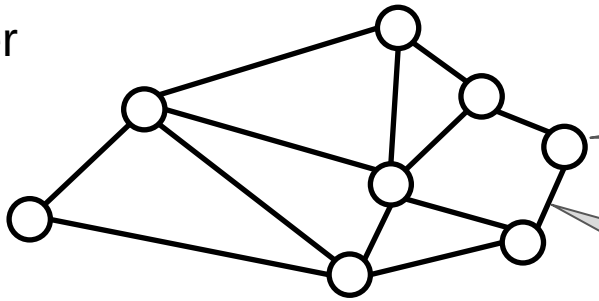
- Existing solutions not scalable, zero-touch, or topology specific

- So, neither designed nor optimized for Mobile Ad-hoc Networks, but…zero-touch and ID-based

SDN: Software Defined Networking,
NFV: Network Function Virtualization,
VIM: Virtual Infrastructure Management,
NM: Network Management,
OAM: Operations Administration, and Maintenance

What KIRA provides…

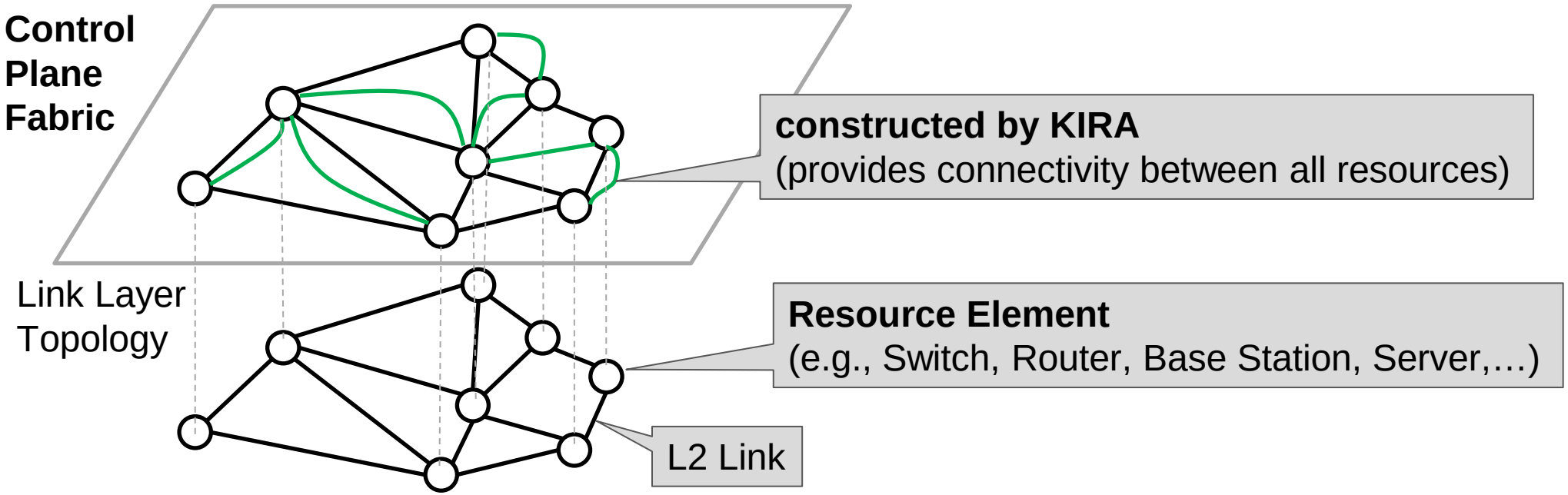
Link Layer
Topology



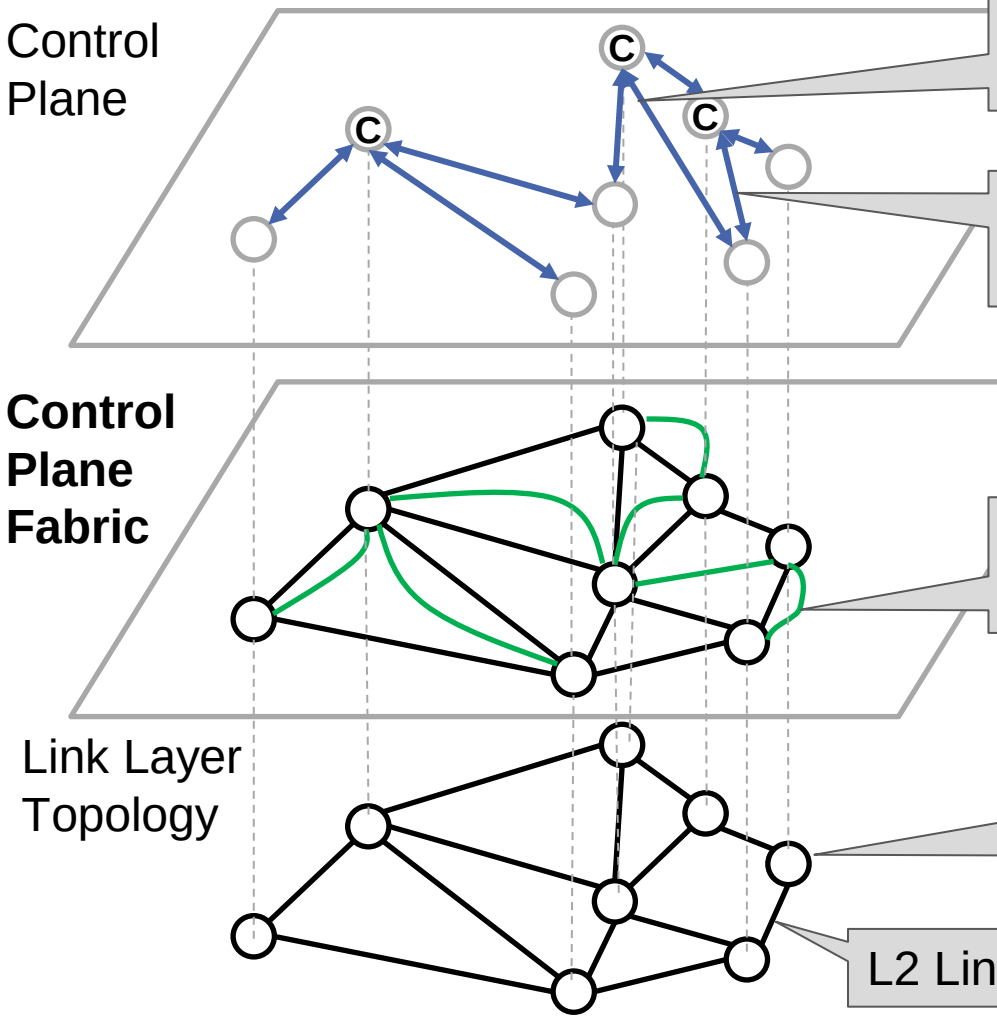
Resource Element
(e.g., Switch, Router, Base Station, Server,…)

L2 Link

What KIRA provides…



What KIRA provides…



Controller
(e.g., SDN controller, 5G/6G SBA entities, K8s controller, PCE,…)

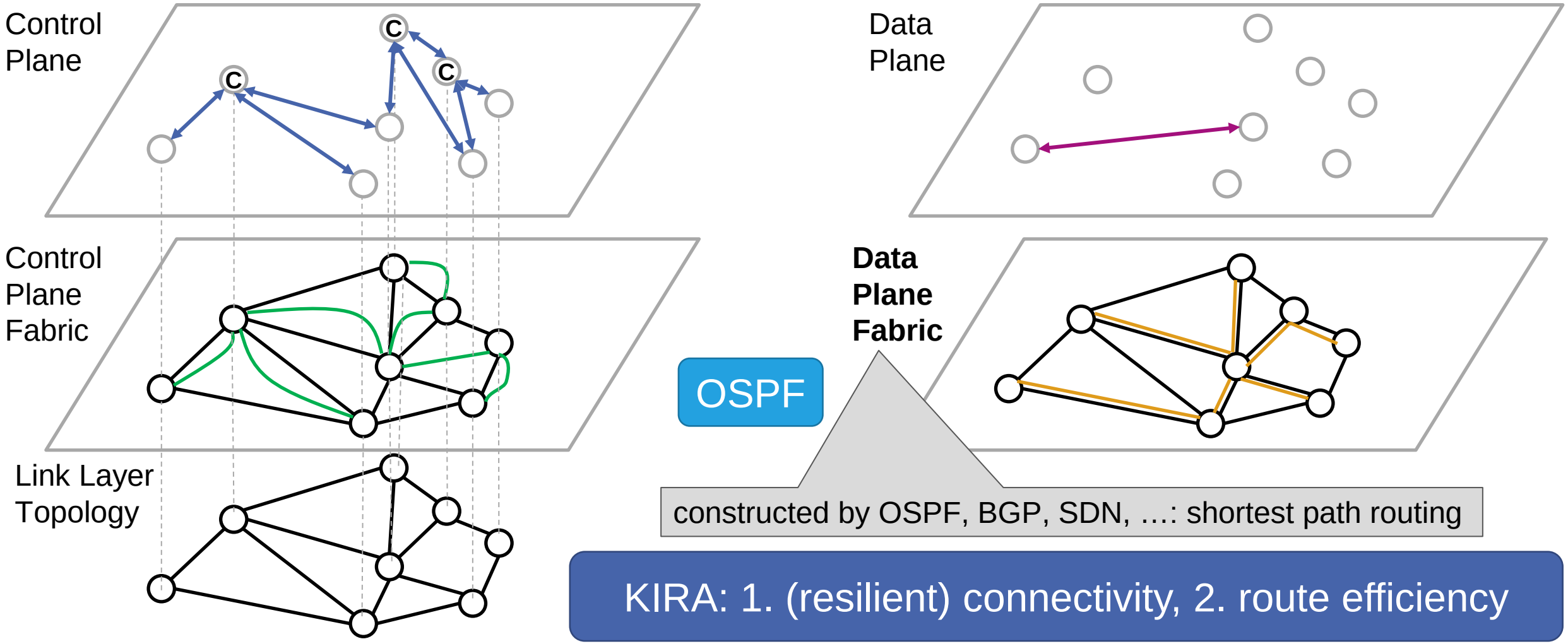
Control Connection
(e.g., Openflow, Netconf, REST, ssh)

constructed by KIRA
(provides connectivity between all resources)

Resource Element
(e.g., Switch, Router, Base Station, Server,…)

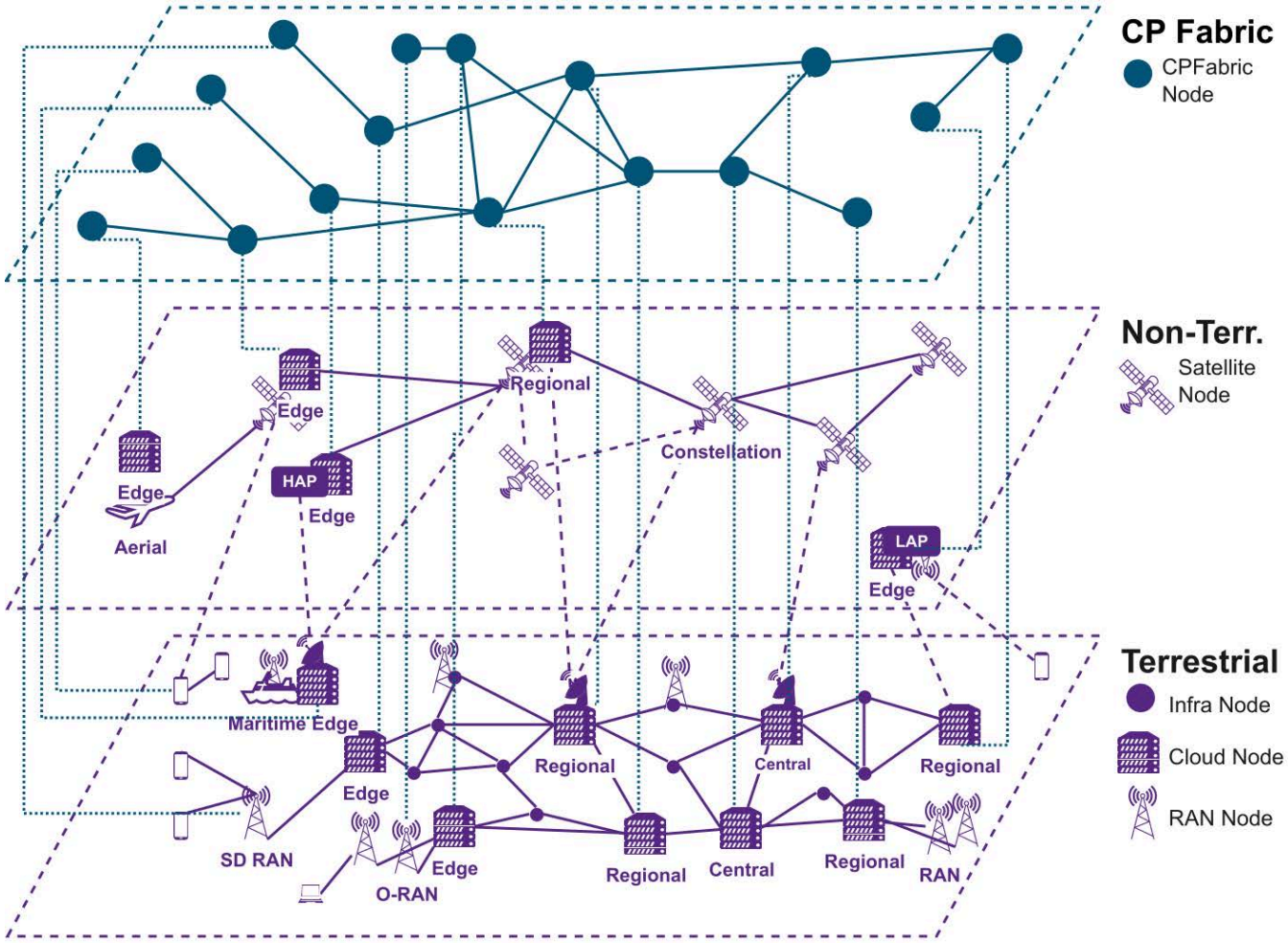
L2 Link

What KIRA provides…



Use Case – 6G Control Plane

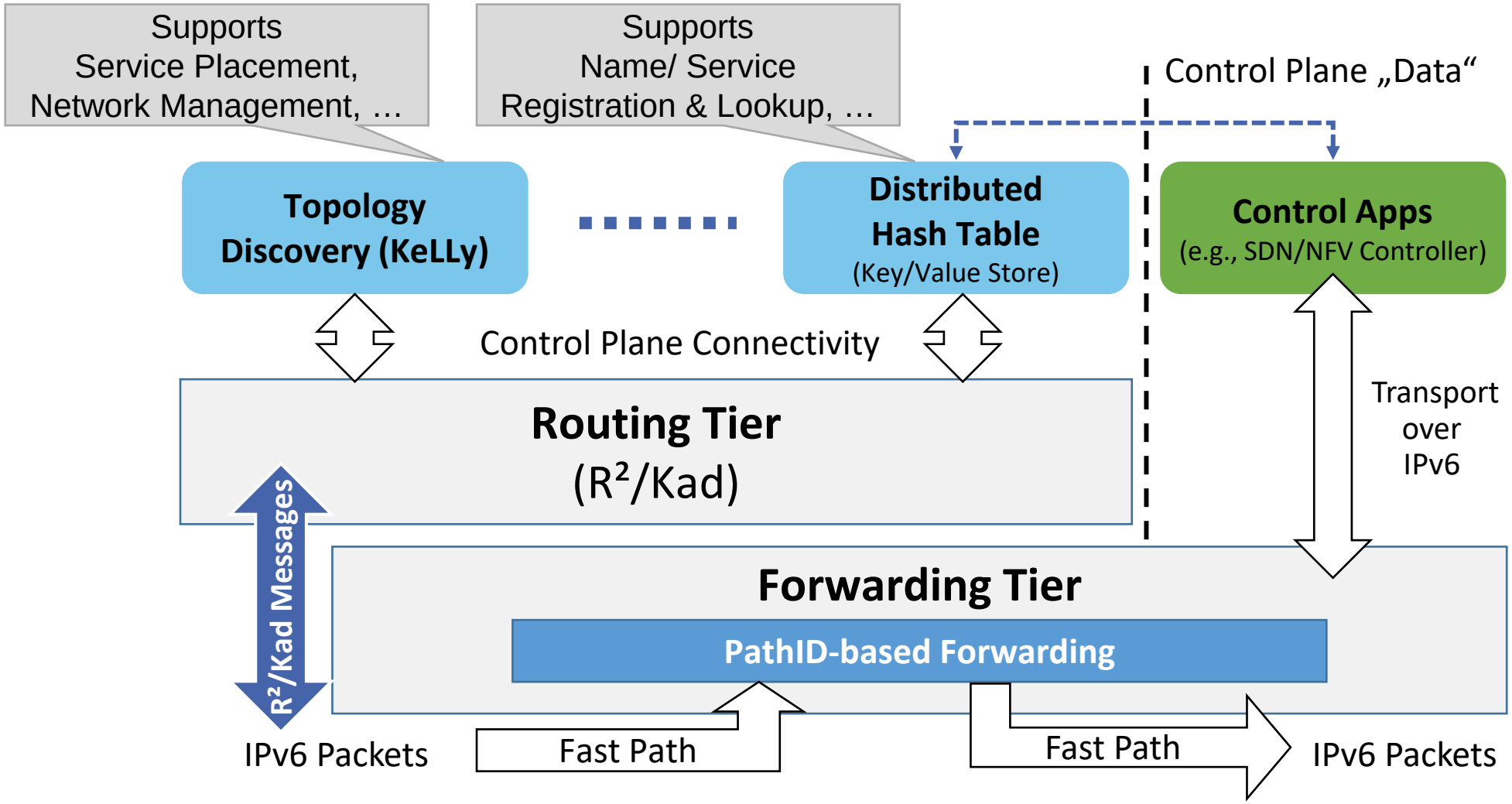
- Non-terrestrial Networks (Drones, Satellites)
  → dynamic and mobile
- Nomadic Networks
  → autonomous, self-organizing control plane
- 10^7 of base stations in China in a single provider network
  →scalability



Features

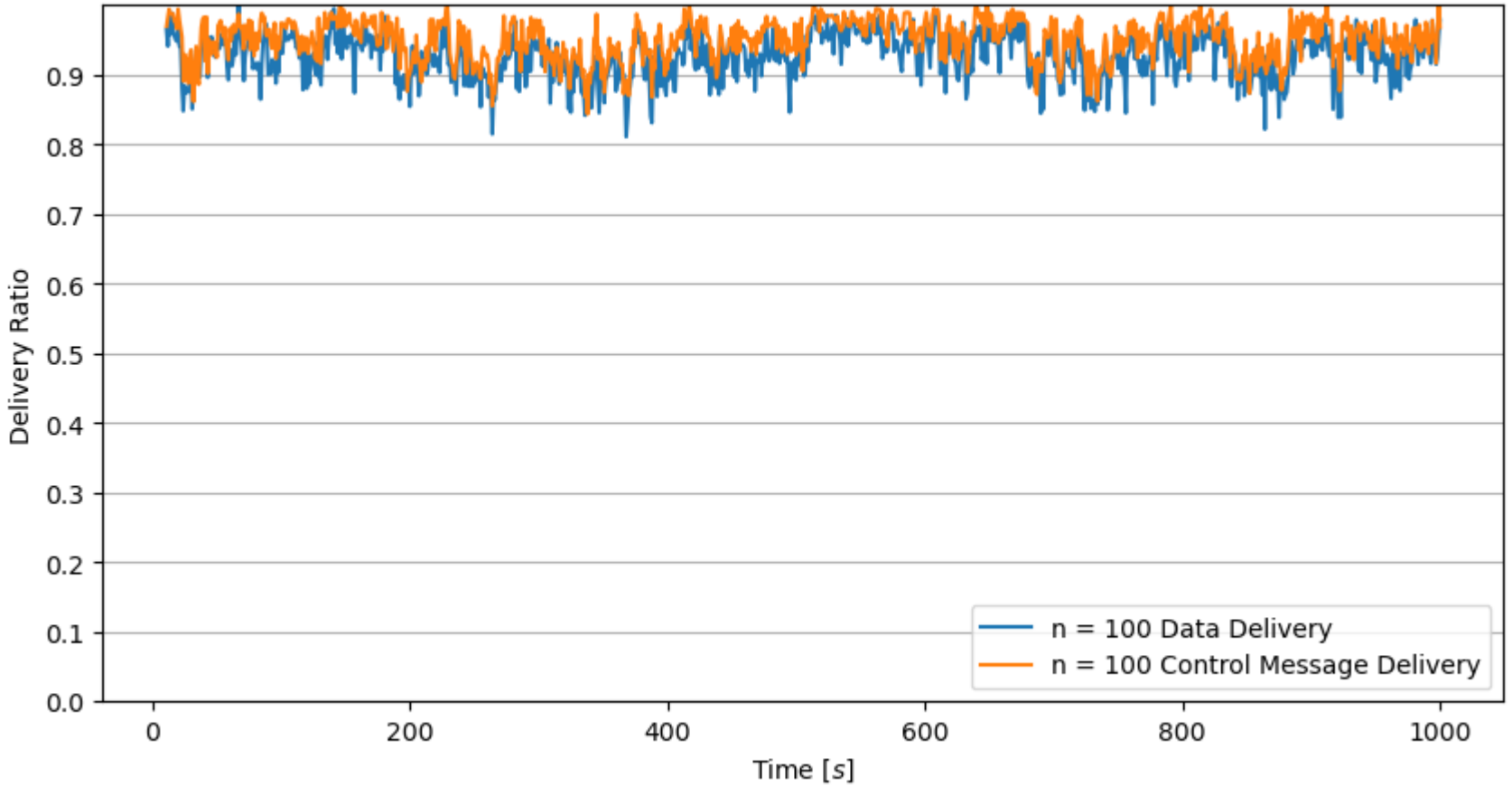
- Kademlia as ID-based Overlay (XOR metric)
  - 112bit NodeID
  - Similar to Virtual Ring Routing (that is less efficient)
  - Small routing tables – $O(\log n)$ n: number of nodes → Stretch
- Proximity Neighbor Selection and Proximity Routing
- Path Discovery (First Path, Later Path) + Path Rediscovery (Dynamics)
- Loop-free even during convergence
- Source routing for routing messages, PathID-based forwarding for data
- Multi-path capable
- Can provide additional services like key-value store and topology discovery

Architecture



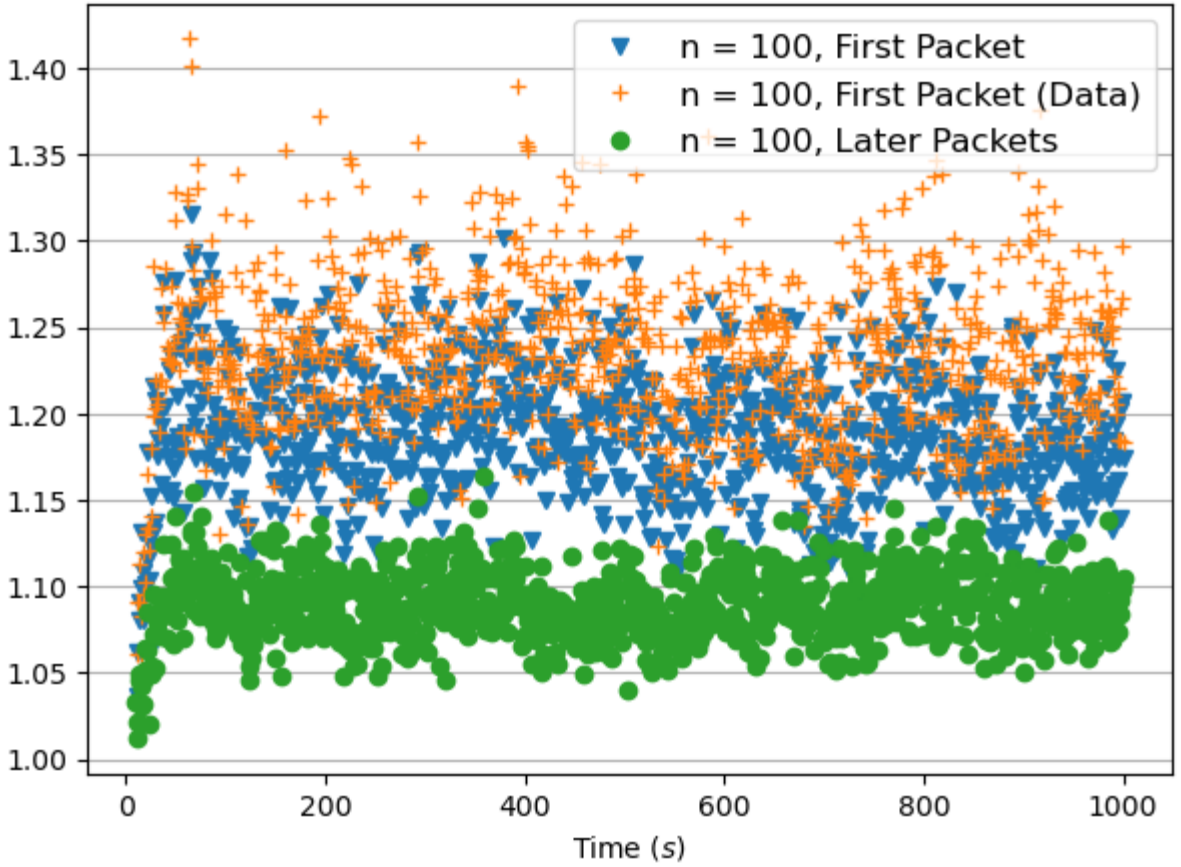
MANET Performance (1)

- 1000m², 100 nodes, RandomWaypoint v=[1,10]m/s
- PosUpdate=25ms
- Hello_min=100ms, Hello_max=1s
- No optimizations

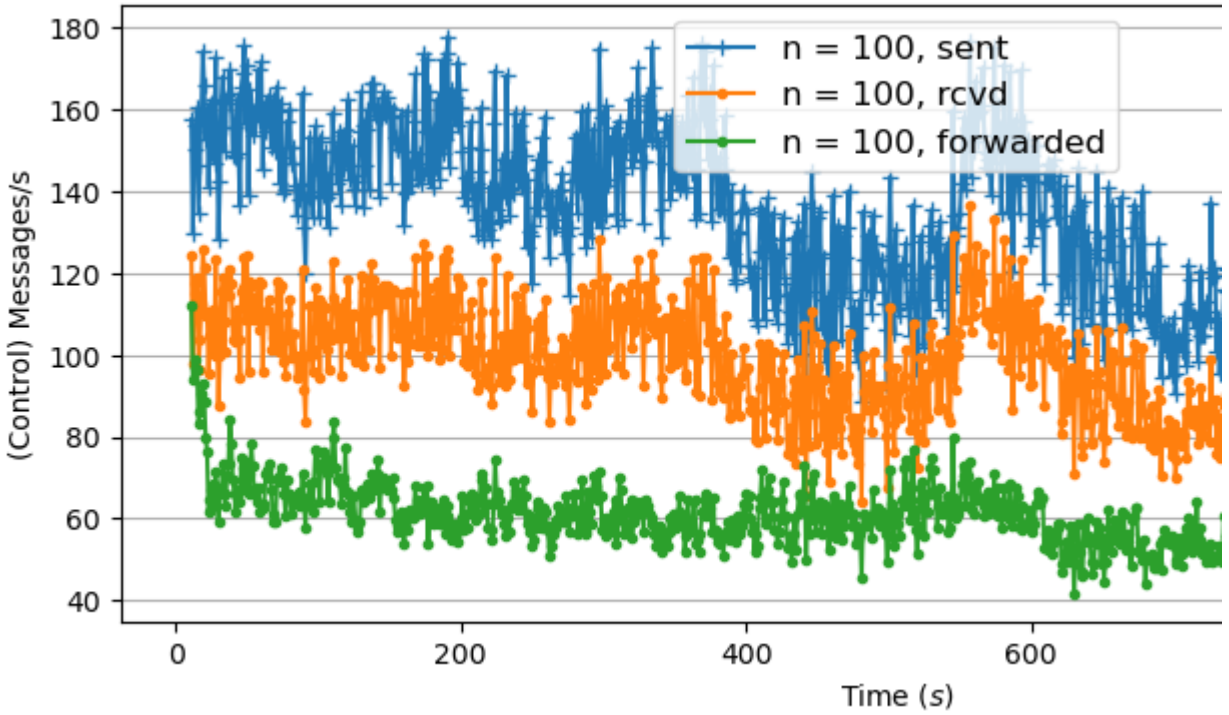


MANET Performance (2)

- Average packet stretch

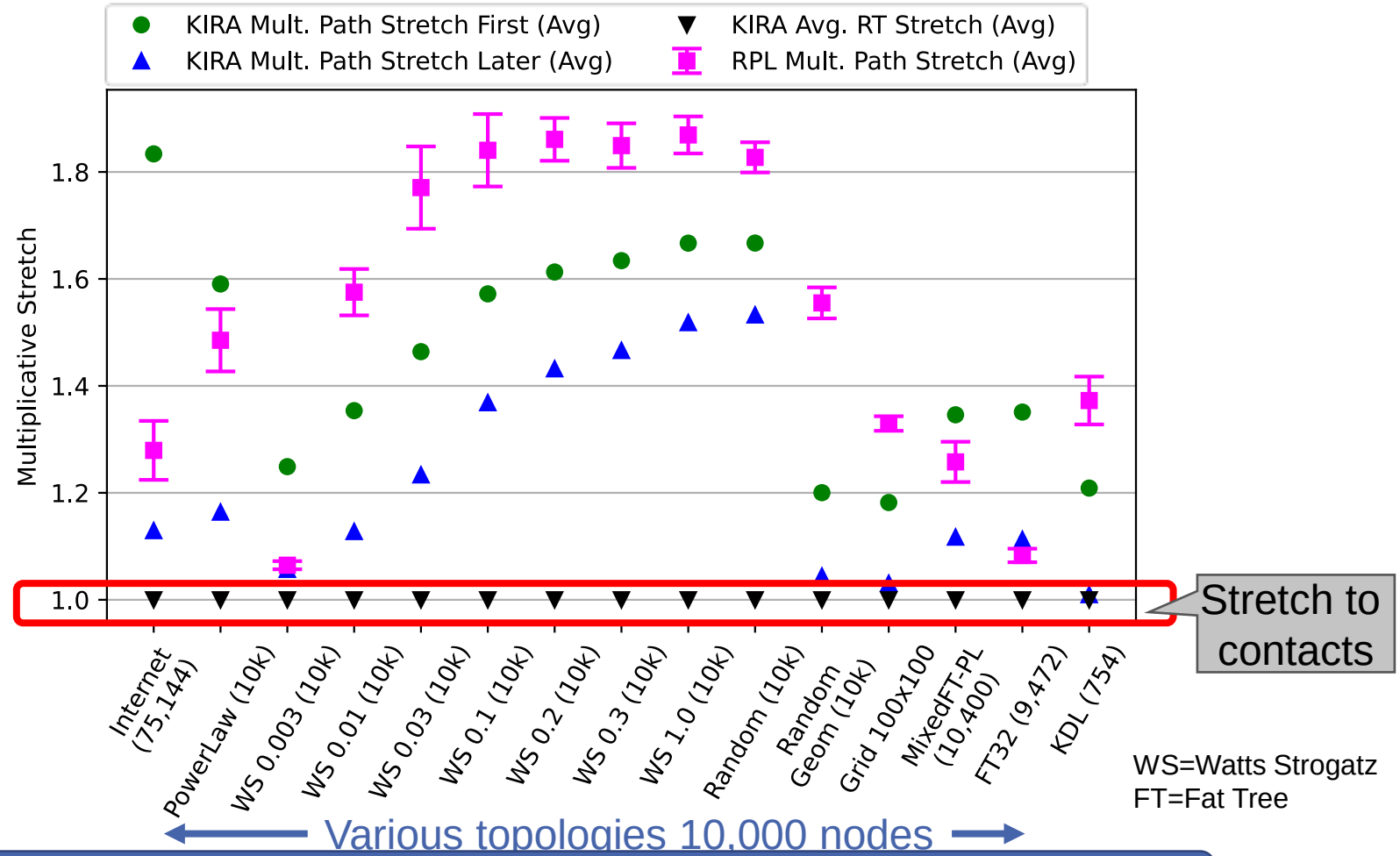


- Overhead



Stretch in Different Fixed Network Topologies

- Multiplicative Stretch
- RPL-ACP:
  - Storing-mode
  - Single DODAG
  - Single DODAG version



WS=Watts Strogatz
FT=Fat Tree

Low stretch across various topologies + Shortest paths to contacts

Please Support KIRA!

- Internet-Draft https://datatracker.ietf.org/doc/draft-bless-rtgwg-kira/
  - Updated to -01: added action descriptions for sending/receiving messages
  - Please provide feedback!
- Running Code available
  - Hackathon IETF 121
  - Native Routing Daemon Linux (Rust) → Zero-touch IPv6 Connectivity
    - Forwarding Tier uses nftables
    - Alternative eBPF implementation nearly complete
- Want IETF expertise
- Side meeting Wednesday Nov 6th, 19.00–20.00h, WMR 4
  - KIRA Intro, Q&A, collaboration, next steps towards standardization

https://s.kit.edu/KIRA