PLACEMENT AND ALLOCATION OF COMMUNICATIONS RESOURCES IN SLICING-AWARE FLYING NETWORKS

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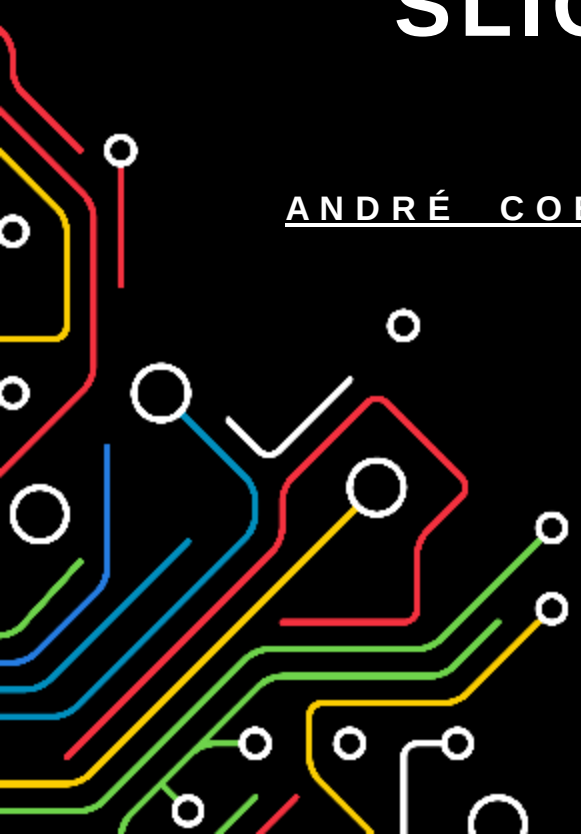

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Context

Motivation

System Model

SLICER Algorithm

Performance Evaluation

Conclusions

CONTEXT

- **Network Slicing** → different performance requirement on top of shared infrastructure
- **Mobile Network Operators (MNOs)** provide wireless infrastructure and slices
- **Service Providers / Virtual MNOs** act as tenants that exploit network slices
  - **Offer services to users** – e.g., video streaming, virtual reality, smart metering
- **Service Level Agreement (SLA)** → target service requirements defined at high level
  - Quality of Service (QoS) requirements, user density, coverage area, etc.

Mobile Network Operators (MNOs)

Network Slices

Service Level Agreement (SLA)

Service Providers or Virtual MNOs

Services

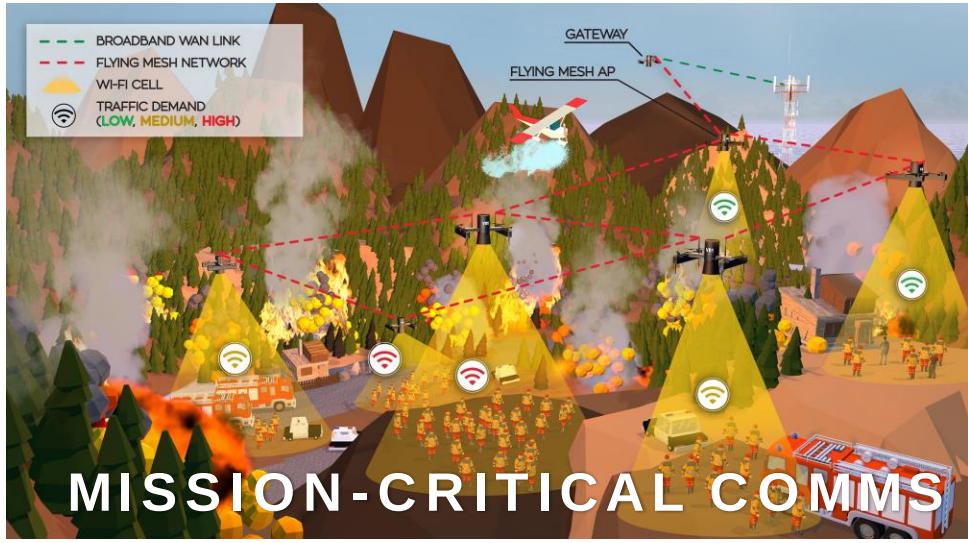
Users

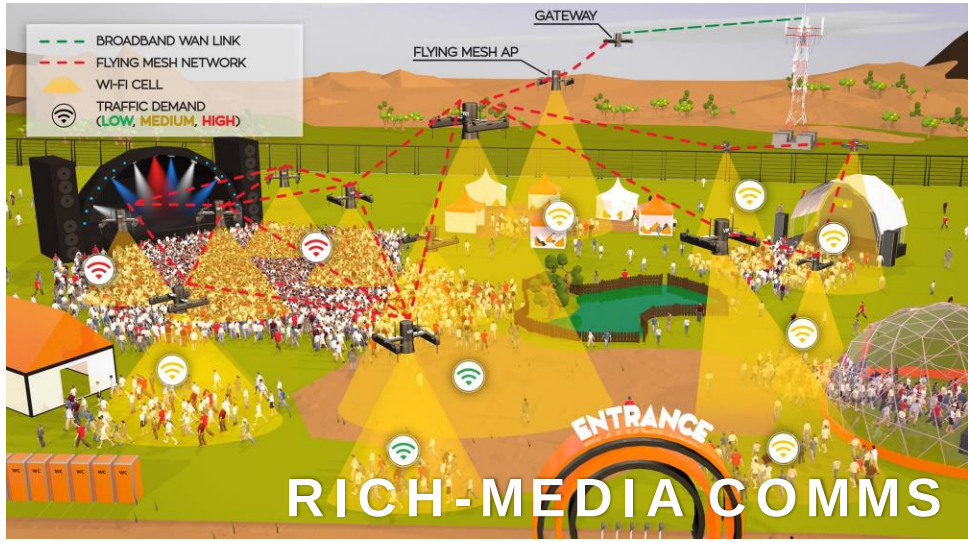
MOTIVATION

- **Fixed network infrastructures used by MNOs**
  - Demand for dynamic wireless coverage and resources
- **Temporary crowded events**
  - Insufficient coverage and communications resources
- **Flying networks using drones/UAVs**
  - Wi-Fi Access Points and 5G Base Stations
  - Maximize aggregate network performance (best-effort)

CHALLENGE

Flying network enabling **on-demand network slices** with **target coverage** and **heterogeneous QoS** levels





SYSTEM MODEL

- **Network made up of Flying Access Points**
  - On-demand Radio Access Network
- **Centralized paradigm (Edge/Cloud)**
  - Placement and allocation of communications resources

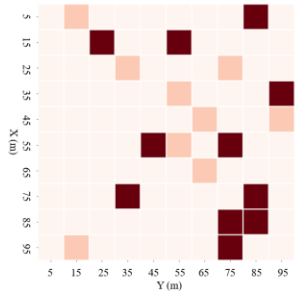
FAPs Positions and Comms Resources Configuration

Service Level Agreement (SLA)
- QoS levels
- User density
- Coverage area

Placement and Allocation of Comms Resources

Central Node (Edge/Cloud)

SLICER
ALGORITHM



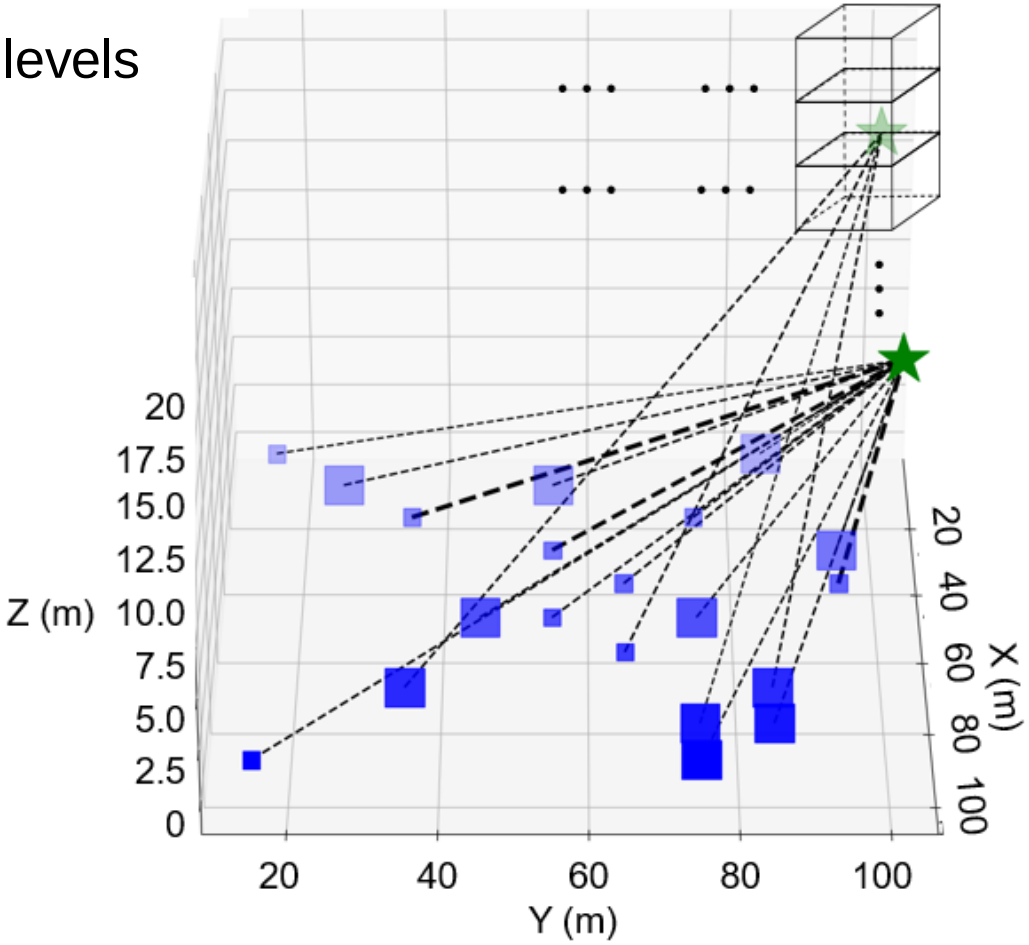
2 network slices (in orange and brown) available in different ground subareas

★ FAP / UAV ■ Ground user — Wireless link

Given
- Set of **network slices** with target coverage and QoS levels
- Set of **geographical subareas** to be served
- Set of **potential UAVs** in admissible positions

Determine
- Set of **UAVs to be used**
- **Association** between **UAVs** and **subareas**
- **Channel bandwidth** for each subarea

To minimize
- **Number of UAVs** to be used



PERFORMANCE EVALUATION

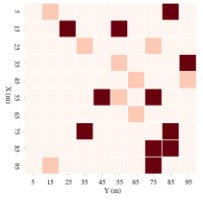
BASELINES

A. **One FAP for each network slice** with 160 MHz channel BW (IEEE 802.11ac)
   - **Independent network** for each network slice
   - FAP in **geometric center of all subareas** belonging to same network slice

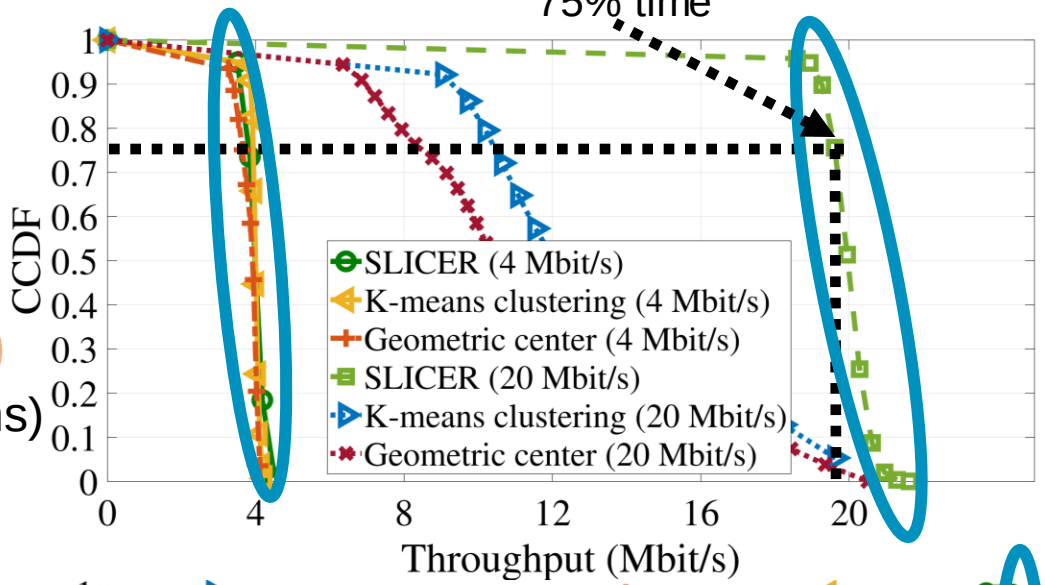
B. **|K| FAPs for each network slice** providing same channel BW as SLICER
   - K-means clustering algorithm forming **|K| clusters of subareas** per network slice
   - FAP in **geometric center of each cluster** of subareas

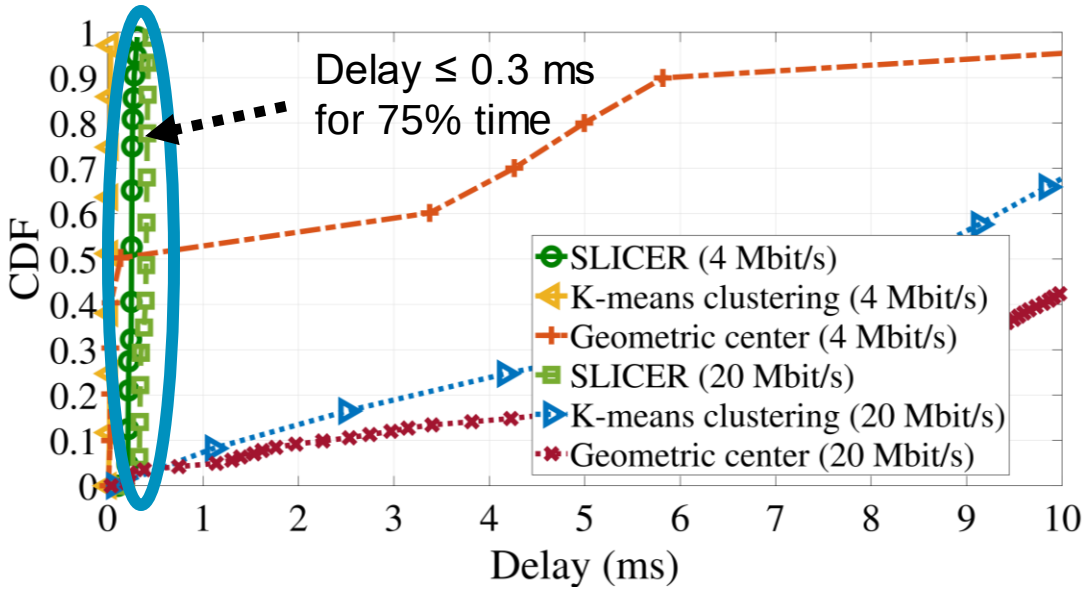
PERFORMANCE RESULTS

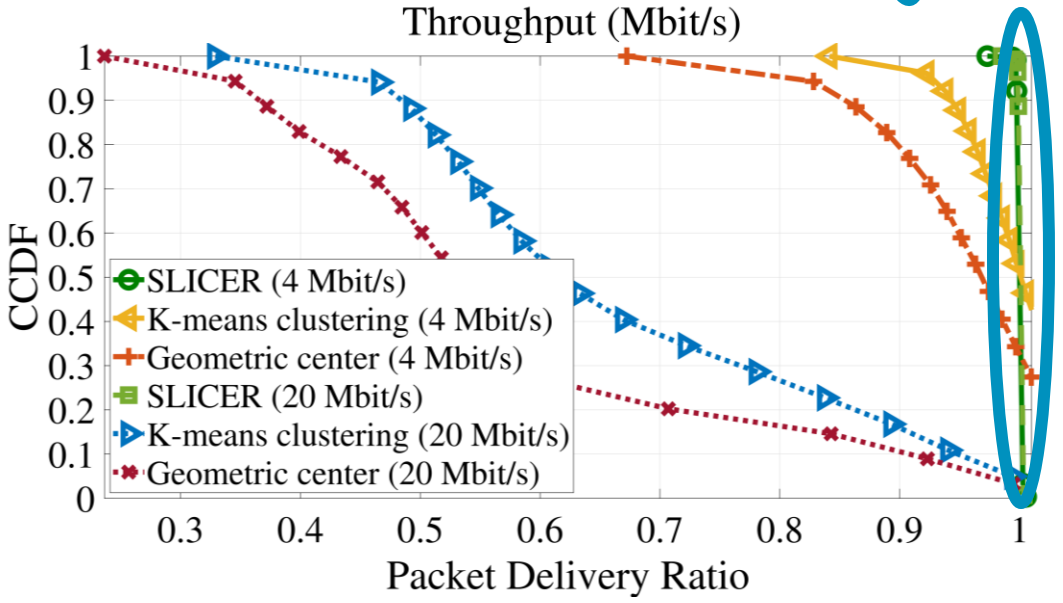
- 20 subareas
- **enhanced Mobile Broadband (eMBB)**
  - **20 Mbit/s**, 5 ms, 10^{-5} BER (e.g., video streaming)
- **Ultra-Reliable and Low Latency Comms (URLLC)**
  - **4 Mbit/s**, 1 ms, 10^{-10} BER (e.g., mission-critical comms)
- **SLICER meets QoS levels of network slices**



Throughput > 19 Mbit/s for 75% time

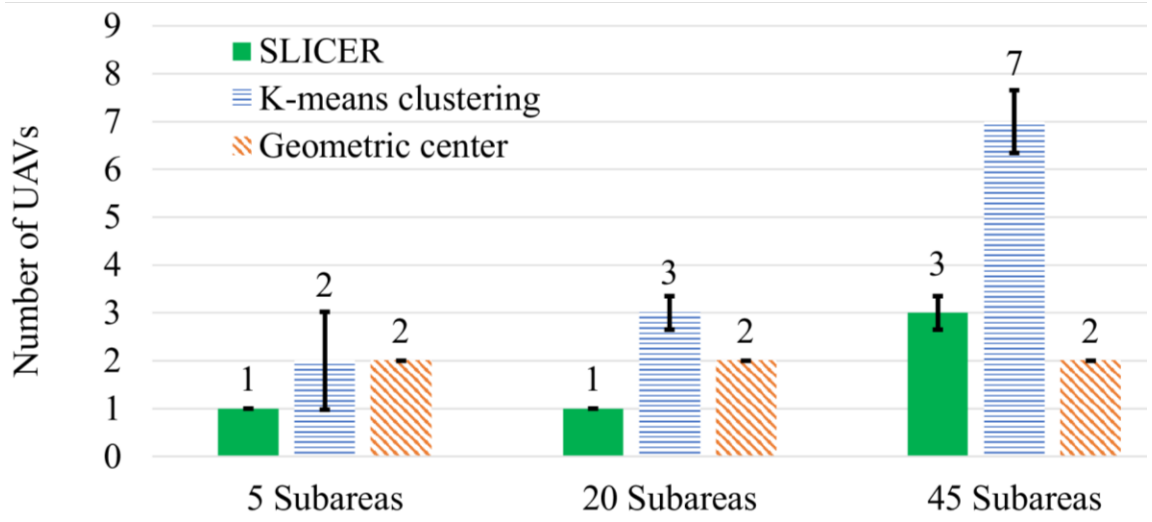


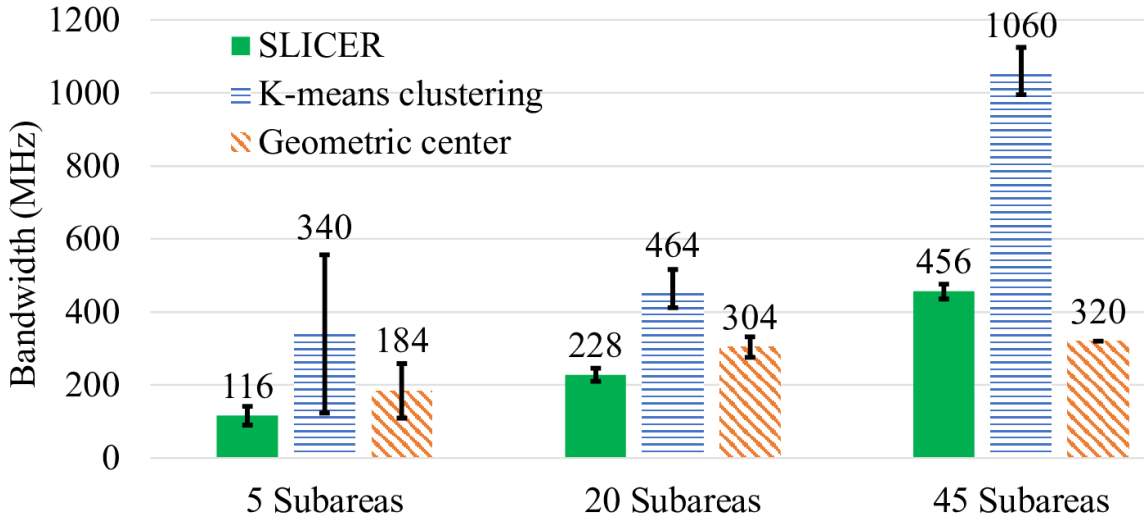




PERFORMANCE RESULTS

- **SLICER → reduced amount of comms resources used (UAVs and channel BW)**
- Geometric center → single UAV per slice with limited channel BW (up to 160 MHz)
  - QoS degradation as number of subareas per network slice increases
- **K-means** → highest number of UAVs and amount of channel BW
  - |K| FAPs, each using 20 MHz, maximizing SNR for each cluster of subareas





CONCLUSIONS

SLICER ALGORITHM

- On-demand placement and allocation of comms resources in flying networks
  - Minimum **number of FAPs**
  - 3D **positions**
  - FAPs **comms resources (channel bandwidth)**
- **Meets coverage and QoS levels for any number and type of network slices**

ONGOING WORK

- Development of a **slicing-aware flying network prototype** for experimental evaluation

THANK YOU!

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