Decentralized Internet Infrastructure
Overview of Potential Use-Cases and Drivers

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DINRG

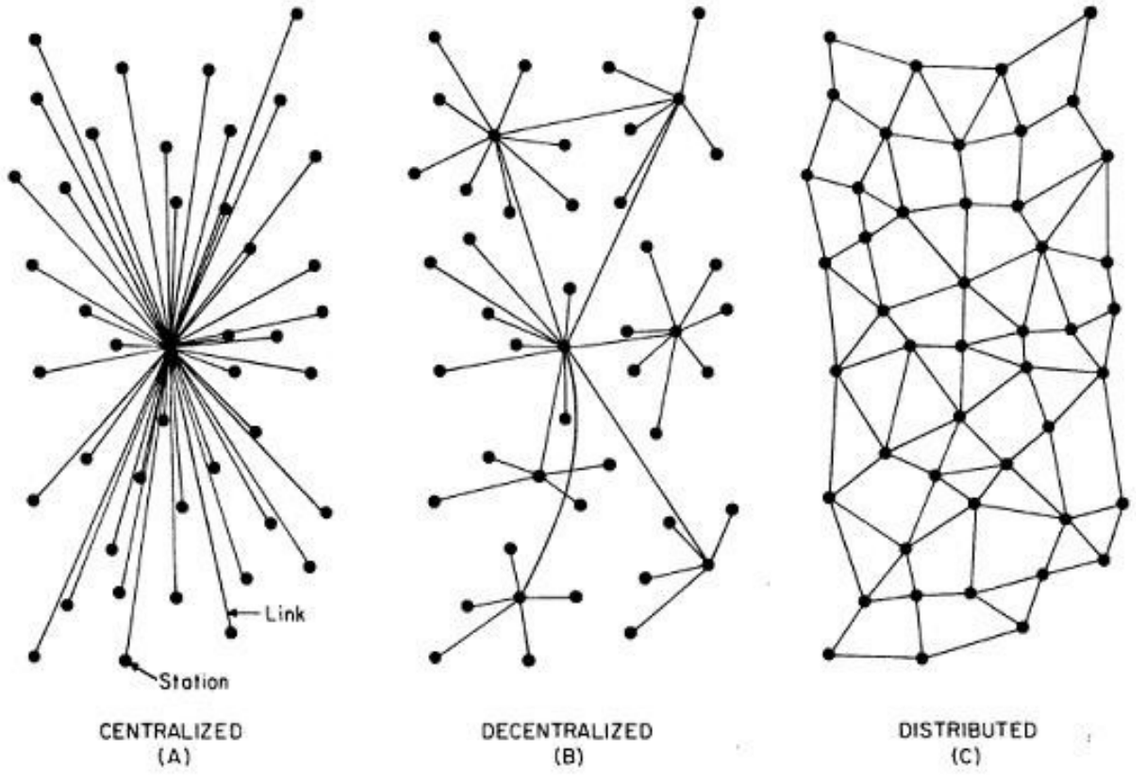
Terminology issues

Decentralized

- A distributed network of centralized networks.
- Stability: Finite points of failures.
- Management: Coordination of “head” nodes
- Scalability: Moderate
- Heterogeneous: Moderate

Distributed

- Each node is connected to various other peer nodes
- Stability: without single point of failure
- Management: Self-x
- Scalability: high
- Heterogeneous: High.



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Motivation

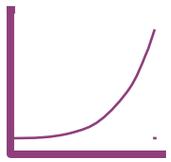
Need for Decentralization/Distribution

Avalanche of
Mobile Broadband

Expansion of traffic volume

Multi-tenant control

Robust Mobility management



“1000x in ten years”

Massive growth in
Connected Devices

Internet of Things

Density control

Diversity control

“50 billion devices in 2020”

Large diversity of
Services
&
Applications

Internet of People

Context awareness

Social Interaction Design

Simplicity

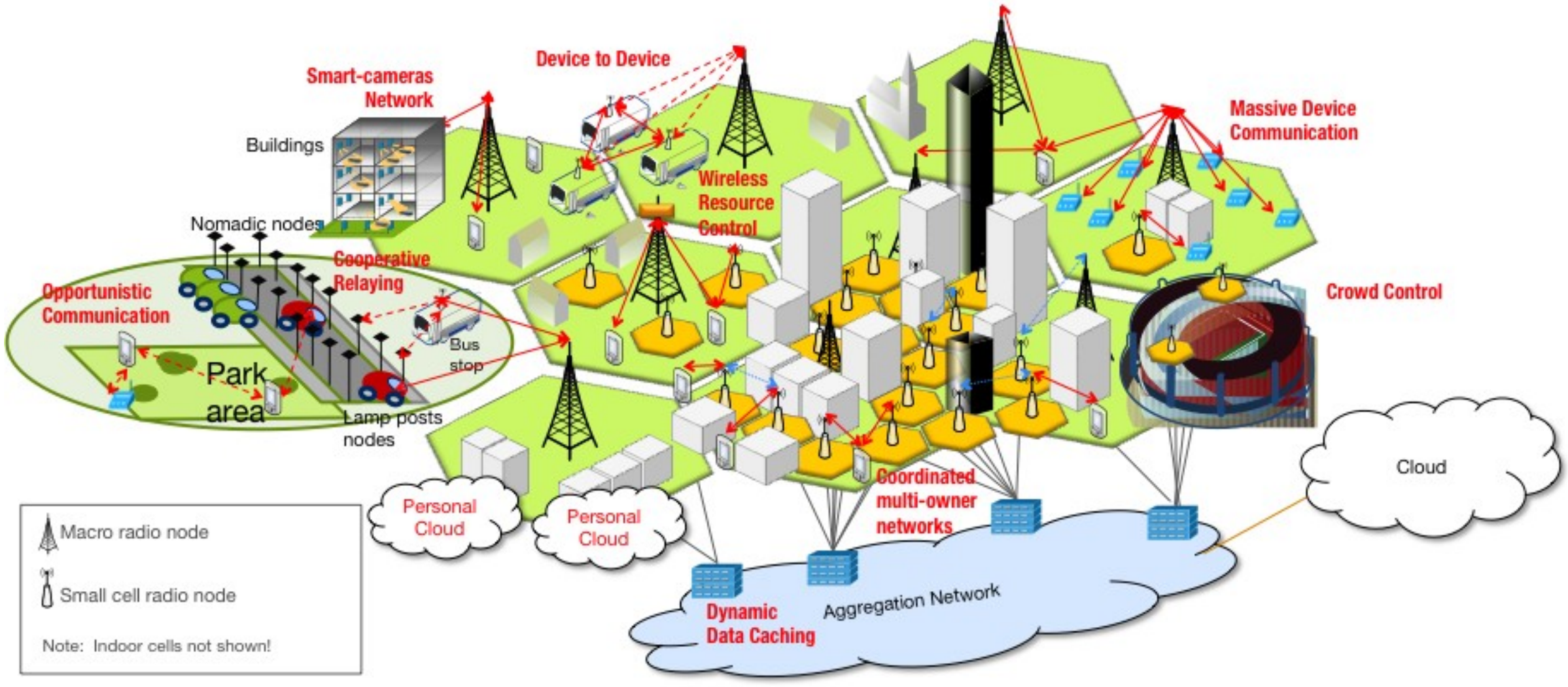
New requirements to allow fast adaptation to users’ daily life needs

Required Network Operation

- Higher traffic capacity and performance
- Higher energy efficiency
- Scalability
- Personalized networking services
- Support for a high number of mobile heterogeneous devices (e.g. IoT)

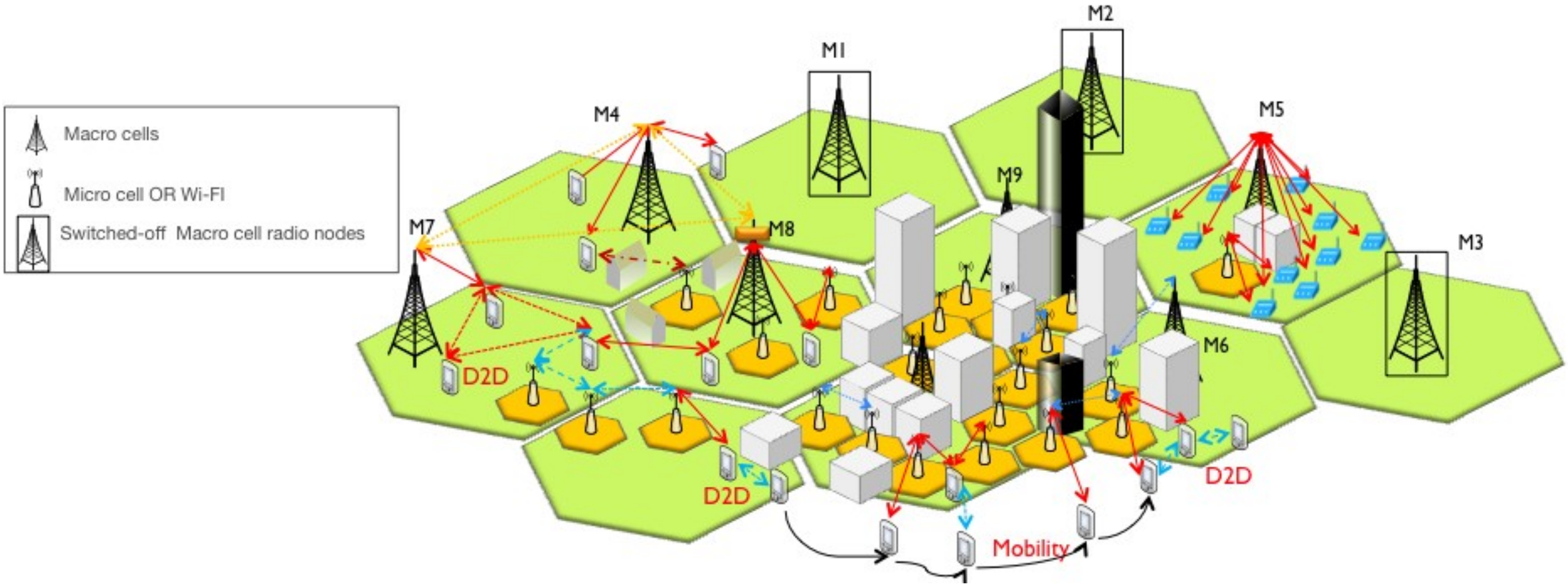
Network Services

Wide Perspective



Potential Use-cases

Personalized Network Experience

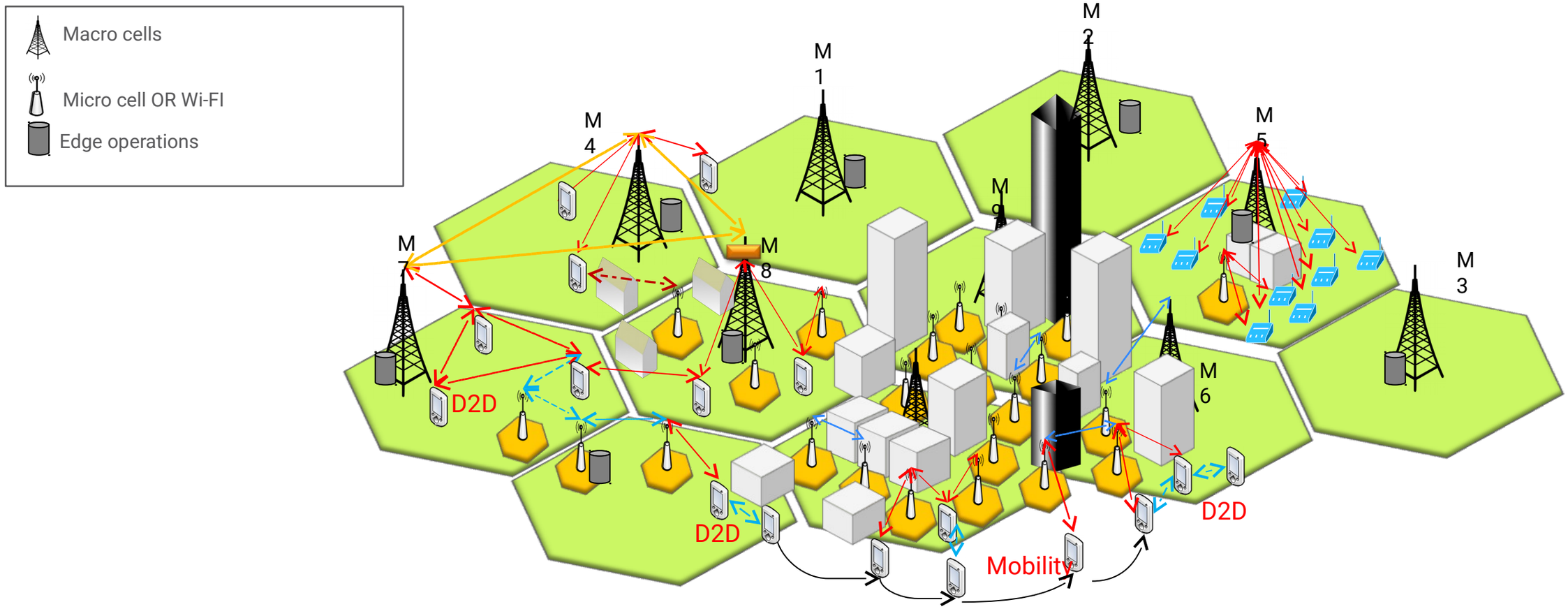


Baselines

- Operators collect data about the network and users' behaviour.
- Operators adjust network functions in real-time to adapt different operations to the users' communication needs (at least priority users)

Potential Use-cases

Edge Networking

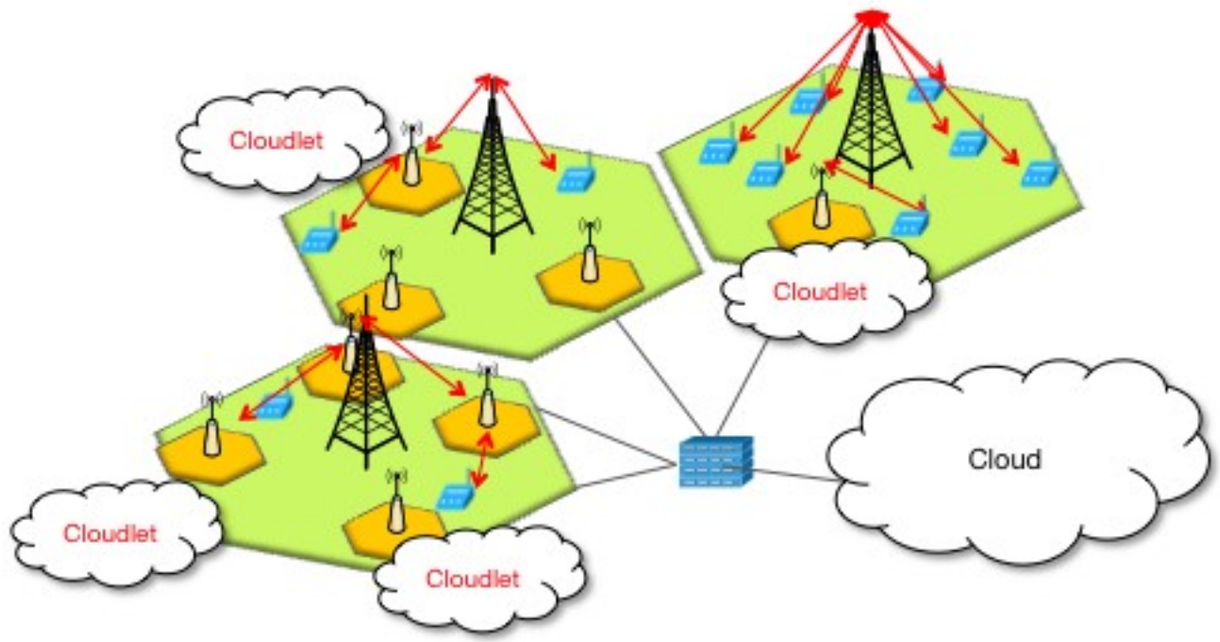


Baselines

- Edge data mapping and adaptation for better network resource usage.
- Ensures energy efficient mobility (fine tuned of handover execution).
- Traffic steering among multiple network service classes.
- Self-healing after detection of service degradation.

Potential Use-cases

Distributed Edge Computing for Scalable IoT



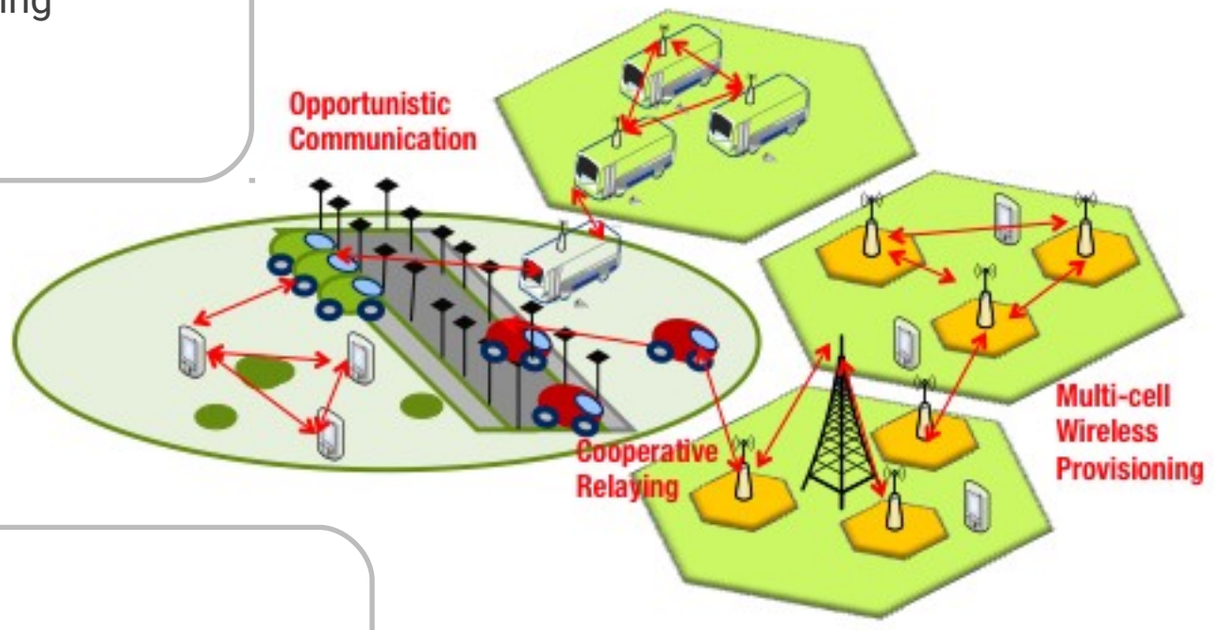
Baselines

- Distributed Operation
  - Data is kept by the data owner
  - Data is shared based on service agreements
  - No central entity has access to a large set of data
- Data Access Locality to reduce latency of operations:
  - Placing correlated data together.
  - Placing frequently accessed data close to the requester.
- Distribution of computation effort to balance resource utilization:
  - Based on awareness about workload patterns (e.g. data consumption patterns, user mobility patterns).
  - Allocation of computation tasks to balance load across all network nodes.
- Availability:
  - Data can be replicated depending on probability of node failure.
  - Data queries should be aware of nodes energy constraints.

Potential Use-cases
Wireless Networks

Name-based Opportunistic Communication:

- Local decisions about forwarding/routing
- Decentralized name verifications
- Decentralized Trust management



Cooperative Relaying:

- Local selection of best relaying nodes
- Relay switching for higher resilience
- Interference reduction

Multi-cell Wireless Provisioning:

- Every cell is aware of the available resources of other cells in its neighborhood over time.
- Solve interference and frame collision; the exposed terminal problem; the 802.11 anomaly.

Potential Drivers

Cooperation Incentives, Trust Management, Consensus

Trust Management

- Dynamic circles of trust.
- Based on reputation mechanisms.
- Identification of misbehaviors.
- High trust levels lead to more opportunities of cooperation.
- Virtual Identities: Crypto-ID.
- May prevent scalability.

Cooperation Incentives

- Avoid scalability issues and the appearance of disjoint groups.
- Cooperation with un-trusted devices.
- Based on a custom virtual currency system.
- Based on cooperation credits which, once earned, can be used to obtain services/resources.
- Penalization of cooperation misconduct.
- Cooperation may increase the reputation of the involved parties.

Consensus

- Reaching an agreement on a certain quantity of interest that depends on the state of all agents.
  - Ex. optimization of different network functions.
- Based on classification of time/ spatial patterns of data flows.
- Relies on the self-organization and cooperation.
  - E.g. swarm Intelligence optimization.
- Investigation needed to allow a completely distributed operation.