**Motivation**

Problems with centralized architecture of urban IoT:
- Overloads central processing cloud
- Bandwidth consumption is extremely high
- Significant increase in latency of response
- Overloads the wireless edges and routers of networks
- Redundant information flow
- Causes coexistence problem of IoT applications with traditional traffic

**Solution: Multi-scale Architecture**

- E-UTRAN
- LTE licensed, D2D underlay (LTE ProSe)
- Network Assisted: D2D underlay devices supported by E-UTRAN
- Network: Data and video streaming

**Interconnect Computation & Network Control**

- Multinet Control => Individual network control
- Select a subset of devices to interconnect
- Interconnection is a function of time
- Delegate control to Edge with a QoS requirement Q
- Q is also a function of time

**Coexistence Problem:**
- Heterogeneous communication technologies share spectrum, causes interference

**Wireless Coexistence and Interference**

- Example:
  - 2.4 GHz: WiFi, Bluetooth, ZigBee
  - 5 GHz: WiFi and WiFi-Direct, WiFi and LTE unlicensed (5G)
  - LTE licensed, D2D underlay (LTE ProSe)
- Solutions:
  - Allocation of dedicated resources: **Inefficient**
  - Control interference at physical layer:
    - Complex to implement
    - Difficult to exchange control information across heterogeneous communications technologies
  - Cross-layer Control at layer 3 or higher:
    - Protocol delay, packets out of sequence

**Use case scenario**

- A video surveillance application coexisting with data communications
- Video over LTE & Data over D2D underlay of LTE in the same spectrum
- D2D underlay in LTE spectrum:
  - Proposed in 3GPP vol.12
- Network Assisted: D2D underlay devices supported by E-UTRAN
- LTE network
- Video streaming

**Interference Control Strategy**

Optimization Problem: Maximizing D2D throughput under constraints on video quality

- \( \min \{ T_{D2D}(p) \} \) s.t. \( R_{D2D}(p) \) ≥ requirement

- Heuristics for optimal policy:
  - FDTP (Frame Dependent Transmission Probability):
    - D2D Tx probability which is a function of transmitted frame
    - Tx Power and Channel access schemes are function of video
    - Only statistical knowledge of the channel needed
  - Baseline strategy: Fixed Probability (FP):
    - D2D is agnostic about frame type of the video
    - Tx Probability of D2D is constant for all conditions

**Conclusion**

- Content and computation aware wireless protocols supports coexistence of heterogeneous applications
- Aims at better support for real time Urban IoT services while maintaining or improving QoS for the traditional services.
- Constraints:
  - The Edge computing processor should have capability to decode the content and evaluate the quality requirement
  - Heterogeneous interfering wireless technologies should be able to communicate for better spectrum utilization

**References**