NSF Joint CSR/NeTS PI Meeting 2019

-Spectrum Management in 5G and beyond

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Session abstract

- When it comes with 5G, especially with requirements such as high node density, high heterogeneity, massive connectivity, ubiquitous coverage, low latency, high capacity (with mmWave or even Tera Hz bandwidth), the complexity of resource nad spectrum management goes up tremendously.
- Deployment paradigms such as licensed spectrum, shared spectrum, and unlicensed spectrum at different possible bands such as sub-6 Ghz and mmWave can be supported.
- Motivated by the increasing computational capacity of wireless local devices as well as the ever increasing concerns on sharing data due to privacy and security, next-generation communications/computing networks will encounter a paradigm shift from conventional cloud computing to edge computing, which largely deploys computational power to the network edges/fog nodes to meet the needs of applications that demand very high computations and low latency.
- This session will focus on 5G and beyond resource management and spectrum management as well as how to leverage the edge computing to enable distributed resource allocation and spectrum management. How cloud/edge computing platforms facilitate the research and development of distributed machine learning for radio resource and spectrum management

Topics

- Distributed/collaborative/centralized full band radio map configuration – how to leverage edge/local nodes
    - Fast and reliable spectrum monitoring: fast, accurate, reliable; detect anomalies
    - Data used to identify waveform, interference, usage pattern, channel characterization (e.g., for tailed channel models), technology identification, latency, what else;
    - How to build up network/system level model that integrates what has been learned;
    - ML, distributed learning, collaborative learning, and transfer learning: time/frequency/location;
    - Block chain techniques
    - how to calibrate and how to validate;
- LSA, LAA, LWA, LTE-U: research issues such as learning based co-existence
- Rural area spectrum management
- Performance metric when evaluating spectrum sharing
- New Interference issues when doing spectrum sharing at various bands.
- Solutions for High mobility contexts: high speed rail, vehicles, drones, etc
- New applications 5G and beyond can enable
- Domain specific integration tailored to applications
- New research issues and challenges in Terahz: from access to core
- Research and challenging issues when sharing for example radar military band:
- New ML based access/core resource (communication, computing, cache/storage) management that improve spectral efficiency/latency/power when considering massive connectivity, high density, low latency, etc. => connected intelligence of machine learning in enabling better 5G services – how to leverage edge/local nodes

Radio Environment Map

- Radio environment map is a really powerful concept, but we have not fully exploited in many dimensions. Like channel model for UAVs, spectrum sharing for satellites, new territory, propagation in 3-D space, really tough to collect that data.
- Local AI, build local models, rather than sending the raw data. Federated learning. Learn from your neighbors, and it is cheap. A lot prior knowledge you can take advantage of. You do not have to learn everything from scratch.
- Speeds, convergence issues, given the extremely wide band (to TeraHertz). Federated learning. Learn from your neighbors. A lot prior knowledge you can take advantage of. Do not have to learn everything from scratch.
- Is it possible to create a general (3-D) dataset for community to share – yes PAWR is planning for that
- Channel models: how to use it and how to calibrate/validate channel models learned
- etc

Spectrum sharing, coexistence, what the new performance metrics?

- We had latency, air rate, mobility, spectral efficiency b/s/hz, etc. We are talking about a whole range of metrics. Anything specific (new) to capture the sharing efficiency?

Solutions for High mobility contexts: high speed rail, vehicles, drones

- Low band for mobility anchor and high band capacity
- As trajectory can be predictable, high band can be explored as well.
  - Relay, cluster of beams, dual connectivity, etc

Rural area spectrum management

- Should rethink regulation - Expensive to deploy infrastructure, although spectrum could be free.
- For really rural areas, satellite can be used. Low orbit satellites, latency should not be a problem.
- Beamforming, free space optics, mmWave for backhaul
- Coverage, mobility – all challenging issues in rural

Others

- How to realize efficient network slicing?
- NB-IoT: challenges from IoT co-existence with high power devices.
- Spectrum policy issues:
- Autonomous vehicles:
  - Rural: V2V
  - Urburn: can only use V2I