

Network Assisted Spectrum Coordination for Heterogeneous Radio Coexistence

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Motivation

- ◆ Rapid growth of mobile data is leading to imminent spectrum scarcity
- ◆ Fundamental change in spectrum usage: Towards dynamic, shared and 'smarter' schemes
- ◆ Agencies looking at more open access bands

TV White Spaces:   

- ◆ Multiple Standards under development:

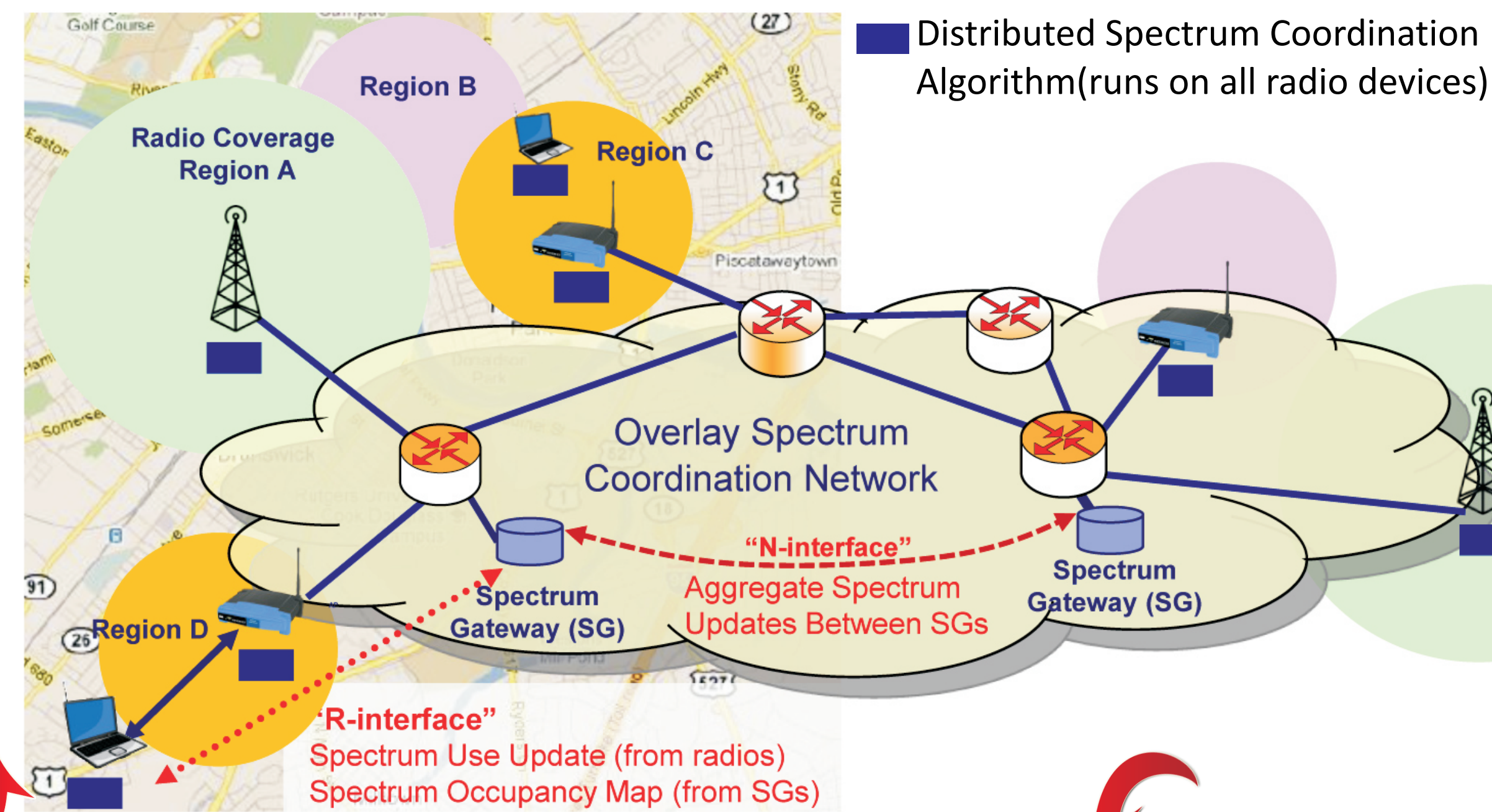
   

Aim of this project:

Enable co-existence in the shared spectrum by using back-end network connectivity

Network Assisted Spectrum Coordination: Concept

Ubiquitous Internet connectivity of access points and base stations provides a unique mechanism for spectrum coordination architecture



Spectrum Coordination Steps

1. All devices update in-network Spectrum Gateways with usage parameters
2. Spectrum Gateways aggregate and relay neighborhood spectrum report to each radio device it serves
3. Information is passed between gateways if required
4. Devices select spectrum parameters by running a Distributed Spectrum Coordination Algorithm

Major Components of the System

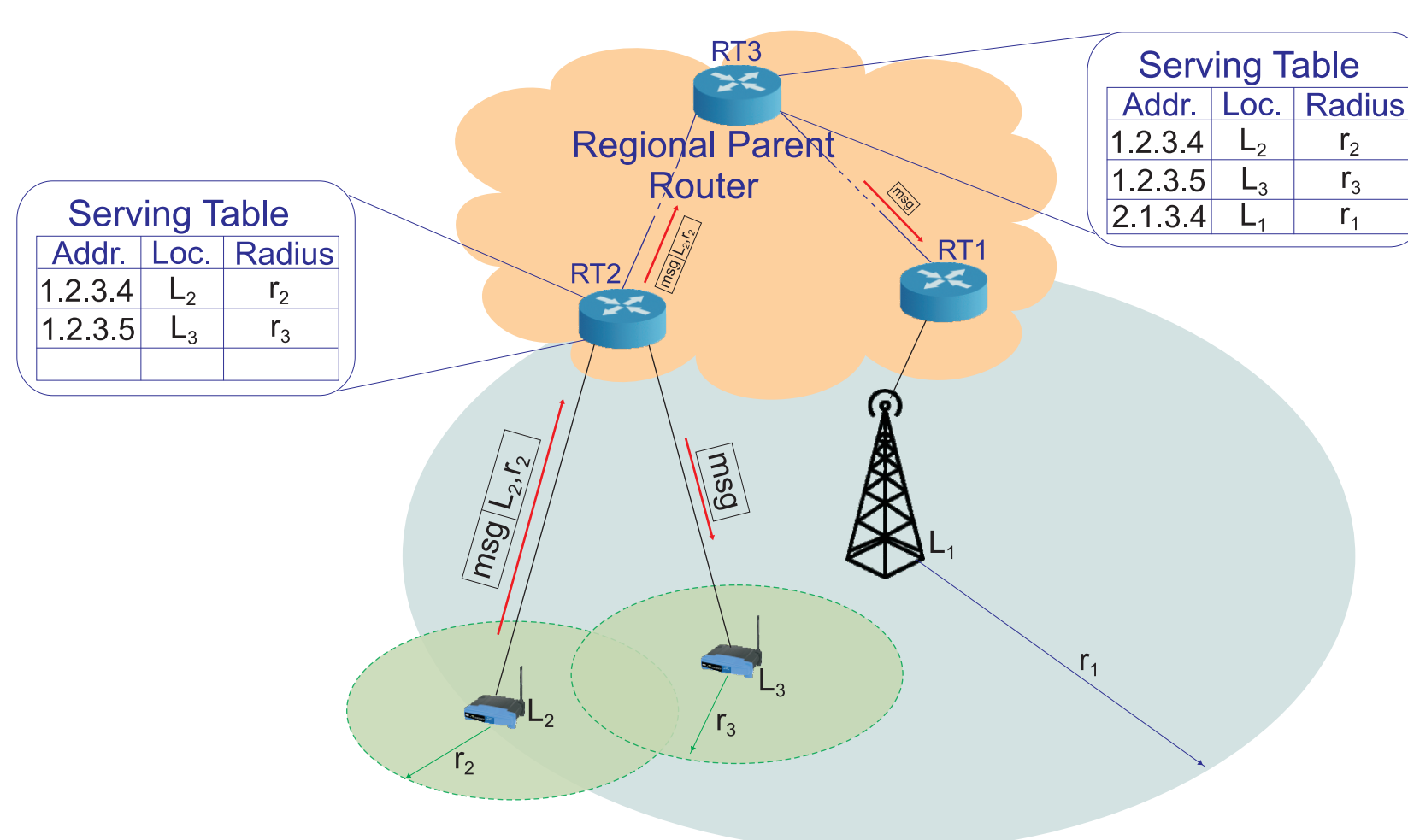
Characterizing Radio Interference

- ◆ Interference in wireless systems is traditionally measured in terms of interference power
- ◆ However in multi-radio environment, different types of interference can have different impacts even with the same average interference power

Our Approach:

1. Derive a set of transmission parameters (power, hopping nature, duty cycle, MAC behavior, etc.) that affect interference
2. Define new metrics, e.g. Impact on Throughput which can characterize the impact of interference as a function of these parameters

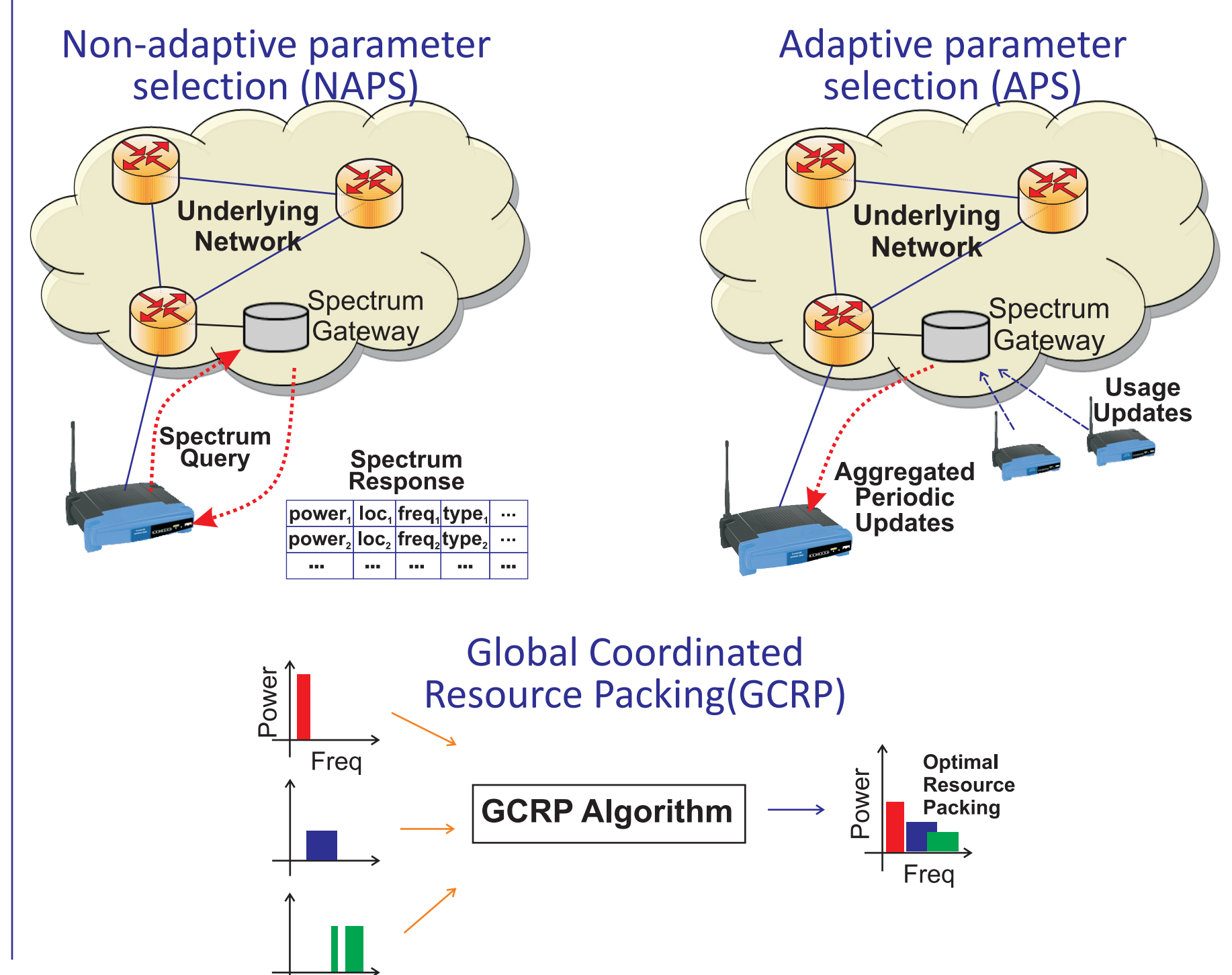
Spectrum Usage Dissemination Protocol



Region-of-interest based geocast to relay spectrum update messages to only neighbors which affect or are affected by a radio device

Distributed Co-existence Algorithms

Many Options:



Research Plan and Evaluation Metrics

Semi-independent design, development and prototyping of the key building blocks:

1. Interference Characterization:
 - Explore broad range of alternatives to define the final set of parameters for characterizing the radio interference for different kinds of interferences
 - Metrics: Impact on Throughput (IoT), Estimation error
2. Spectrum Usage Dissemination Protocol:
 - Verification of correctness of region-of-interest based geo-casting scheme
 - Metrics: Stretch factor, Traffic overload
3. Distributed Coordination Algorithms:
 - Comparative evaluation with no-coordination and central server based co-ordination approaches
 - Metrics: Spectral packing efficiency, Overhead vs. Throughput tradeoff



Experimentation Platforms: ORBIT multi-radio testbed, USRP2 GNU Radios, NS2 Simulation, Analytics

Conclusions

- ◆ Project focused on enabling efficient spectrum sharing by leveraging network connectivity of heterogeneous radio devices
- ◆ With multiple TV White Space standards being drafted, proposal is timely and high-impact
- ◆ The solution provides a distributed framework for co-existence of heterogeneous radios without the need for secondary transmitters or centralized spectrum allocations
- ◆ Approach is scalable with increasing number of devices trying to co-exist in a region
- ◆ Project in initial phase, with detailed evaluation and prototyping planned spanning 18 months