



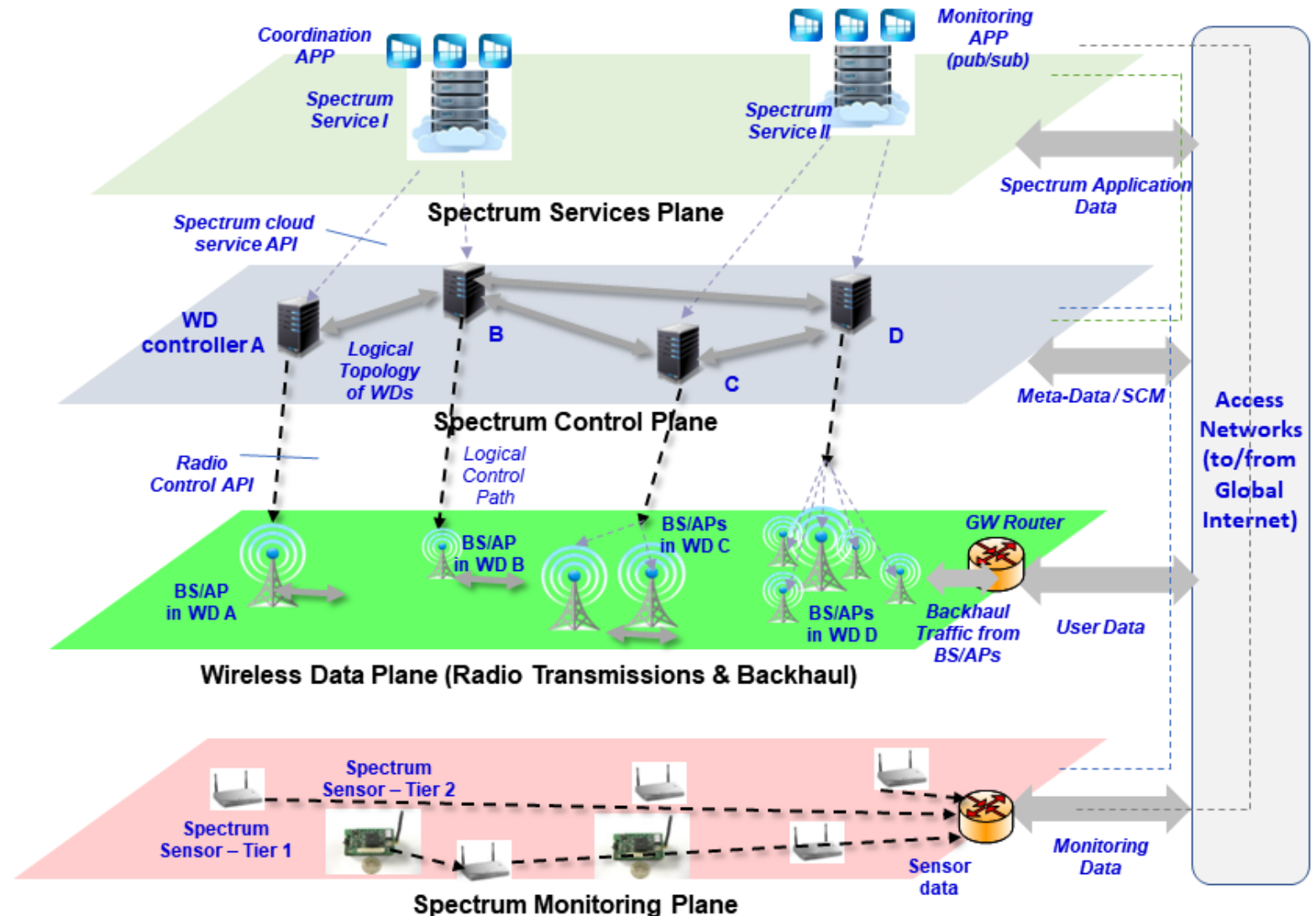
NewSpectrum: Distributed Data-Driven Spectrum Management Architecture

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The D3SM Architecture

This project focuses on the design and validation of a distributed and data-driven architecture for dynamic spectrum management among decentralized and heterogeneous wireless systems: *The distributed data-driven spectrum management (D3SM) architecture*



Main Objectives

Collaboratively develop and experimentally validate a distributed data-driven spectrum management architecture that will enable dynamic, and fine-grained flexible spectrum management interactions for:

- a) Spectrum sharing and co-existence among heterogeneous devices/systems
- b) Fine-grained management of interference, including aggregate interference effects to support high spectrum efficiency/reuse
- c) Supporting centralized and distributed spectrum sharing coordination methods
- d) Enabling experimental validation of methods and algorithms proposed to meet the previous listed goals (a) to (c).

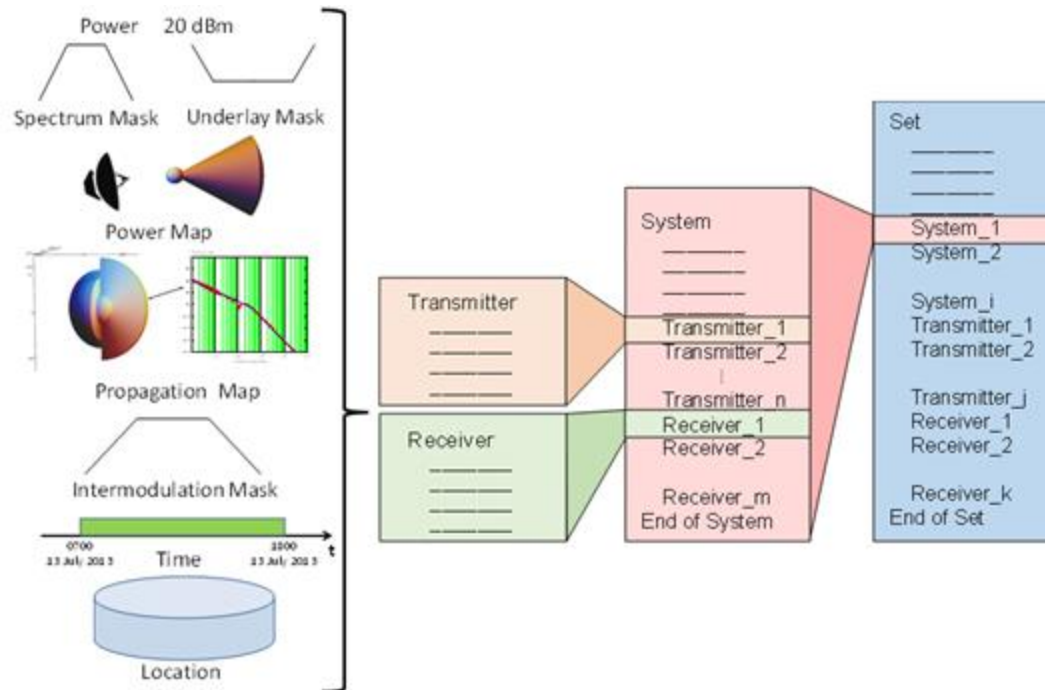
Background: Spectrum Consumption Models (SCMs)

- (Data model that) Provides the means to capture all the relevant parameters and phenomena that affect spectrum consumption for a device or spectrum-dependent system

SCM Constructs (IEEE 1900.5.2)

- Reference power
- Spectrum mask
- Underlay mask
- Power map
- Propagation map
- *Intermodulation masks**
- *Platform**
- Location
- Schedule
- *Minimum power spectral flux density **
- *Protocol or policy **

* Optional



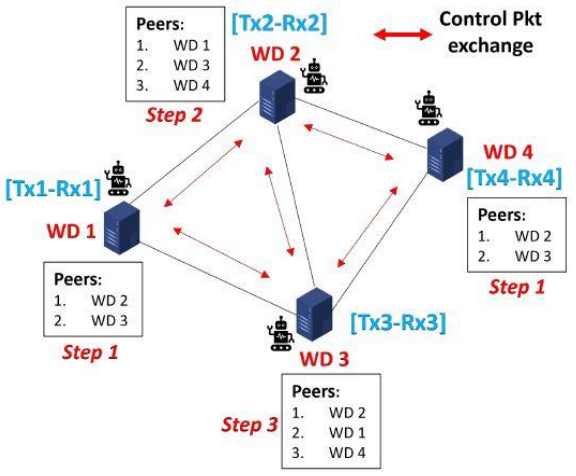
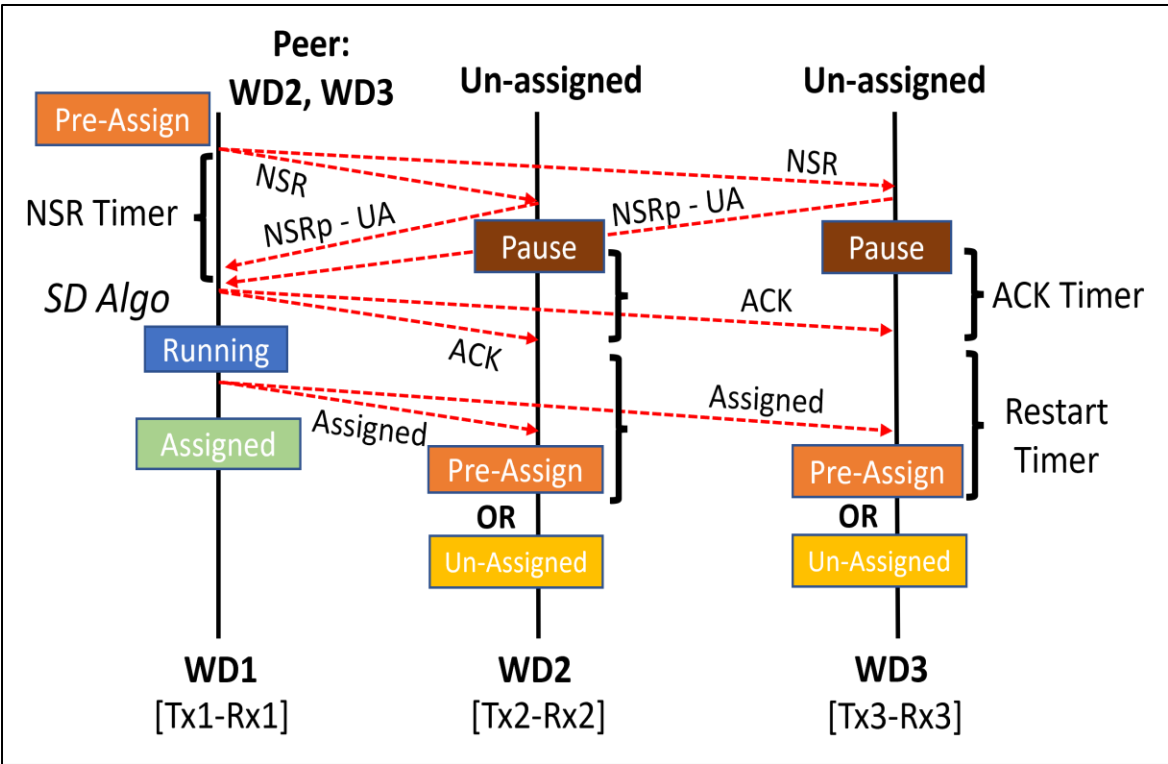
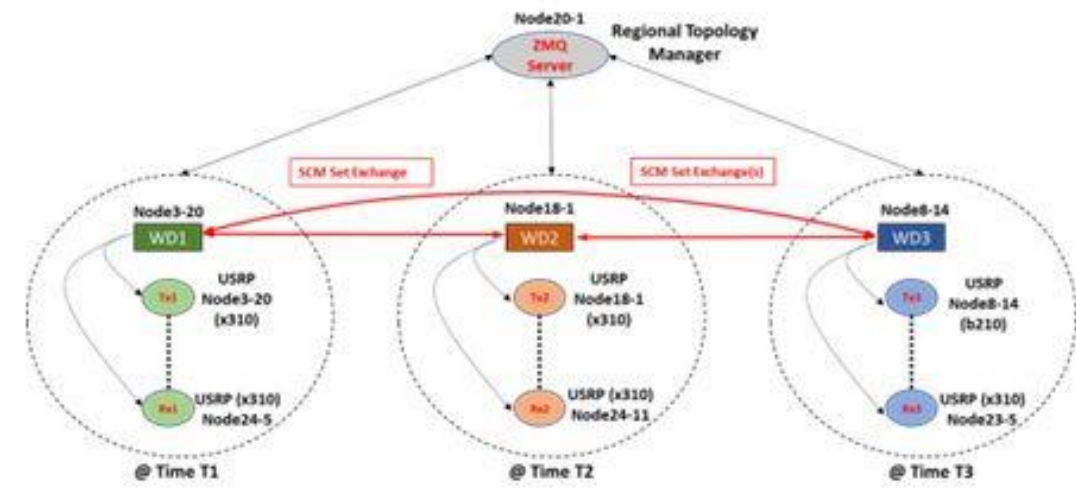
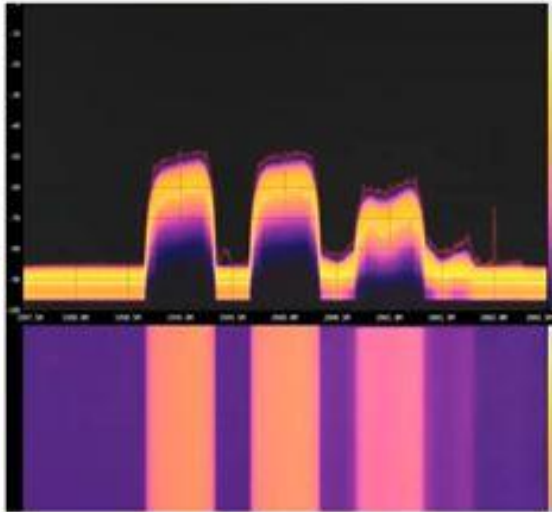
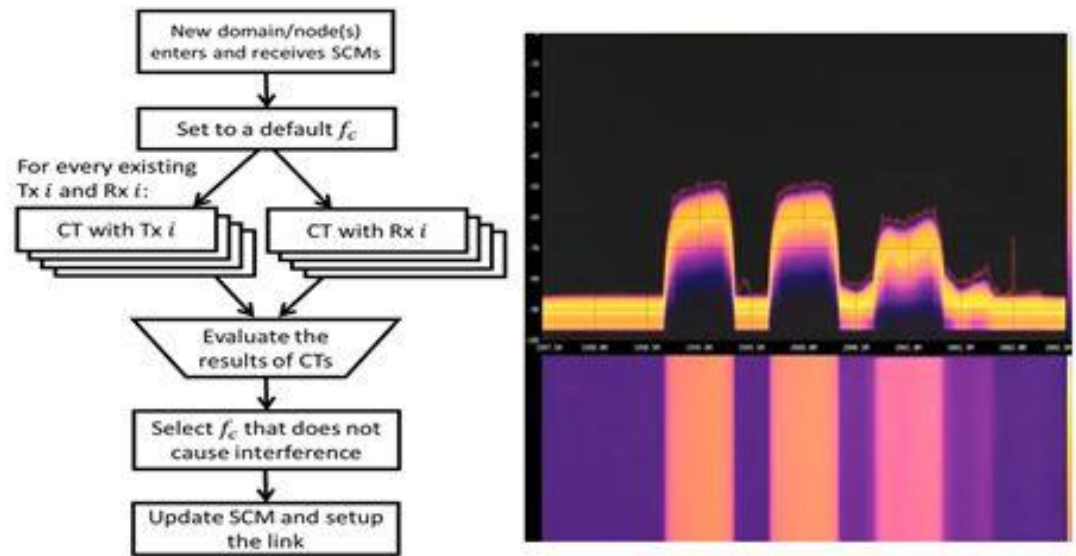
Types of Models

- Transmitter Model
- Receiver Model
- System Model
 - Consists of transmitter and receiver models that are part of a system
- Sets
 - Collective Consumption Set
 - Spectrum Authorization Set
 - Spectrum Constraint Set

Roles of Models

- Consumption
- Authorization
- Constraint
- Request
- Configuration Options

From centralized to distributed spectrum use deconfliction



NSR: Node Status Request
NSRp: Node Status Response
UA: Unassigned
A: Assigned
ACK: Acknowledgement

Distributed spectrum use deconfliction (1)

Our development and validation of distributed spectrum deconfliction methods currently follows three phases:

Phase I:

- WD Neighbor determination
 - Bootstrapping / Beacons

Phase II:

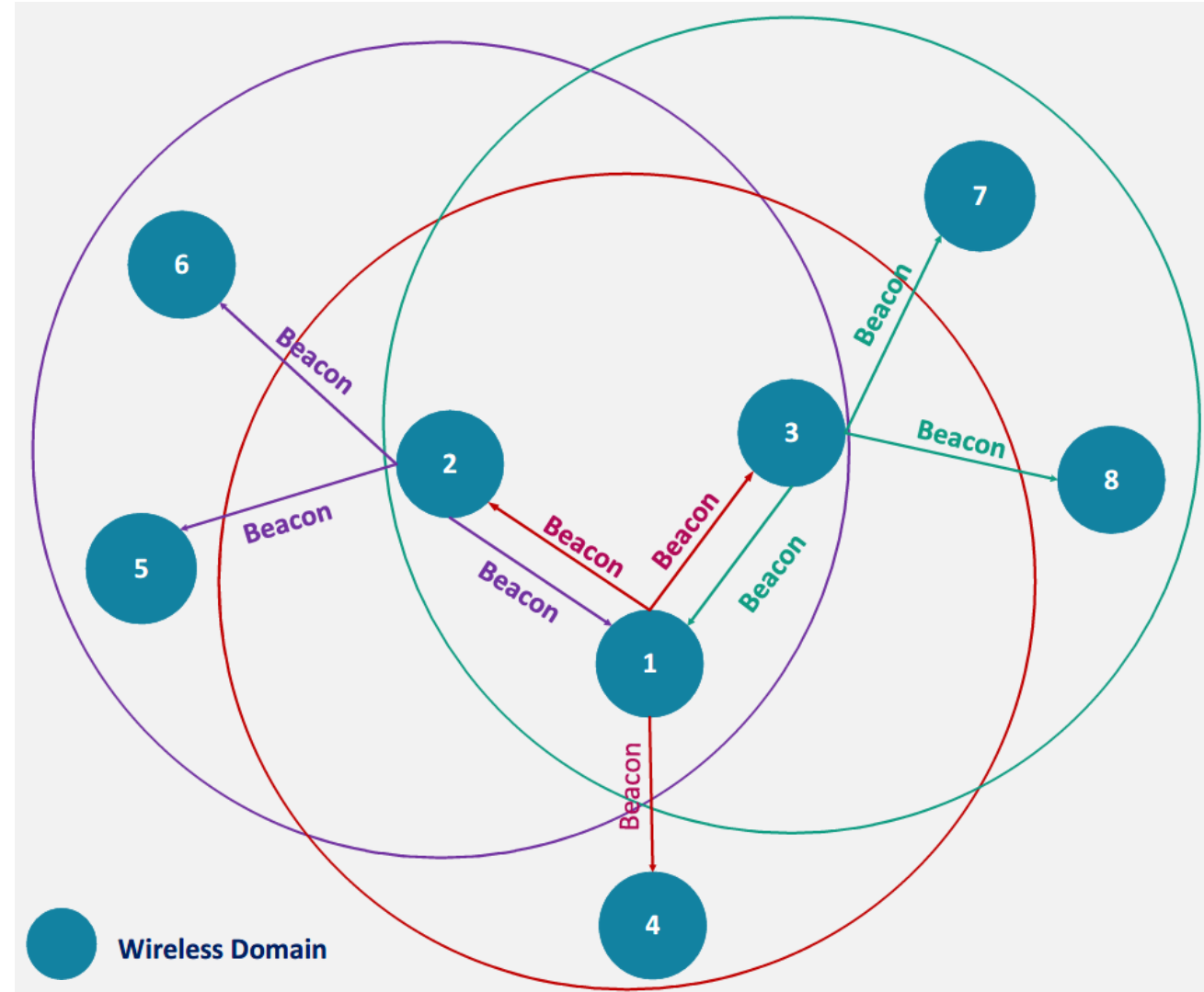
- Spectrum Consumption model exchange
- Spectrum Deconfliction with SCMs

Phase III

- *Account/adapt for mobility and/or propagation changes*

Message exchanges/interactions take place in the *control plane* of the architecture

Note: For any particular WD, the Beacon transmission range > RF device tx range



Distributed spectrum use deconfliction (2)

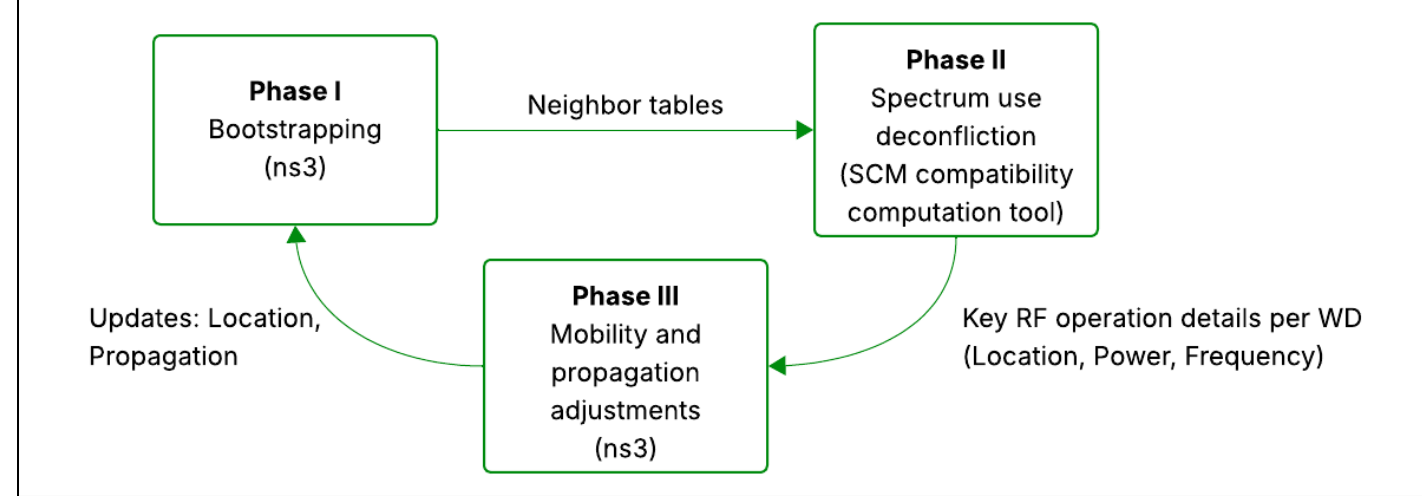
Main tools/platforms for distributed spectrum deconfliction algorithm design and simulation:

ns3 (@Phase I):

- Analysis/simulation of Bootstrapping methods
- Generation of neighbor tables

ns3 (@Phase III)

- Mobility and propagation modeling



SCM-based compatibility computation tool (@Phase II)

- SCM exchange and processing
- Compatibility computation (spectrum deconfliction)
- Supports analysis of RF spectrum deconfliction for many RF device configurations/parameters such as:
 - Directional antennas
 - Complex propagation conditions
- Supports spectrum use deconfliction methods based on changes to:
 - Tx Power
 - Frequency
 - Duty cycle

Ongoing and Future work - Summary

- Building the components for the implementation of a distributed data-driven spectrum management (D3SM) architecture
 - Spectrum Consumption Models (SCMs) as a key information building block
 - Implementing protocols for each layer of the architecture
- Evaluating distributed spectrum use deconfliction algorithms
 - Simulation and (future) experimental evaluation on COSMOS PAWR + NRDZ / ZMS
 - Wi-Fi and O-RAN based setups
- (Future) Definition and experimental validation of a policy language for spectrum sharing interactions under the D3SM architecture