



Spectrum Sharing in 5G & Beyond Mobile Network

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Agenda

- Need for Spectrum Sharing in 5G
- Static Spectrum Sharing - Licensed Shared Access
- Dynamic Spectrum Sharing in 5G
- 5G Flow – Architecture for Unified Multi-RAT RAN
- 5G-Flow & Multi-Connectivity

Need for Spectrum Sharing in 5G

5G Operating Bands

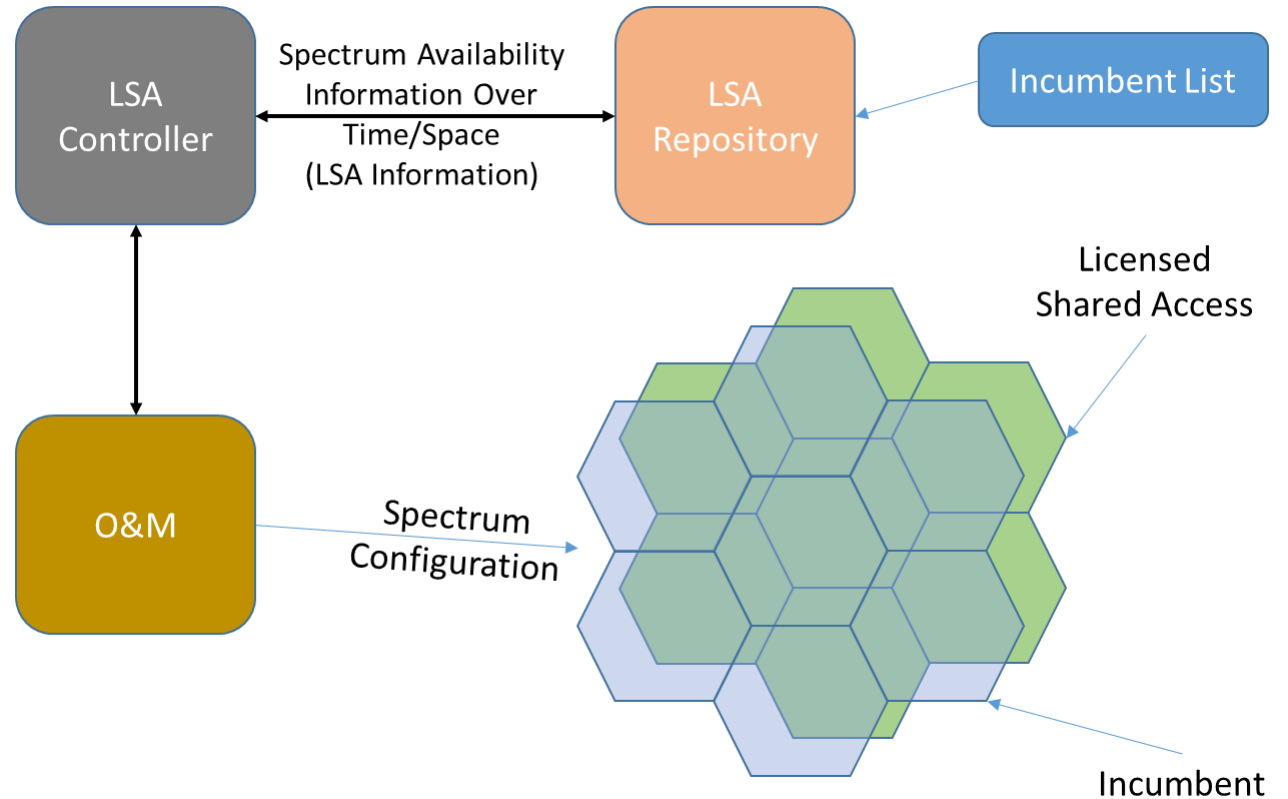
410 MHz – 7125 MHz
(Frequency Range - I)

24250 MHz – 52600 MHz
(Frequency Range - II)

- Frequency Range - I
 - Existing Cellular Deployments
 - Usage of 5G devices to increase only slowly
 - Re-farming Carriers from LTE to 5G
 - Static Spectrum Sharing may not be a good idea
 - Additional Incumbents too
 - Not just LTE Cellular Usage
 - Re-farming not an option for many such incumbents
 - Licensed Spectrum typically underutilized by Incumbents
 - Spectrum Holes or White Spaces
- Static Spectrum Sharing with Other Incumbents
- Dynamic Spectrum Sharing
 - DSS between LTE & 5G
 - DSS between 5G and Other Incumbents

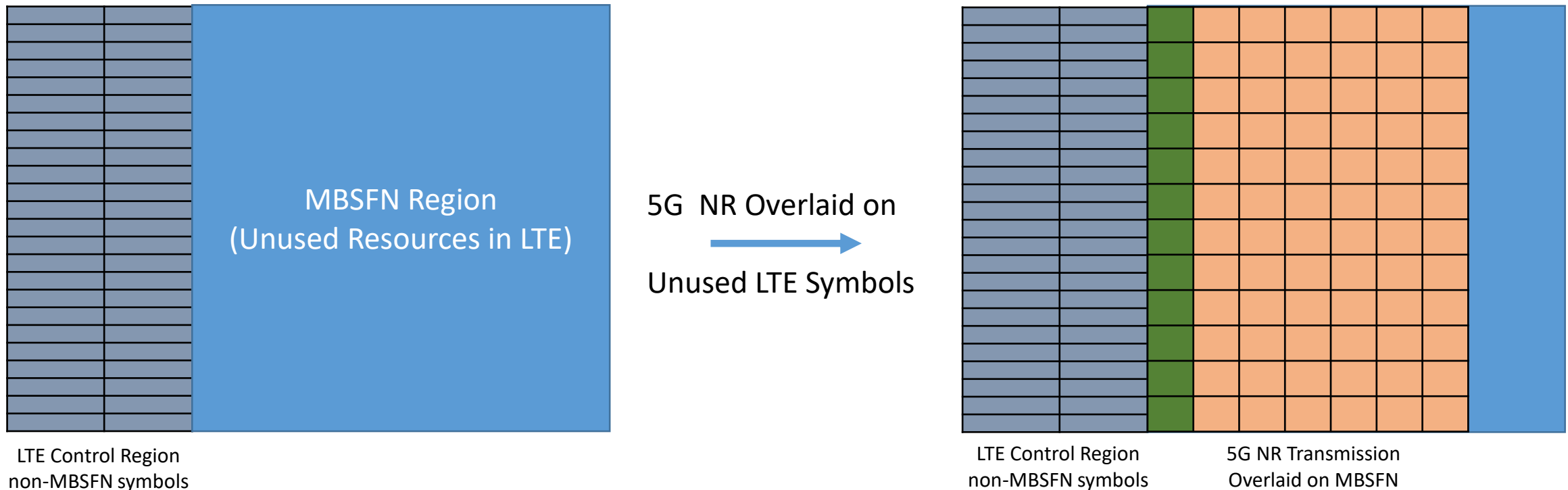
Licensed Shared Access for 5G

- Licensed Shared Access (LSA)
 - Long-term Sharing Arrangement
- No “surprise” usage of LSA bands
 - Neither by Incumbents nor by Cellular Operators
- Spectrum Access Agreement for
 - Specific Geographic Areas
 - Specific Frequency Bands
- Incumbents can Request Exclusion Zones
 - Area where Cellular Operators have no access to Spectrum Resources



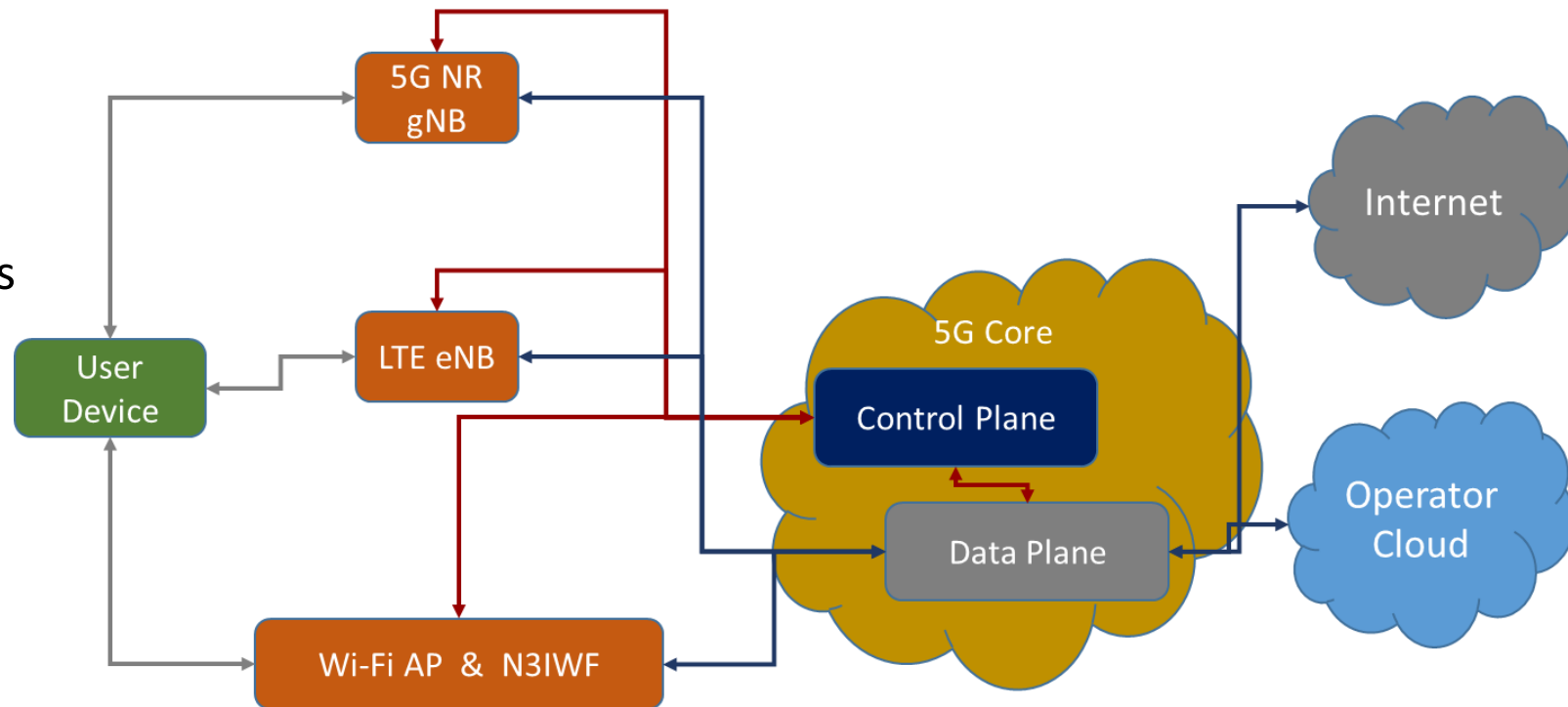
Dynamic Spectrum Sharing across 5G & LTE

- Demand based Dynamic Allocation of Spectrum Across LTE & 5G
- How does it work? - 5G overlaid on unused LTE symbols
 - Example - Designate certain LTE frames as MBSFN frames
 - Do not use the data symbols for LTE MBMS Transmission – Unused Resources
 - Overlay NR Transmission on Unused Resources
 - Coordination based DSS
- Requirement of Synchronization and Coordination across RATS/Base Stations
 - **Not Easy to Achieve in existing 5G Network**



5G Mobile Network Architecture

- Multi-RAT Access Network
- Fragmented Decision Making in RAN
 - gNB, eNB, Wi-Fi AP
 - Controlled and Managed Separately
 - Not easy to support features like DSS across RATs, across BS
- Existence of a Unified Core
 - Even Unified Core can't facilitate DSS as RAN level information not available in Core
- Need for Unified Control of Radio Access Network to support features like DSS



5G-Flow : Unified Multi-RAT RAN

Unified Multi-RAT RAN

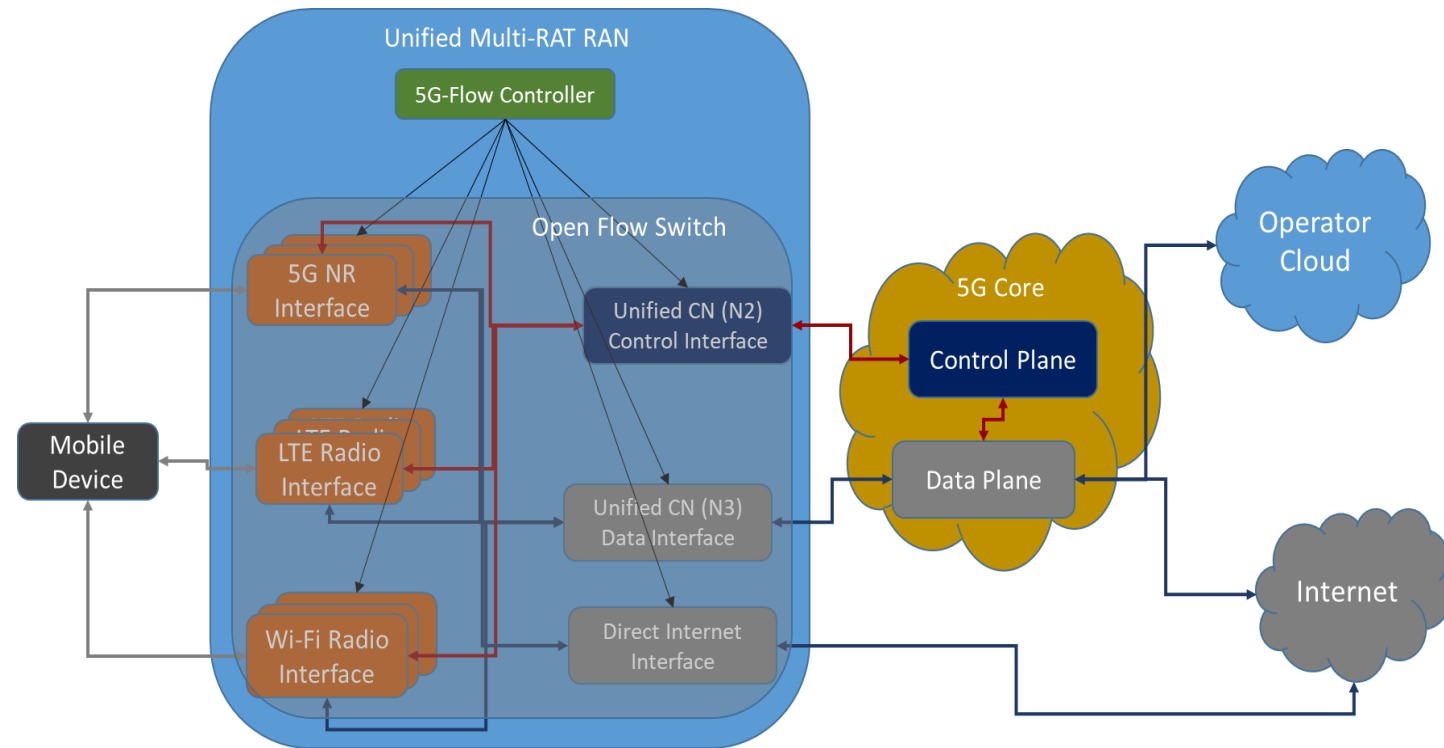
- Logically Centralized Multi-RAT RAN Control
- Access Network Controlled by a unified OpenFlow Controller

Unified Core Network Interface

- Unified Core Interworking replacing RAT Specific CN Interworking functions

Optional CN Connectivity

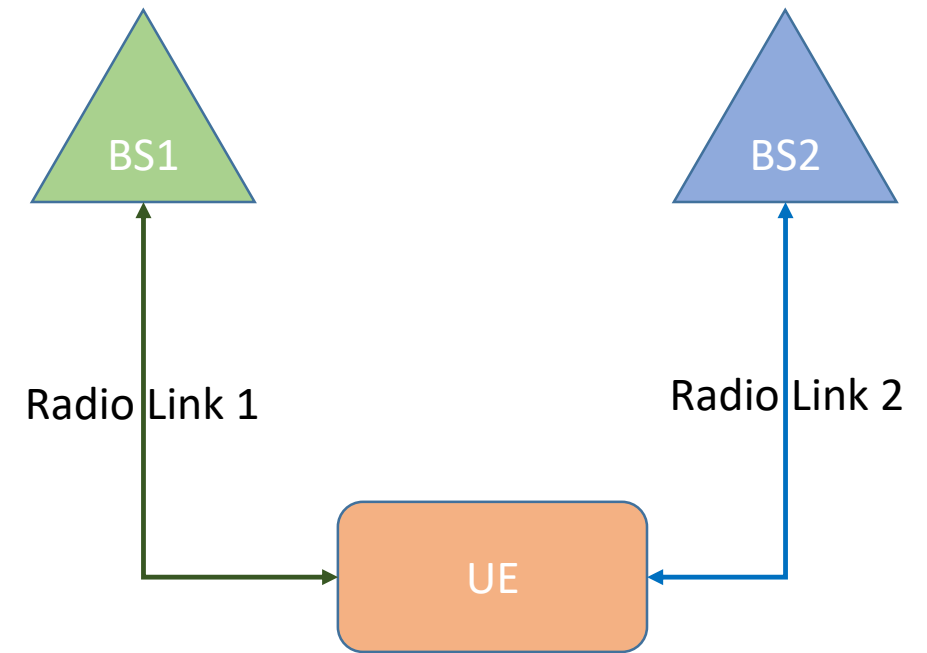
- Optional Core Network Connectivity
- Captive/Private Network Support



Courtesy: 5G-Flow: Flexible and Efficient 5G RAN Architecture Using OpenFlow
By Meghna Khaturia, Pranav Jha, Abhay Karandikar

UE Multi-Connectivity - Enhancing Cognitive Capability

- Multi-Connectivity
 - More than one Radio Support in UE
 - Receive Data from more than one Base Station
- Concurrent Measurement Reports & Data Tx by UE
 - One Radio for Data Transfer
 - Other One for Measurements
 - More frequent search for available bands by UE
 - No need for Measurement Gaps
 - Can Detect Primary User Transmission
- Improved Measurement Collection & Reporting
- UE Measurement Reports for DSS Decision Making
 - Enhances Cognitive Capability for DSS Decision Making



Multi-Connectivity & 5G-Flow - Enabling DSS

- Centralized RAN Architecture
 - Multi-RAT Controller managing multiple Radio Network Interfaces
- Usage of UE Multi Connectivity
 - Concurrent Measurement Reports & Data Tx by UE
- Improved RAN Awareness at Centralized Controller
 - Multi-RAT Awareness at a centralized place
 - UE Measurement Reports
- DSS Decision Making & Enhanced Spectrum usage across RATS

THANK YOU

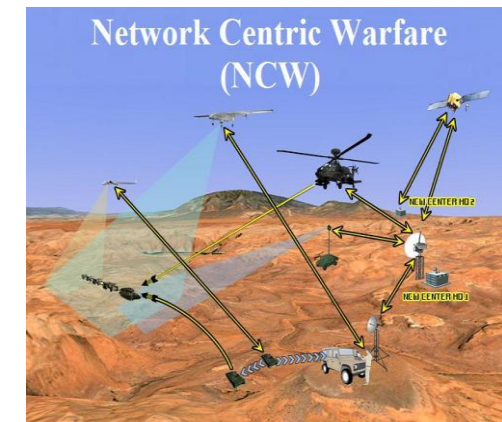
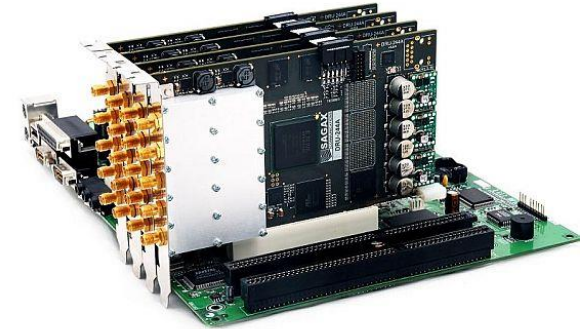


Dynamic Spectrum Sharing

- Licensed Spectrum underutilized by Primary Users
 - Both in Space and Time
 - Opportunity for Radio Communication by Secondary Users (SUs)
- Dynamic Spectrum Access/Sharing
 - Secondary Users (SUs) dynamically search for Idle Spectrum Bands
 - Temporarily Access them for Radio Communication
 - Avoid interference to Primary Users (PUs)
 - SUs Monitor the Spectrum Bands and Yield to PUs when needed
 - Utilizes Spectrum Holes
 - Increased Spectrum Utilization

Software Defined Radio, DSS & Tactical Radio System

- Software Defined Radio
 - Highly Configurable
 - Can Switch Waveforms on the fly
 - Components can be implemented in software in a modular way
- DSS & SDR
 - Easy to Implement on SDR based Platforms
 - SDR brings Immense Flexibility to DSS
 - Easy to Change Frequency Band, RAT
- DSS and SDR
 - Critical Elements for Tactical Radio System & Network Centric Warfare



Spectrum Sharing across Unicast & Broadcast Tx

-Extending 5G Flow

- Large Amount of Whitespaces in Sub-GHz band
 - 410 MHz Onwards
 - Esp. TV-UHF Band: 470 – 590 MHz (Broadcast Tx)
- Sub-GHz Band
 - Very Effective for Rural Connectivity
- Converged Mobile and Broadcast Network
 - Unified Unicast & Broadcast Transmission
 - Controls Broadcast as well as Unicast Transmission
 - DSS across Unicast and Broadcast Transmission

