AGENDA

- 6G@WInnF Update (6G Chair)
- *Emerging Models / Illustrative Sketches:* Exploration of a Notional Dynamic Tiered Authorization Framework (Pathfinder Wireless)
- Sharing Native 6G, Dynamic Coordination, & O-RAN
- Q&A

Wireless Innovation Forum ISS Workshop

WInnForum 6G: Building a Collaborative Future

- Group Update*
- Notional "Dynamic Tiered Authorization Framework (DTAF) for 7-8 GHz" ‡

Colby Harper

***6G Chair, WInnForum**

‡CEO, Pathfinder Wireless

International Spectrum Sharing Workshop

22 May 2025

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Wireless Innovation Forum ISS Workshop

WInnForum 6G: Building a Collaborative Future

Group Update

Colby Harper
6G Chair, WInnForum

International Spectrum Sharing Workshop
22 May 2025

WInnForum 86th General Meeting & International Spectrum Sharing Workshop

WInnForum 6G-Era Topics

21 MAY 2025
6G WORKGROUP
@THE WINNFORUM

Wireless Innovation Forum 86th General Meeting & ISS Workshop

WInnForum 6G-Era Topics:

- *Emerging Models, Sharing-Native 6G, & Dynamic Coordination*
- *Multi-Tech ISAC for Intelligent Spectrum Sensing*
- *SOSA, DSMS, & O-RAN*
- *5G/O-RAN Layers 1 & 2 Control for Dynamic Spectrum Sharing*

86th General Meeting

& International Spectrum Sharing Workshop

21 May 2025

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6GWG@WInnForum Path to Spectrum Sharing Commercialization & Value

6GWG update & 2H25 6GWG Guiding Themes:

- Late summer/early fall Interim Draft of TR-1021 “***Solution Options for Sharing in the 7/8 GHz Band including 6G/IMT-2030***”
  - Two sharing system and flexible regulatory framework prelim draft TR’s transitioned into current active TR-1021 7/8 GHz Band sharing options effort
  - **DSCF (Dynamic Spectrum Coordination Function)** = DSMS + Various Sharing-Native / Dynamic Coordination Mechanisms (*further evolutions of CBRS, AFC, DSAS, HDSS*) fit to both Lower 7 (notional eAFC-based DSCF subset *+ gap closers*) and Mid/Upper 7 (notional CBRS/eDSAS-based
  - Application to other bands, including re-farmed 3G/4G/5G bands
- **Sharing Native 6G & HetNet** SDS Spectrum C2
- 6G-era sensing and nodes in motion architectural implications:
  - **Multi-tech ISAC/Sensing, Local Licensing/Private Wireless, NTN Native 6G, TAMRSS, V2X**
- **Essential 6G: Multi-sector, simplified, needs-driven**… What is essential to 6G end-users, public/private sectors, & commercialization?

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WINNF 6G-era Study/work Topics: *Join The Conversation*

Enhanced 7/8GHz Solution Options (*+ adaptation to other Bands*)

- **Dynamic Spectrum Coordination Function (DSCF)**
  - **DSCF = DSMS *plus* Sharing-Native 6G**
    & Other Dynamic (Temporal/Geo/Signalling) Coordination Functions
- **Building on solid foundations:** Evolved and Further-evolved DSMS (Dynamic Spectrum Management Systems/Frameworks): *fe*CBRS, *fe*AFC, *e*DSAS, *e*HDSS
- **Separation of Policy & Mechanism (Spectrum Requests, Sensing, +)**
  - Including via CDAP open interface modeling & implementation protocol
- **Multi-tech Intelligent Spectrum Sensing Function**
  - Including AI-enhanced Identification and Classification Function
- **Technology-Agnostic Multi-RAT Spectrum Access Request/Response Function**
  - ORAN DU & RU Low-latency Interface Functions for Spectrum Request & Spectrum Sensing Integration
- **Incumbent Awareness & Protection, Geo-Envelope (Zone/Area) Functions, Closed-loop AI Orchestration & Optimization Functions**

***Multi-Tech* across *all* 6G-Era HetNet wireless stakeholders:** Mobile and Fixed Wireless, Terrestrial/Non-Terrestrial/Maritime, Sensing, Private/Public, Indoor/Outdoor, and other Mission-Critical, Essential, & Commercial Applications for all Spectrum Dependent Systems. (LAN/WAN, IMT, Fixed, FSS, MSS, ISAC/JSAC, proprietary, etc.)

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Example Inputs

6GWG/RAC JWG: Selected spectrum sharing flexible regulatory framework reference input documents

1) 6G Principles Joint Statement
2) ITU IMT-2030 Framework, Rec. ITU-R M.2160-0
3) WInnF/ETSI JWG Spectrum Sharing Reports
4) WInnF Spectrum Sharing May ’23 Infographic
5) US FCC TAC Advanced Spectrum Sharing & 6G WG’s
6) US National Spectrum Strategy, NTIA, OSTP, et al.
7) UK Ofcom 6GHz “hybrid” approach; Shared Access
8) EU CEPT/ECC common position on Upper 6GHz
9) Japan NICT B5G/6G Whitepaper
10) India ITU-APT Spectrum Issues Summary
11) UAE Spectrum Report
12) US National Spectrum R&D Plan RFI
13) US NSF Spectrum Program Solicitation (Spectrum Eras 3 & 4)
14) NextG Comms Research/Dev Gaps Rept, US NIST, et al.
15) ITU Council Strategic Plan 2024-2027

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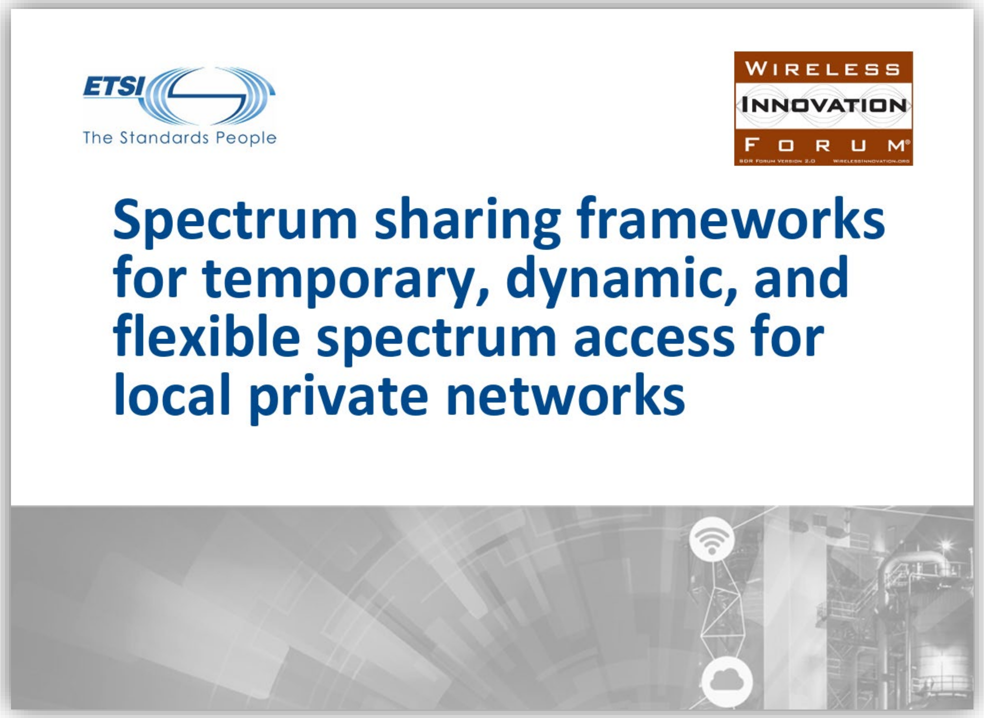
Ref: WInnF/ETSI JWG Spectrum Sharing Repts



"After an extraction of the most challenging use case parameters and a comparison of all sharing frameworks against it, the present document summarizes the following features which need to be supported by a sharing framework for temporary and flexible spectrum access, namely:

- *ensuring incumbent protection and inter-system coordination between secondary users,*
- ***allowing for usage independent of specific frequency bands and RF technology**, and*
- ***introducing a high degree of flexibility and scalability to adapt to the specifics of the frequency bands, incumbents, and secondary users**"*

ETSI-WinnForum-WPSpectrum_sharing_frameworks_for_temporary_dynamic_and_flexible_spectrum_access_for_local_private_networks.pdf (wirelessinnovation.org)

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NTN Native

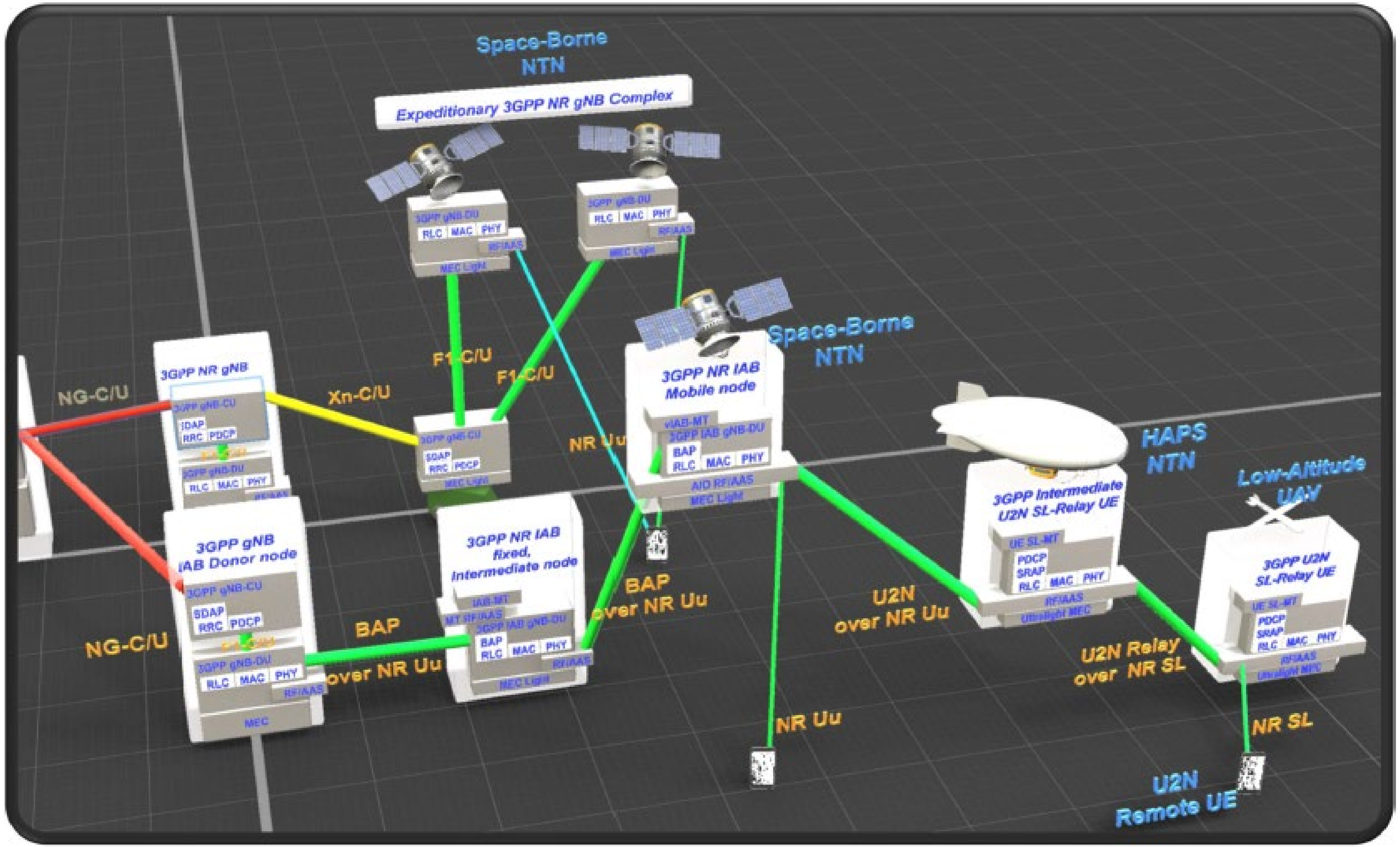


Figure 4: Example SL-Relay Device-side Radio Service Nodes in 5G RAN Architecture

SSFwk Dynamic Spectrum Sharing Coordination Functional Architecture Draft TR (r0.3c) December 11th, 2023

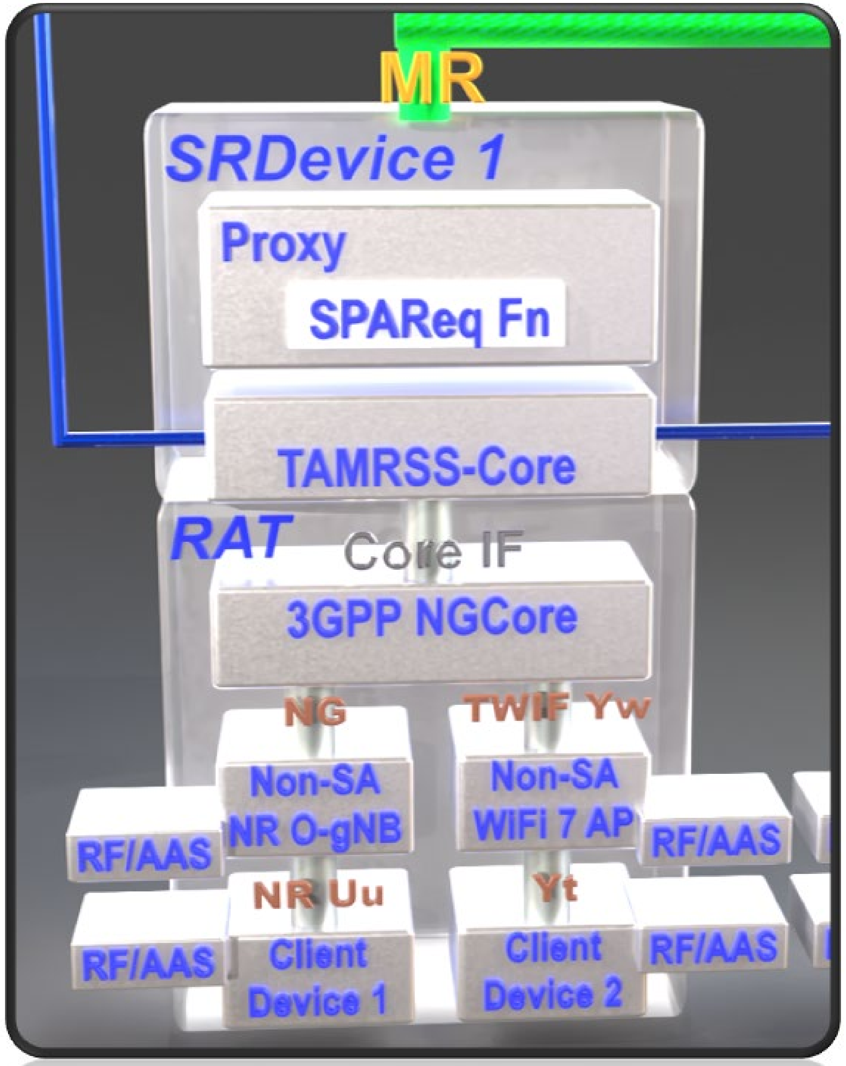
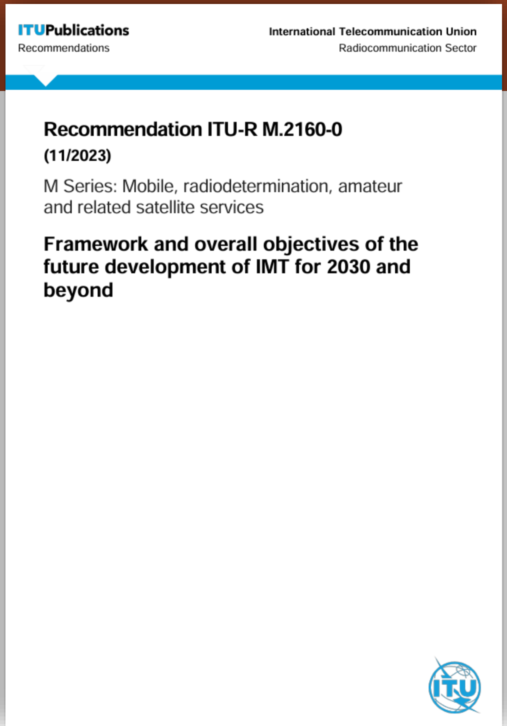


Figure 4: Example SRDevice-Proxy Detail

As a technology-agnostic multi-RAT function, given Radio Service Node (RSNode) RAT's may include though are not limited to:

1. *3GPP NG-RAN NR-based* gNB RSNodes and UE client devices.
2. *3GPP NR-based* SideLink-Relay RSNodes and client devices.
3. *O-RAN Alliance 3GPP NG-RAN NR-based* O-gNB RSNodes.
4. *Wi-Fi Alliance/IEEE Wi-Fi 7 802.11be-based* RSNodes and client devices.
5. *3GPP NG-RAN IoT NTN (LTE-M)-based* ng-eNB RSNodes and UE client devices.
6. *Other Non-3GPP* NG-RAN RSNodes and Air Interfaces, such as UWB.
7. *Proprietary* RSNodes and their client devices.
8.

Global 6G definition *is still emerging*


ITUPublications
Recommendations
International Telecommunication Union
Radiocommunication Sector

Recommendation ITU-R M.2160-0
(11/2023)

M Series: Mobile, radiodetermination, amateur and related satellite services

Framework and overall objectives of the future development of IMT for 2030 and beyond

The definition of 6G definition is still emerging and is greatly though not entirely anchored in ITU-R WP5D's *ITU IMT-2030 Framework, Rec. ITU-R M.2160-0.*

Other ITU groups (eg: ITU-R WP4 and broader WP) and various related non-ITU group specs and needs are also being addressed in the yet TBD emerging 6G HetNet.

6G as a network of networks—or HetNet (heterogeneous network)—is an essential IMT-2030 pillar. This HetNet is expected to provide unprecedented performance, reliability, and effectiveness empowering people and businesses to use it and innovate with it for a broader and deeper set of use cases, environments, and sectors

R-REC-M.2160-0-202311-I!!PDF-E (itu.int)

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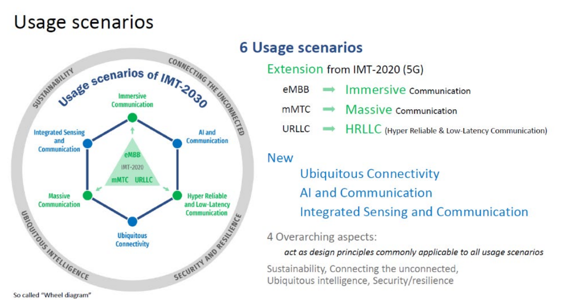
What is 6G & *what would you like it to be?*



A few of the key pillars of the still-emerging definition of 6G:

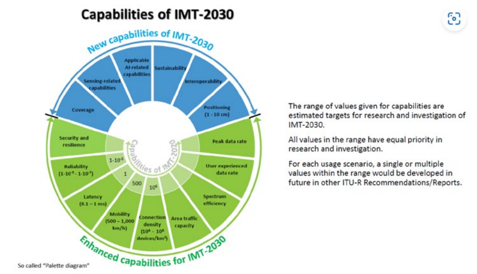
•Includes new and extended key Usage Scenarios (see "Wheel diagram")

•Includes new and enhanced key Capabilities (see "Pallette diagram")

•**Includes spectrum sharing, per ITU re: it's developing definition of "IMT-2030"**

•Interoperability across a **"Sharing-Native" heterogeneous network** of networks, or "HetNet" including though not limited to:

- **terrestrial and non-terrestrial**
- **mobile and fixed services and infrastructure, core and edge**
- **indoor and outdoor public and private nets, both WAN and LAN**
- **consumer, business, and industrial in urban, rural, remote, and maritime environments.**



Spectrum sharing in these various contexts is an area in which the Wireless Innovation Forum's 6GWG contributes to the ecosystem by **helping to build cross-ecosystem awareness and education as well as inter-system/inter-service sharing contributions.**

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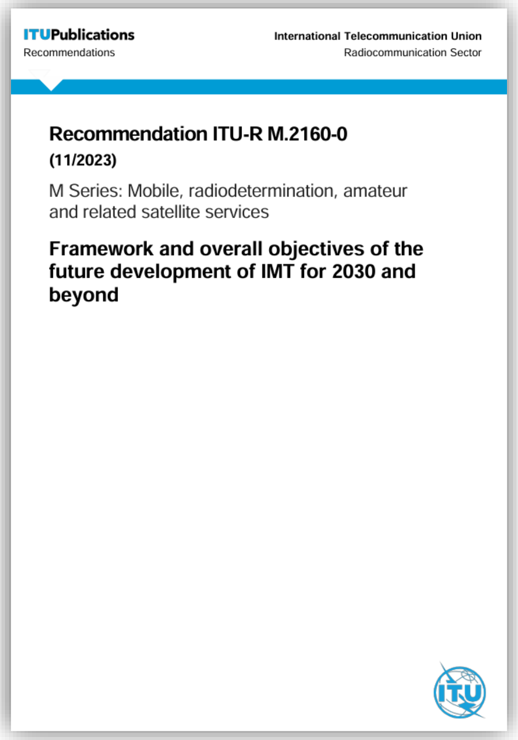
Ref: IMT-2030 Framework, Rec. ITU-R M.2160-0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Framework and overall objectives of the future development of IMT for 2030 and beyond

"IMT-2030 systems are expected to continue to utilize a mixture of different frequency bands as in the current IMT system, but with potentially larger bandwidths and higher operating frequencies. Spectrum utilization can be further enhanced by efficiently managing resources through different technologies such as advanced carrier aggregation (CA) and distributed cell deployments, as well as spectrum sharing technologies and technologies for broader frequency spectrum."

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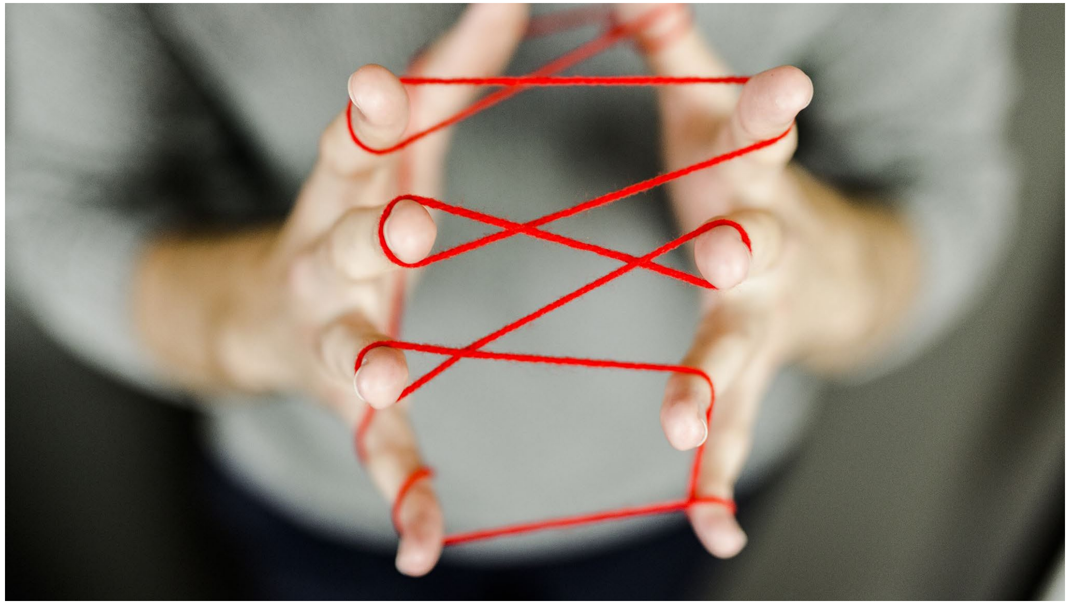
MT-ISAC IN THE INTERNATIONAL-SDO ISAC USE CASE SPACE



Multi-Tech ISAC in the Global Context

INTERNATIONAL-SDO SPACE OF ISAC/JCAS/PNT+ USE CASES

ITU-R: Service Groups
- WP4 (MSS, GNSS, FSS+)
- WP5D (IMT)
- WP5A (WAS/RLAN, ITS, Auto-RADAR, LMR)
- WP5B (maritime, aero, radio loc/nav)

(Other)

(Various National Spectrum Regulatory Authorities)

ETSI
ISAC Use Cases
- IMT (3GPP & ORAN, +)
- WAS/RLAN (WiFi DECT, +)
- Other (Literature, ETSI THz & RIS, Auto, one6G)

ETSI / WinnF Radio Joint WG
- Technology Agnostic
  - Multi-Service
  - Multi-Technology

(Non-ETSI / Other)

3GPP IMT (SA, Core & Terminals, RAN)
3GPP WG's for ~Subset+ of ETSI-based ISAC Use Cases
- SA1& 2
- SA5 Mgmt, $, System-wide AI
- SA3 Security
- RAN enablement set
- CT enablement set

ORAN IMT (RAN)
ISAC/Sensing Use Cases not addressed in WG1 (Use Cases & Architecture). There will be message & traversal/architectural impacts on key interfaces.

WiFi 802.11
WiFi ISAC Use Cases (~Subset of ETSI UC's)
- H&O Mon
- Env/Sec Mon
- Automation

UWB & 802.15
UWB+ ISAC Use Cases
- H&O Mon
- Sec Acc, Auto, Env

(Satellite)

(Proprietary & Other}

WInnF JCAS/ISAC/PNT *HetNet Spectrum Management* Use Cases [eg: TAMRSS-Sensing component (Technology Agnostic Multi-RAT Spectrum Sharing)]:
- 3GPP+ORAN
- WiFi 802.11
- UWB & 802.15
- SOSA / SCA
- MSS/SCS/FSS (NTN+)
- DECT IMT-2020 & ARIB PHS RCR STD-28
- *ETSI/WF JWG*, ITS, Proprietary & Other

Wireless Innovation Forum ISS Workshop

Emerging Models / Illustrative Sketches

Building a Collaborative Future in the 6G-Era:

Notional "Dynamic Tiered Authorization Framework (DTAF) for 7-8 GHz"

Colby Harper

CEO, Pathfinder Wireless

International Spectrum Sharing Workshop

22 May 2025

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MAY 2025
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NOTIONAL "DYNAMIC TIERED AUTHORIZATION FRAMEWORK (DTAF)" FOR 7-8 GHZ

ILLUSTRATIVE EARLY SKETCHES

COLBY HARPER

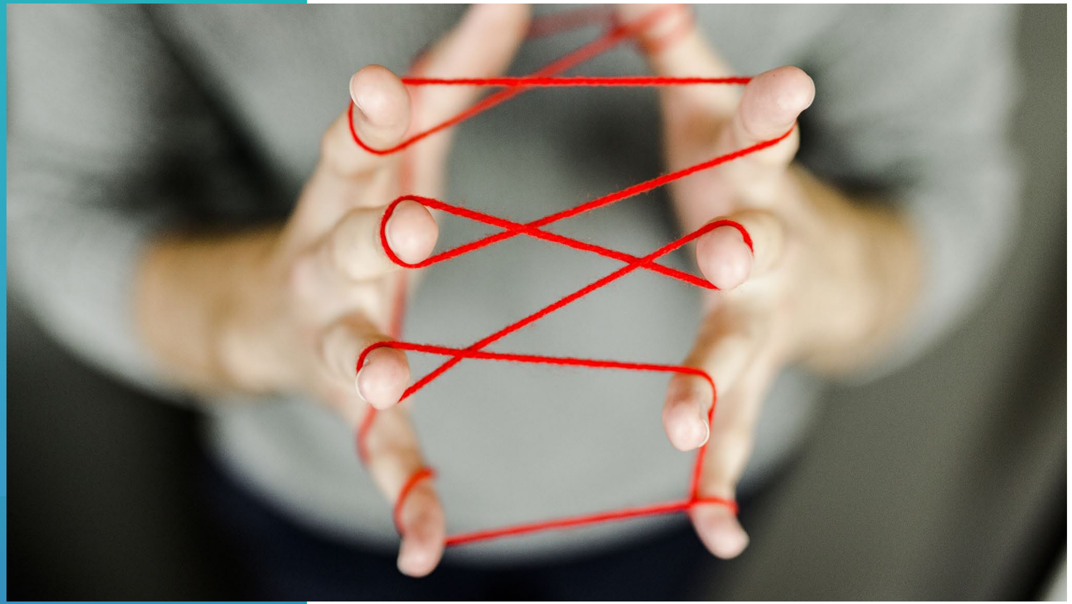
PATHFINDER WIRELESS, CEO

PATHFINDERWIRELESS

EMERGING MODELS / ILLUSTRATIVE SKETCHES

- The Opportunity Before Us
- The Notional Dynamic Tiered Authorization Framework (DTAF)
- A Framework for Shared Success
  - Enabling Carrier Innovation and Quality for All; Supporting the *Full Spectrum* Ecosystem
- Aligning with Market Realities
  - The Indoor Imperative; Building on Global 3-4 GHz Success
- Future-Proofing the Digital Economy
  - Adaptive Excellence; Fostering Collaborative Innovation
- Technical Excellence Serving All Stakeholders
  - Sophisticated Protection Mechanisms; Evidence-Based Optimization; A Notional Path Forward for All Stakeholders
- Security & Privacy for Cross-Domain Spectrum Sharing
- Emerging Dynamic Spectrum Coordination Functions (DSCF) to implement DTAF Authorization Framework
  - Notional *DSCF-Light* for Lower 7 & significantly enhanced CBRS + DSAS-based "*Full DSCF*" for Mid/Upper 7
- Conclusion: An Invitation to Leadership
- Notional Transition Pathway Sketches

THE OPPORTUNITY



The Opportunity Before Us

Creating **reasonably harmonized international approaches to spectrum sharing** that respect each nation's specific needs and sovereignty, while still enabling federated global learning and advancement, can't yet be considered easy or solved…

That said, we *are* finding there are prospective approaches **balancing innovation with practical regulatory frameworks** building on evolved versions of **already validated dynamic sharing/coordination system foundations**, *are feasible* across much of the ecosystem.

One such prospective approach we present here for your considerations is the ***notional*** **"Dynamic Tiered Authorization Framework, DTAF."** Building on and evolving:

- Multiple countries' existing approaches to 3-4GHz spectrum regulatory sharing/coordination
- Along with validated spectrum sharing foundation systems (ie: **feAFC, feCBRS, eDSAS, eHDSS**)

To stimulate (further) conversation amongst this expert group, we offer **these cross-ecosystem and per-country "illustrative sketches"** of this notional DTAF, and we *invite you to get further involved in the ongoing techno-regulatory conversation here at the WInnForum.*

The Opportunity Before Us

- **Framework Evolution**: Evolution toward sophisticated spectrum sharing frameworks
- **Band Challenges**: 7-8 GHz band presents unique multi-service challenges
- **Balanced Approach**: The prospective *"Dynamic Tiered Authorization Framework, DTAF"* offers promising regulatory approach and path forward balancing diverse needs
- **Innovative Extension**: Built on proven foundations with innovative extensions
- **Continuous Improvement**: Learning journey that will strengthen with implementation

Notional DTAF Phase 3

Dynamic Temporal & Spatial Protection: The most advanced element involves ***real-time adaptation*** through:

•Distributed sensor networks providing actual interference conditions
•Satellite transmission pattern detection for precise protection
•Environmental monitoring that adjusts protection zones based on actual propagation
•Three-dimensional protection modeling that accounts for satellite elevation angles

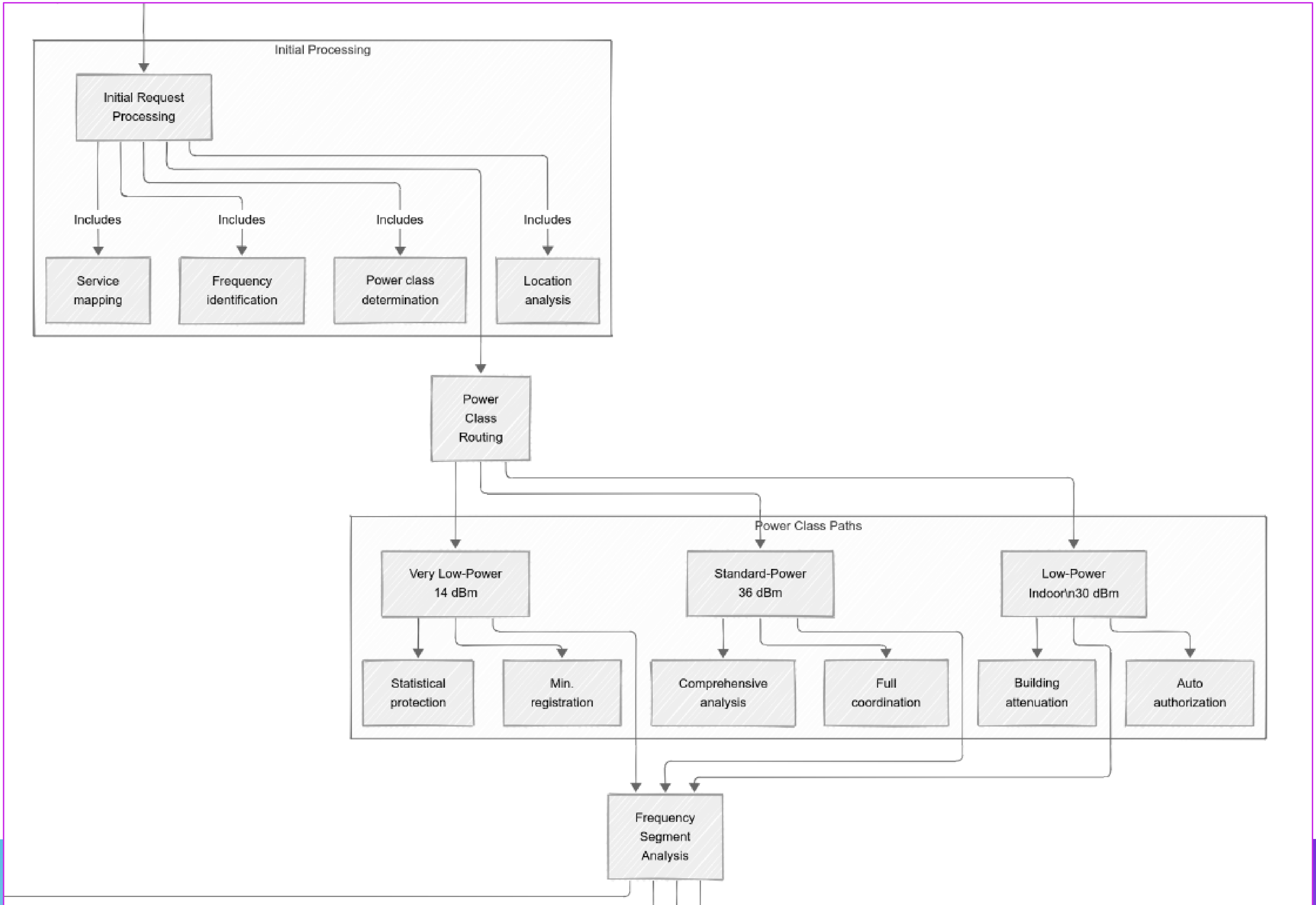
Why Such an Evolution Matters

Here's what makes this type of progression particularly important to understand: each phase represents not just technological advancement, but a fundamental shift in how we think about spectrum as a shared resource.

Phase 1 Thinking: "Let's create different access levels for different users"
Phase 2 Thinking: "Let's make those access levels more responsive to real conditions"
Phase 3 Thinking: **"Let's create an intelligent ecosystem that continuously optimizes itself based on actual usage patterns and real-time conditions**"

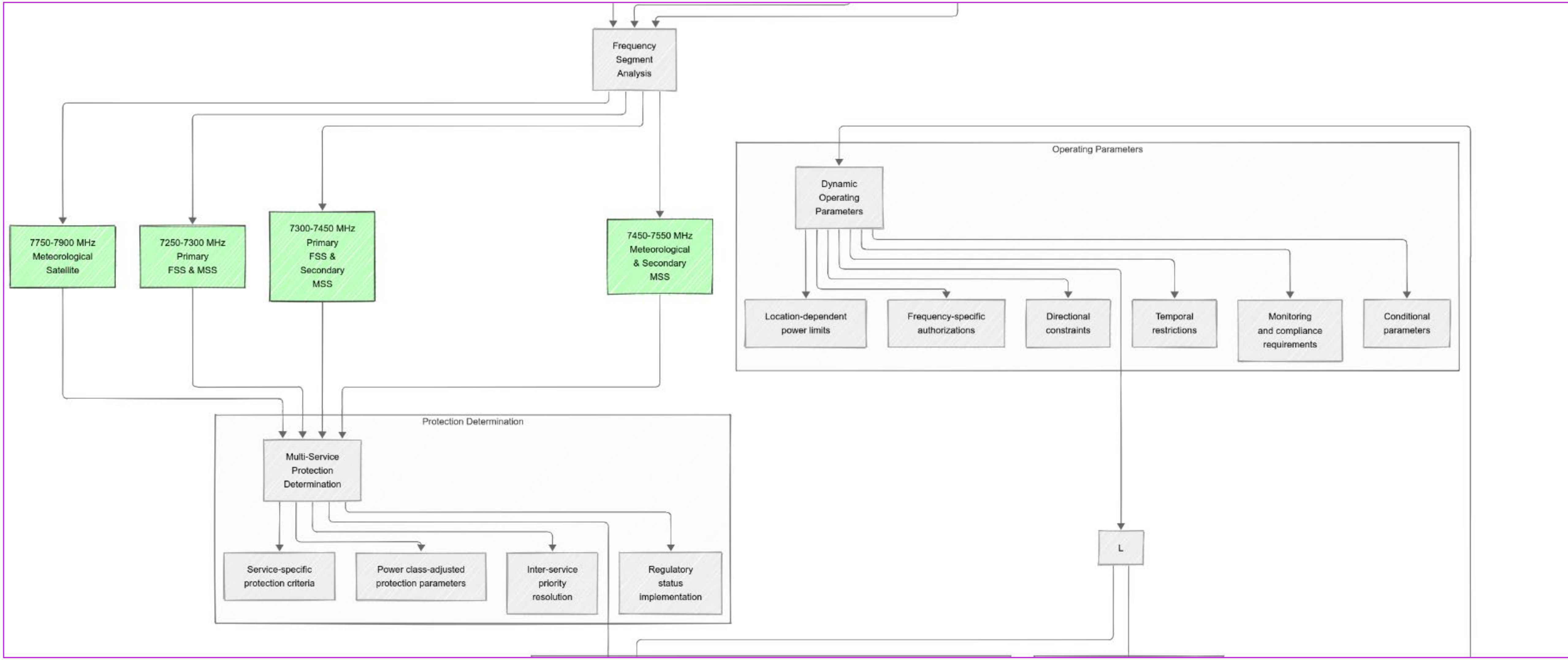
Notional DTAF "Phase 3" is proposed as a "learning journey" rather than a finished product. Such a framework is built to evolve further based on operational experience, potentially leading to even more sophisticated phases.

Illustrative Sketch; DTAF Framework Overview

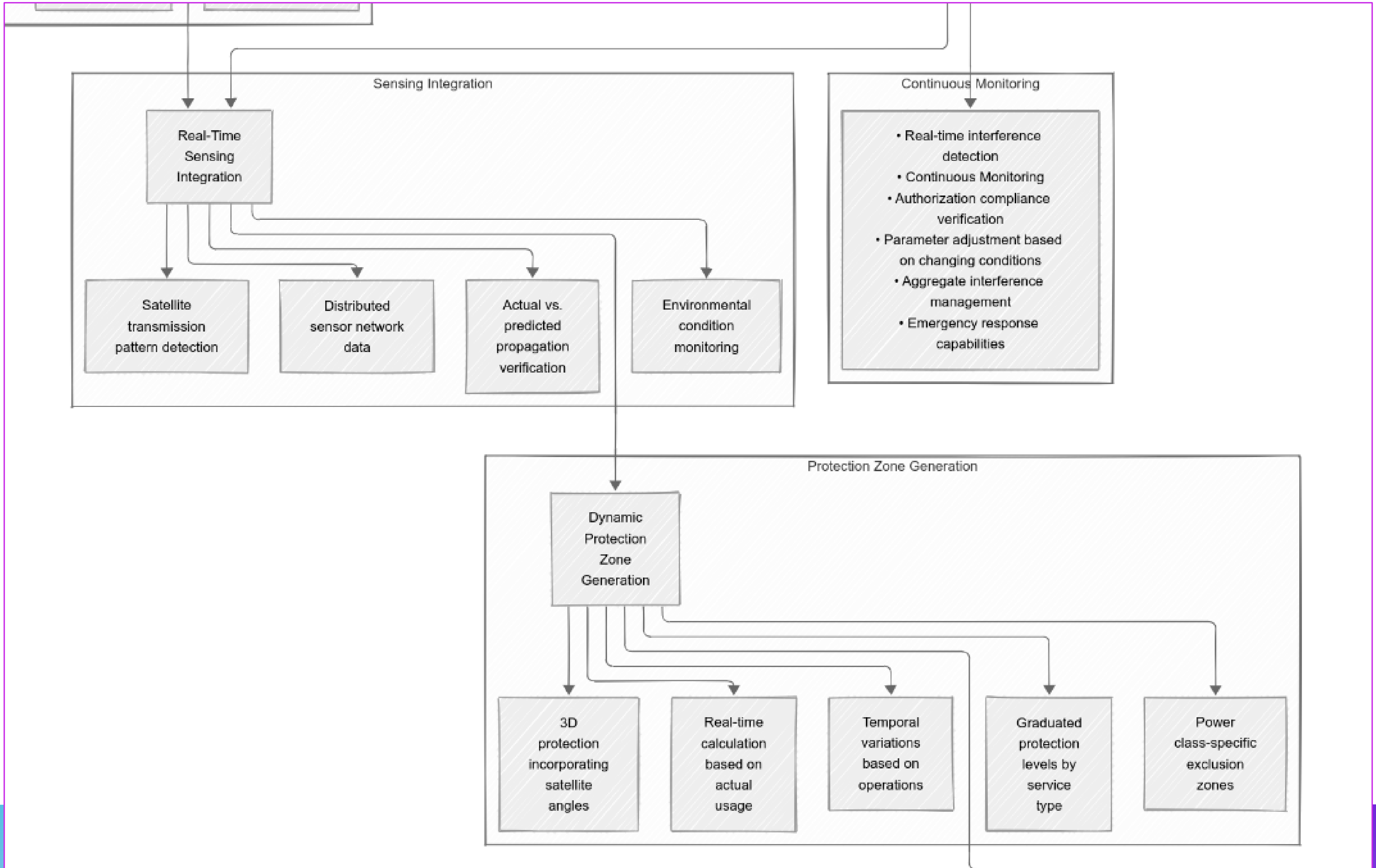


PATHFINDERWIRELESS

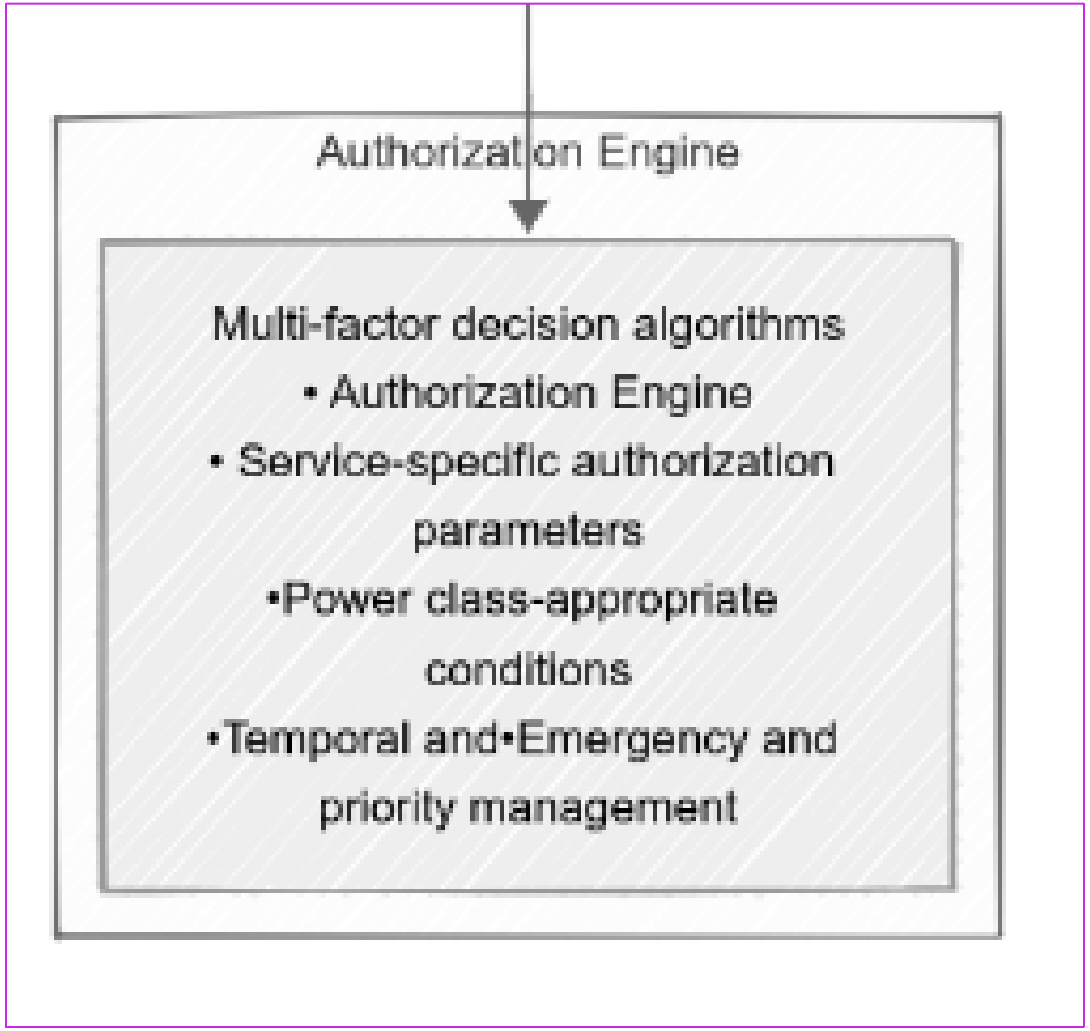
Illustrative Sketch; DTAF Framework Overview



Illustrative Sketch; DTAF Framework Overview



Illustrative Sketch; DTAF Framework Overview



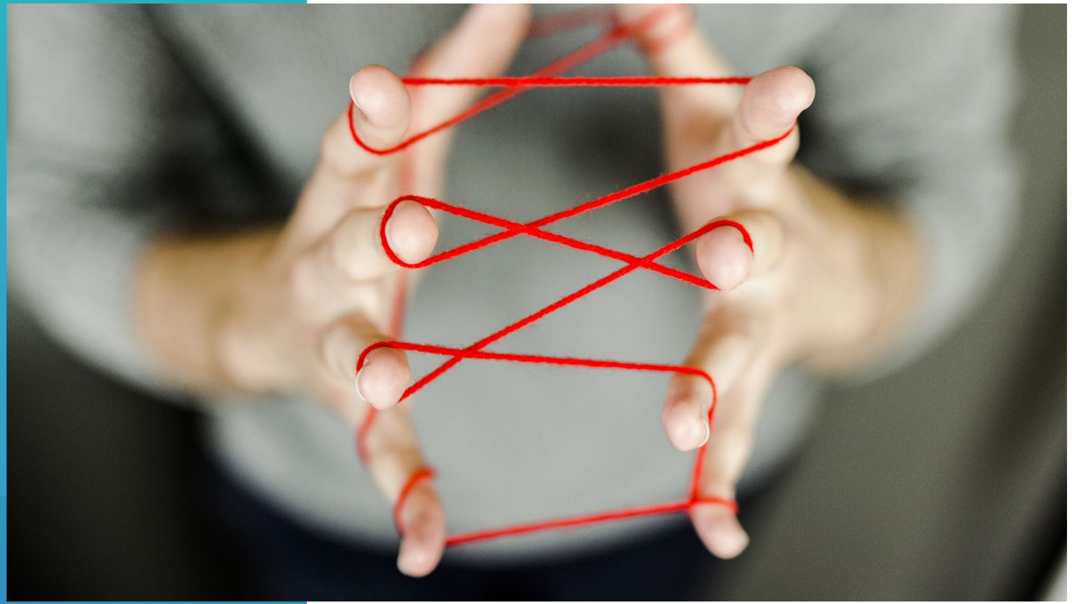
The DTAF Illustrative Sketch’s Regulatory-related Functions:

- The **Dynamic Tiered Authorization Framework (DTAF)** introduces a **policy-driven** approach to spectrum sharing that transcends traditional static allocation models.
- By establishing a **graduated authorization regime based on transmitter power class, frequency segment characteristics, and real-time operational conditions**, DTAF creates a regulatory framework that **maximizes economic value while ensuring incumbent protection**.
- Unlike conventional sharing mechanisms that rely on fixed protection zones, DTAF implements **dynamic protection boundaries informed by distributed sensing networks**, enabling **proportionate regulatory treatment calibrated** to ***actual interference potential*** rather than coarse-grained worst-case statistical scenarios.
- This framework aligns with the regulatory principle that **spectrum access restrictions should be the minimum necessary to achieve protection objectives, while accommodating diverse service classes with varying regulatory status**, from IMT, to Fixed, to FSS, & to MSS services.
- The result is a governance model that supports both **innovation and investment certainty** through ***clearly defined authorization pathways*** appropriate to each combination of **power class**, **location**, and **operational parameters**.

The DTAF Illustrative Sketch (more) technical view:

- **The Dynamic Tiered Authorization Framework (DTAF)** represents an advanced spectrum sharing approach that enables efficient utilization of spectrum while **protecting incumbent services through a multi-dimensional analysis system**.
- DTAF **simultaneously evaluates access requests across three critical dimensions: power class** (determining the authorization path based on interference potential), **frequency segment** (applying service-specific protection criteria for different portions of the band), and **real-time operational status** (incorporating sensing data to create dynamic rather than static protection zones).
- By implementing **graduated authorization parameters tailored to each combination** of these factors, DTAF maximizes spectrum access opportunities while **ensuring appropriate protection for critical services** like satellite communications.
- The framework's continuous **closed operational control loop** allows protection parameters to **adapt to changing conditions**, creating a sophisticated sharing ecosystem that balances innovation with reliability for diverse users across various power levels and use cases.

A FRAMEWORK FOR SHARED SUCCESS



PathfinderWireless

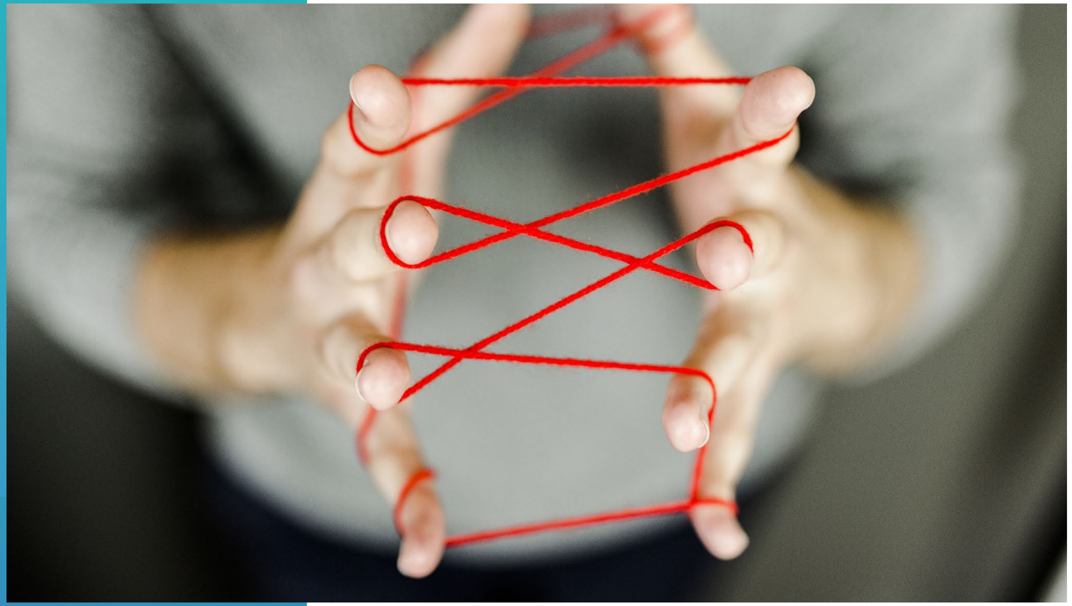
Enabling Carrier Innovation and Quality *for All*

- **Reliable Access**: Designed to provide reliable spectrum access
- **Hybrid Protection**: Dynamic protection mechanisms combine proven and novel approaches
- **Innovation Extension**: Expands on current-spectrum inventory innovation seen in FWA deployments and low-power for indoor coverage
- **Enhanced Guarantees**: Models suggest potential for overall stronger efficiency and resilience than traditional static allocations
- **Implementation Learning**: Implementation will provide valuable refinement opportunities
- **Flexible Evolution**: Adapts to evolving business cases and technologies

Supporting the *Full Spectrum* Ecosystem

- **Win-Win Approach**: Spectrum success isn't a zero-sum proposition
- **Efficient access for diverse use cases**:
  - Indoor networks
  - Private network deployments
  - Traditional carrier services
- **Building on Success**: Building on CBRS and AFC successes while extending into new territory
- **Technology Synergy**: Private wireless and WiFi complement carrier networks
- **Integration Validation**: Implementation will validate integration of multiple sharing approaches

ALIGNING WITH MARKET REALITIES



PathfinderWireless

The Indoor Imperative: Aligning with Market Realities

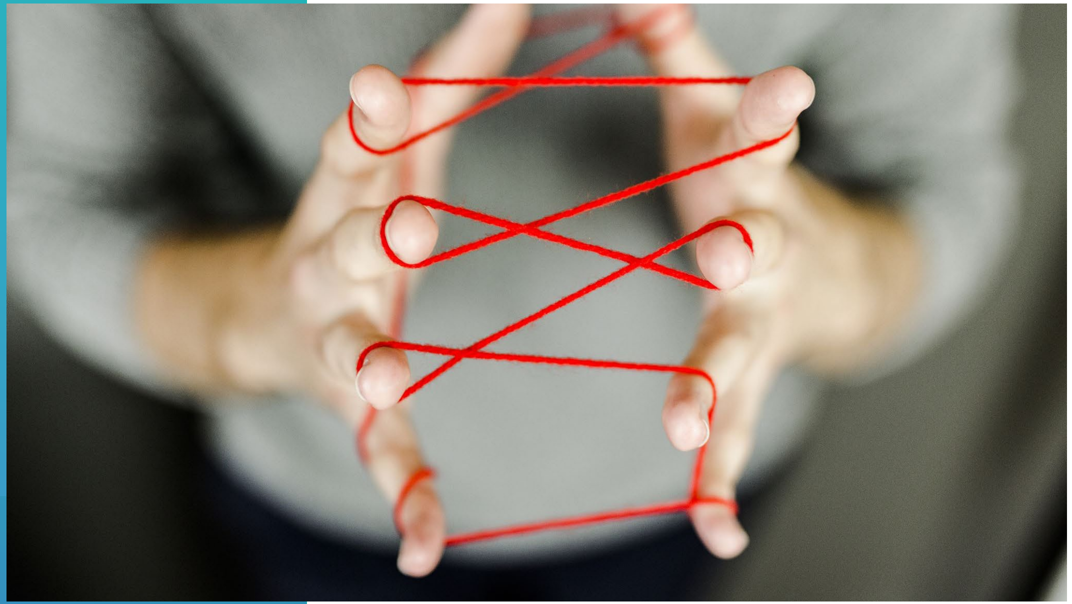
- **Indoor Dominance**: 80-90%+ of wireless data traffic occurs indoors
- **Reality-Based Design**: Power-tiered approach designed for *actual* usage patterns
- **Physics Advantage**: 7-8 GHz propagation physics strongly supports tiered approach, as with 6GHz
- **Universal Benefits**: Benefits for *all* users
- **Practical Validation**: Real-world implementation will provide validation and refinement

Building on Global Success

One example: International 3-4 GHz FSS/IMT sharing precedents

- The global spectrum landscape is undergoing a profound transformation as regulators and industry stakeholders develop increasingly sophisticated approaches to enable sharing between satellite and terrestrial services.
- Our preliminary sketch of C-band (3.7-4.2 GHz) sharing frameworks across multiple countries reveals a rich diversity of regulatory innovations that provide valuable lessons for future sharing bands, particularly the 7250-7900 MHz range with its complex multi-service environment.

FUTURE-PROOFING THE DIGITAL ECONOMY



PathfinderWireless

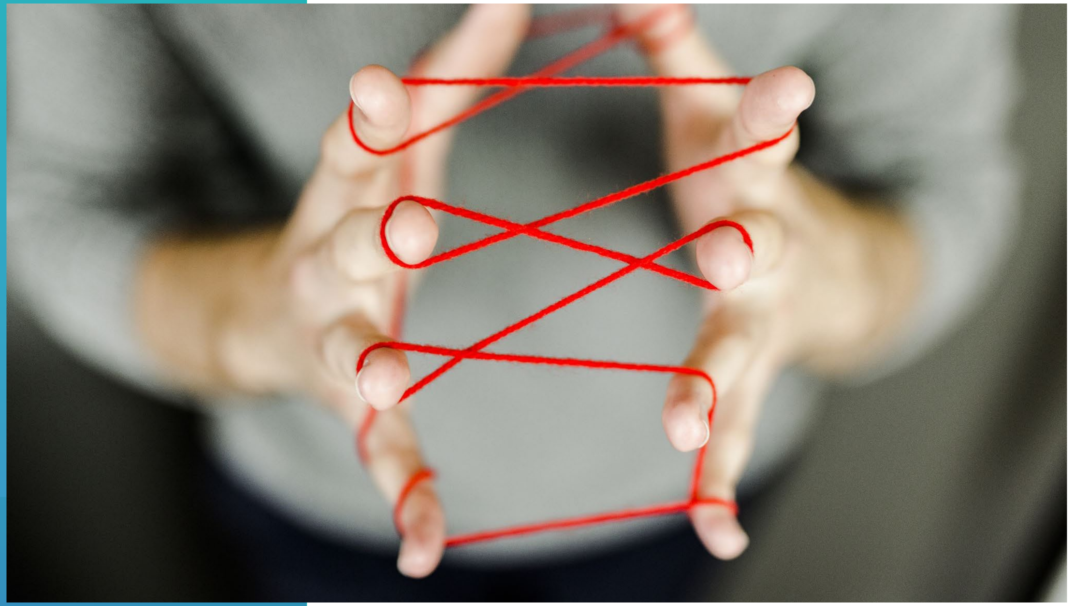
Adaptive Excellence: Future-Proofing the Digital Economy

- **Evolving Design**: Designed to evolve with technological advances and market changes
- **Investment Protection**: Adaptability aims to protect stakeholder investments
- **Learning Innovation**: Framework's learning mechanisms represent forward-looking innovation
- **Implementation Maturity**: Concepts theoretically and practically sound, though need maturation through field trials and implementation
- **Feedback Refinement**: Collaborative refinement based on operational feedback
- **Band Opportunity**: 7-8 GHz physical characteristics create opportunity for efficient sharing

Fostering Collaborative Innovation

- **Usage Flexibility**: Creates pathways for diverse spectrum use
- **Collaborative Delivery**: Encourages collaborative approaches to service delivery
- **Proven Foundation**: Initial-phase mechanisms for 7-8 GHz based on proven methods and systems; while *newest* extensions still evolving
- **Partnership Models**: Potential for new partnership models and shared infrastructure
- **Field Validation**: Real-world validation will refine collaborative frameworks
- **Spatial Efficiency**: Opportunity to further demonstrate *spatial reuse* efficiency in practice

TECHNICAL EXCELLENCE SERVING ALL STAKEHOLDERS



PathfinderWireless

Emerging Dynamic Spectrum Coordination Fn (DSCF)

- **Implement Notional DTAF**: Notional systems for realizing the illustrative DTAF Regulatory Authorization Framework sketch
  - Notional "***DSCF-Light***" *for Lower 7*
    - Adjacent to 6/7 GHz Band
    - Early easier phase: Predominantly though not exclusively Fixed Services
    - **Evolve WInnF's AFC** + Notional *DTAF-Light gap closers*
  - Notional "**Full DSCF**" *for Mid/Upper 7*
    - The greater challenge: Mix of Fixed Services, Fixed Satellite, Mobile Satellite, & Meteorological
    - **Significantly enhance WInnF's CBRS + WInnF/ETSI's DSAS** + Notional *DTAF Phase 3 gap closers*

Sophisticated Protection Mechanisms

- **Adaptive Sensing**: Real-time adaptation and sensing capabilities extend proven technologies
- **Multi-dimensional**: Multi-dimensional approach combines power, frequency, and service considerations
- **Hybrid Methods**: Integration of established methods with innovative techniques
- **Validated Potential**: Models and prototypes show promise for nuanced management
- **Experience-driven**: Learning system designed to improve with operational experience

Security & Privacy for Cross-Domain Spectrum Sharing

- **Advanced Cryptographic Techniques**
  - Fully Homomorphic Encryption (FHE) enabling computation on encrypted sensing data
  - Post-Quantum Cryptography ensuring long-term protection against quantum threats
  - Zero-knowledge proofs validating compliance without revealing operational details
  - Hardware-accelerated encryption supporting near-real-time secure operations
- **Privacy-Preserving Data Handling**
  - Differential privacy frameworks maintaining aggregate accuracy while protecting individual contributors
  - Multi-level anonymization techniques for spectrum usage patterns
  - Temporal and spatial obfuscation preventing correlation attacks
  - Secure multi-party computation for collaborative sensing without exposing proprietary information
- **Mission-Critical & Commercial Trust Framework**
  - Secure obscuration methods with precision-reduction for sensitive operations
  - Geographical boundary enforcement and selective revelation protocols
  - Trusted execution environments for processing sensitive spectrum data
  - Mutual verification protocols between government/defense and commercial systems

Securing the Foundation for Next-Generation Sharing

- Balancing transparency with necessary confidentiality; Protecting competitive and national security interests
- Creating verifiable trust without compromising operational security; Enabling collaboration between stakeholders with different security requirements

Evidence-Based Optimization

- **Data-Driven**: Continuous monitoring framework designed for data-driven refinement
- **Efficiency Gains**: Models suggest overall spectral efficiency improvements
- **Phased Validation**: Scaled phased implementation to provide empirical validation
- **Collective Learning**: Each deployment contributes to shared knowledge base
- **Joint Assessment**: Collaborative assessment will identify refinement opportunities
- **Implementation Insights**: Practical implementation will help refine both technology and understanding

A Notional Path Forward for All Stakeholders

Mature conceptual regulatory/technical approach launched from proven spectrum management frameworks, *accommodating diverse needs*:

- **Tested Advancements**: Combines proven precedents with promising innovations
- **Evolutionary Implementation**: Implementation as both deployment and learning journey
- **Focus on shared objectives**:
  - Reliable connectivity; Innovation enablement
  - Economic growth; Efficient resource utilization
- **Validated Foundation**: Starting bases are proven, theoretical foundation is strong, path forward involves continued collaborative validation

Conclusion: An Invitation to Leadership

Forward Thinking: Embracing sophisticated frameworks for modern communication needs

Evolutionary Step: DTAF represents significant step in spectrum management evolution

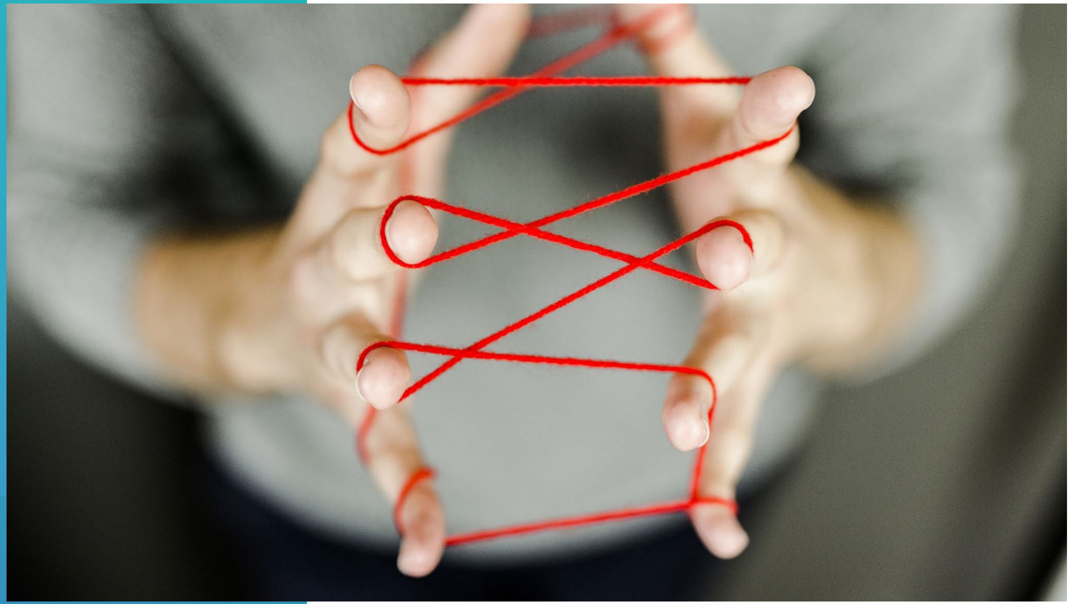
Collaborative Growth: Not a finished product but a promising framework for collective refinement

Leadership Opportunity: Opportunity to lead in intelligent spectrum utilization

Strategic Necessity: Starting from a pioneering history and the solid cross-ecosystem foundation of WinnForum Spectrum Sharing, this journey of discovery and validation is a strength, not a weakness… and given the geo-strategic environment, arguably a necessity.

TRANSITIONING TO DTAF NOTIONAL PHASE 3:

ILLUSTRATIVE COUNTRY-SPECIFIC PATHWAY SKETCHES



PathfinderWireless

Building on Global Success

International implementations provide valuable reference points:

Each notional country sketch could follow a different “regulatory + system” transition path to implement DTAF notional Phase 3 for the 7250-7900 (8400) MHz band, building on their existing C-band sharing regulatory/system frameworks.

To stimulate conversation and for illustration-purposes only, here are per-country *notional* pathway suggestions of how each country could leverage these *rough sketches* of their current approaches to develop a comprehensive DTAF Phase 3 implementation roadmap.

Illustrative Pathway Sketch:
Technical Approaches to Sharing

Across these different regional implementations, several common technical approaches have emerged:

1. **Geographic Separation**: Creating dynamically adjustable exclusion or coordination zones around earth stations based on propagation modeling and interference analysis.
2. **Advanced Filtering**: Requiring improved filtering on either earth station receivers, 5G equipment, or both to enable closer co-existence.
3. **Power Control**: Implementing variable power limits based on location relative to earth stations.
4. **Beam Steering**: Requiring 5G systems to implement null-forming or reduced power in directions toward sensitive earth stations.
5. **Time-Based Sharing**: Coordinating operations based on satellite usage patterns and scheduled transmissions.
6. **Sensing and Monitoring**: Deploying spectrum sensors to verify protection effectiveness and enable dynamic adjustment.

Illustrative Pathway Sketch:
Common Implementation Elements

Despite their different starting points, all countries would need to address certain fundamental requirements:

1. **Regulatory Framework Development:** Establish clear rules for the three power classes and their authorization requirements.
2. **Database Infrastructure:** Create or enhance systems to manage registrations and authorizations across power classes.
3. **Sensing Network Deployment:** Develop capabilities to detect and characterize the different satellite services.
4. **Protection Algorithm Development:** Create sophisticated algorithms for calculating dynamic protection zones.
5. **Monitoring and Feedback Systems:** Implement continuous verification to ensure protection effectiveness.

A transition to a notional DTAF Phase 3 represents a significant evolution in spectrum management practice, though by building on their existing C-band regulatory frameworks, countries can create realistic implementation roadmaps that leverage their current capabilities while progressively developing more advanced features.

Illustrative Pathway Sketch:
Japan: Refining an Already Advanced System

Along w/ extensions to US CBRS, Japan's dynamic multi-zone system for C-band provides a natural foundation for DTAF Notional Phase 3. Their transition would be more evolutionary than revolutionary:

1. **Extend Dynamic Zoning:** Adapt their dynamic protection zone algorithms from C-band to the four distinct segments of 7250-7900 MHz, integrating satellite-specific parameters for each service type.
2. **Implement Power Tiers:** Add power classification to their authorization framework, creating differentiated pathways for very low-power, low-power indoor, and standard/medium-power equipment.
3. **Enhance Sensing Networks:** Expand their monitoring system to detect the diverse signal types in the 7 GHz range (FSS, MSS, and meteorological).
4. **Integrate Weather Systems:** Connect their protection system with meteorological databases to implement special protections for weather satellite operations in the 7450-7550 MHz and 7750-7900 MHz segments.
5. **Develop Cross-Service Prioritization:** Add regulatory status-aware decision algorithms to their existing system to handle the mixed primary/secondary status of different services.

From at least a systems-only standpoint, Japan could likely implement DTAF Phase 3 within perhaps 12-18 months or so, as they would primarily need to recalibrate their existing fairly sophisticated system rather than build entirely new capabilities.

Illustrative Pathway Sketch:
United Kingdom: *Building on Automated Authorization*

The UK's location-specific automated authorization system provides a strong foundation for DTAF Phase 3:

1. **Extend Risk-Based Assessment:** Adapt their existing risk-based authorization algorithms to incorporate the multiple satellite services in the 7 GHz band, with service-specific protection criteria.
2. **Add Power Class Pathways:** Enhance their existing tiered authorization categories to align with the three power classes in DTAF, creating streamlined pathways for very low-power devices.
3. **Develop Real-Time Capabilities:** Transition from their primarily static database approach to a more dynamic system with continuous updates based on sensing data.
4. **Deploy Sensing Network:** Add a distributed sensing infrastructure to provide real-time inputs to their authorization system.
5. **Implement Continuous Monitoring:** Extend their compliance verification system to include ongoing monitoring that feeds back into authorization parameters.

With their advanced database system already in place, from at least a systems standpoint, the UK could implement a basic version of DTAF Phase 3 within perhaps 18-24 months or so, with full sensing integration requiring perhaps an additional 12-18 months or so.

Illustrative Pathway Sketch: South Korea: *From Research to Implementation*

South Korea's research focus provides technical foundations but would require operational expansion:

1. **Apply Research Findings:** Convert their test bed findings into operational specifications for DTAF implementation.
2. **Implement Power-Tiered Authorization:** Start with streamlined authorization for very low-power devices based on their research results.
3. **Expand Test Deployments:** Gradually extend their limited deployments to broader areas using their research-validated parameters.
4. **Deploy Enhanced Sensing:** Leverage their research on interference detection to create a comprehensive sensing network.
5. **Develop Full Dynamic Protection:** Build on their technical expertise to create a fully dynamic protection system.

From at least a systems standpoint, South Korea could potentially implement DTAF Phase 3 within, say, 24-36 months or so by leveraging their extensive research base, though regulatory adjustments might take additional time.

Illustrative Pathway Sketch:
France: *Evolving Tiered Zoning*

France's sophisticated multi-tier system provides a natural pathway to DTAF Phase 3:

1. **Enhance Propagation Models:** Extend their advanced propagation modeling from C-band to the 7 GHz range, accounting for the different propagation characteristics.
2. **Segment-Specific Protection:** Adapt their existing three-tier zoning to create specialized protection for each of the four frequency segments.
3. **Implement Power-Based Authorization:** Add power class distinctions to their existing tiered system, creating streamlined pathways for lower-power devices.
4. **Develop Satellite Detection Capabilities:** Build on their propagation expertise to add real-time sensing of satellite transmissions.
5. **Create Dynamic Feedback Loop:** Transform their primarily static zones into dynamically calculated areas that respond to actual conditions.

From at least a systems standpoint, France could implement most of DTAF Phase 3 within perhaps 24 months or so, leveraging their strong technical foundation in propagation modeling and graduated protection zones.

Illustrative Pathway Sketch:
Australia: *From Geographic to Dynamic Zoning*

Australia: Australia's clearly defined geographic approach provides a strong starting point, though appears to require significant enhancement:

1. **Convert Static to Dynamic Zones:** Transform their clear geographic categorization into dynamically calculated zones based on actual transmission parameters.
2. **Develop Sensing Infrastructure:** Deploy sensors near earth stations to provide real-time data on satellite operations.
3. **Implement Power Class Tiering:** Add power class distinctions to their authorization framework, starting with the simplest (very low-power) category.
4. **Create Service-Specific Protection:** Extend their existing protection framework to account for the different characteristics of FSS, MSS, and meteorological services.
5. **Develop Continuous Monitoring:** Add feedback mechanisms to adjust protection parameters based on actual observations.

From at least a systems standpoint, Australia would likely need about 24-36 months or so to fully implement DTAF Phase 3, with initial deployment focusing on static implementation of the power classes and frequency segments.

Illustrative Pathway Sketch:
Germany: From Manual to Automated Analysis

Germany's case-by-case approach could require perhaps the most significant transformation and enhancement set:

1. **Systematize Analysis Methods:** Convert their detailed manual assessments into algorithmic approaches that can be scaled and consistently for automated application.
2. **Develop Authorization Database:** Create a centralized system incorporating the protection criteria they have been applying manually.
3. **Implement Power Class Fast-Tracks:** Start with automated pathways for very low-power devices while maintaining manual review for higher-power operations.
4. **Develop Sensing Capabilities:** Deploy sensing infrastructure to complement their detailed technical analyses.
5. **Create Dynamic Protection Zones:** Gradually transition from static to dynamic protection zones as operational experience grows.

From at least a systems standpoint, Germany would likely require perhaps 36-48 months or so for full implementation, though could begin with the automated very low-power authorization pathway within, say, 18 months or so.

Illustrative Pathway Sketch:
Nigeria: Building Regional Integration

Nigeria's regional protection framework provides a foundation that appears to require significant enhancement:

1. **Extend Regional Framework:** Adapt their three-zone approach from C-band to create service-specific regions for the 7 GHz band.
2. **Implement Power-Tiered Authorization:** Start with simplified authorization for very low-power devices in urban development zones.
3. **Develop Technical Capabilities:** Build technical expertise and infrastructure for more sophisticated protection calculations.
4. **Create Cross-Border Coordination:** Develop mechanisms for enhanced coordination with neighboring countries for satellite services with continental footprints.
5. **Establish Monitoring Infrastructure:** Deploy basic monitoring capabilities, initially in urban areas and gradually extending to other regions.

From at least a systems standpoint, Nigeria could implement a basic version of DTAF (power classes and static protection) within, say, 24-36 months or so, with full Phase 3 capabilities requiring perhaps 48-60 months or so of progressive development.

Illustrative Pathway Sketch:
Kenya: *Accelerating the Graduated Approach*

Kenya: Accelerating the Graduated Approach

Kenya's time-phased transition provides a logical pathway that could be accelerated:

1. **Create Power-Based Fast Tracks:** Implement streamlined authorization for very low-power devices as an immediate step.
2. **Develop Enhanced Protection Framework:** Build on their existing coordination requirements to create service-specific protection criteria.
3. **Segment-Specific Implementation:** Implement protection for the different frequency segments in phases, starting with the most critical (meteorological).
4. **Build Technical Infrastructure:** Develop the database and sensing infrastructure needed for dynamic protection.
5. **Transition to Dynamic Protection:** Gradually move from static to dynamic protection as capabilities mature.

From at least a systems standpoint, Kenya could implement basic power-tiered authorization within, say, 18-24 months or so, with full DTAF Phase 3 requiring perhaps 36-48 months or so of staged development.

Illustrative Pathway Sketch:
Colombia: *From Economic Zones to Service Zones*

Colombia's economic development zone approach could evolve into DTAF Phase 3:

1. **Redefine Zone Types:** Adapt their three-zone approach to account for both economic priorities and the specific satellite services in the 7 GHz band.
2. **Implement Simplified Authorization:** Create streamlined pathways for very low-power devices in Innovation Districts.
3. **Develop Enhanced Technical Framework:** Build more sophisticated protection calculations that account for different service types.
4. **Deploy Basic Sensing:** Start with sensing infrastructure in shared areas to refine protection parameters.
5. **Create Dynamic Authorization System:** Gradually transition from static to dynamic authorization as operational experience grows.

From at least a systems standpoint, Colombia could implement the basic power-tiered framework within, say, 24 months or so, with full DTAF Phase 3 capabilities requiring perhaps 36-48 months or so of development.

Illustrative Pathway Sketch:
Peru: *Leveraging Topographical Advantages*

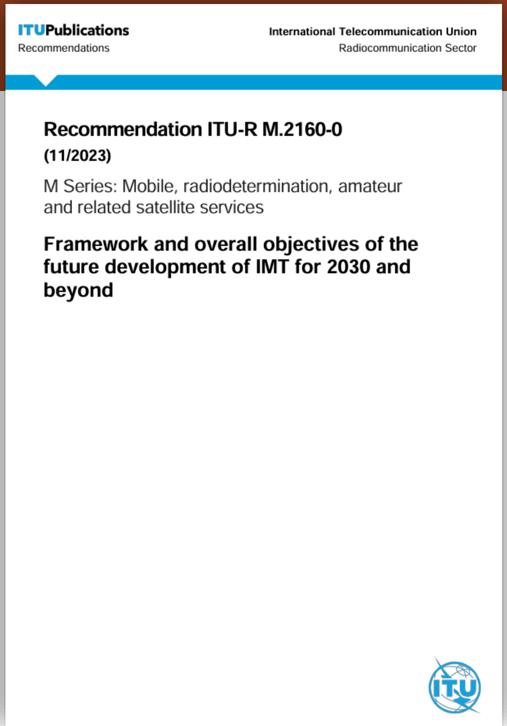
Peru's altitude-based approach provides unique opportunities for DTAF implementation:

1. **Extend 3D Modeling:** Adapt their three-dimensional propagation modeling to the 7 GHz range, accounting for different propagation characteristics.
2. **Implement Power-Tiered Authorization:** Create simplified pathways for very low-power devices, particularly in mountainous regions where natural shielding exists.
3. **Develop Service-Specific Protection:** Enhance their existing framework to account for the different satellite services in the 7 GHz band.
4. **Deploy Strategic Sensing:** Implement sensing at key locations where terrain creates natural sharing opportunities.
5. **Create Terrain-Aware Dynamic Protection:** Develop protection algorithms that dynamically account for both terrain and actual operations.

From at least a systems standpoint, Peru could implement basic DTAF capabilities within perhaps 24-36 months or so, with their existing 3D approach providing advantages for certain aspects of the framework.

Sharing-Native 6G,
& Dynamic Coordination

Global 6G definition *is still emerging*



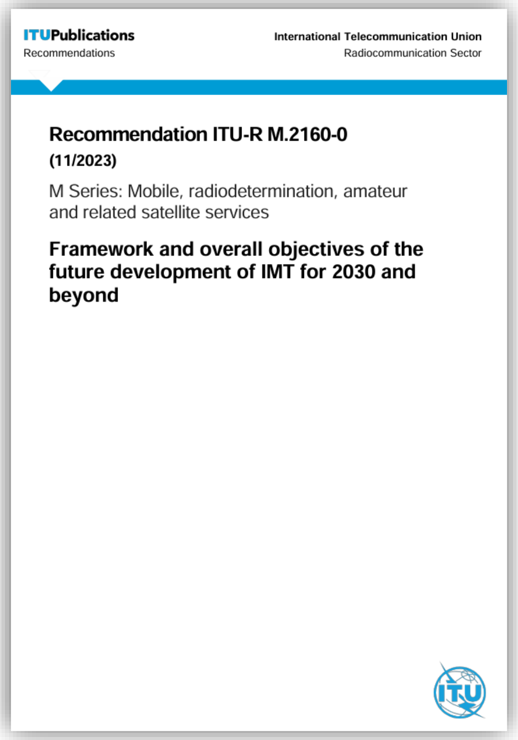
The definition of 6G definition is still emerging and is greatly though not entirely anchored in ITU-R WP5D's *ITU IMT-2030 Framework, Rec. ITU-R M.2160-0*.

Other ITU groups (eg: ITU-R WP4 and broader WP) and various related non-ITU group specs and needs are also being addressed in the yet TBD emerging 6G HetNet.

6G as a network of networks–or HetNet (heterogeneous network)–is an essential IMT-2030 pillar. This HetNet is expected to provide unprecedented performance, reliability, and effectiveness empowering people and businesses to use it and innovate with it for a broader and deeper set of use cases, environments, and sectors

[R-REC-M.2160-0-202311-I!!PDF-E (itu.int)]

IMT-2030 HETNET RELATIONSHIPS


ITUPublications
Recommendations

International Telecommunication Union
Radiocommunication Sector

Recommendation ITU-R M.2160-0
(11/2023)

M Series: Mobile, radiodetermination, amateur and related satellite services

Framework and overall objectives of the future development of IMT for 2030 and beyond

"5.1.2) Relationship between IMT-2030 and *other access systems*
The user experience could be enhanced when users have the option to access a variety of services, anytime and anywhere.

This objective can be facilitated through interworking between different access networks. External standards developing organizations involved in the development of IMT radio interface technologies have ongoing standardization activities that facilitate IMT interworking with non-terrestrial networks of IMT (including satellite communication systems, HIBS and UASs), as well as with other non-IMT terrestrial networks (including RLAN and broadcast).

IMT-2030 should continue this path of interworking to offer users an improved connectivity experience, including the option of offering ubiquitous and continuity of services, in line with service and operational goals**."**

R-REC-M.2160-0-202311-I!!PDF-E (itu.int)

WInnForum Standards™

WIRELESS INNOVATION FORUM®

What is "Sharing Native 6G"? *What might it be to you?*

- "***Sharing Native 6G***", Monisha Ghosh, 2022
- "*AI-native, API-native, spectrum sharing-native, security-native,… in short let's call that* ***X-native designs for 6G",*** Bell Labs President Peter Vetter, Spring '24 6G Symposium
- Our X-Native 6G focus? Sharing-Native 6G (*SN6G*), where spectrum sharing in the 6G era is a fundamental capability incorporated *"By design"*

Sharing Native 6G / Sharing By Design?

- Part of 6G-era HetNet & one of the "X-Native 6G" pillars (AI Native 6G, NTN Native 6G*,* Security Native *6G +) **Sharing Native 6G*** refers to a wireless communications architectural and design approach where the spectrum sharing capability is, ***by design****, **deeply integrated into the 6G HetNet system**, enabling enhanced spectrum efficiency, effectiveness, capacity, and multi-service/multi-allocation inter-system/inter-service coexistence.
- **For *all* forms of national regulatory authority authorized spectrum licensing and use**.
- Designed and built to **seamlessly integrate with one or more sharing regimes or frameworks** at various granularities of frequency/temporal/spatial envelopes.

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* *6G Principles Joint Statement*, Feb 26, 2024

WIRELESS INNOVATION FORUM

Sharing-Native 6G: Dynamic Coordination

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Sharing-Native 6G & Dynamic Coordination

From the latest paper from she who coined it, Monisha Ghosh:
"A New Paradigm: Mid-Band, Sharing-Native 6G"

- **Low-power indoor or medium-power outdoor operation** instead of high-power exclusively licensed spectrum use - allowing >1 GHz of spectrum to be reused for commercial wireless (similar to 6 GHz band)
- **Built-in sensing capability within the 6G network architecture** - implementing "quiet periods" in the frame format when all transmissions cease, enabling distributed sensing at base stations and client devices to detect incumbent activity
- **Database-coordinated sensing** - using a database to coordinate sensing results for better incumbent protection, rather than relying on separate sensing networks like ESC/SAS in CBRS.

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Wireless Innovation Forum 86th General Meeting & ISS Workshop

Sharing-Native 6G & Dynamic Coordination

- **Granular parameter reporting** - having networks report detailed parameters like RSRP, SINR, and RSRQ to databases to enable better management of secondary interference than current SAS systems

- **Native protocols for secondary coexistence** - developing mechanisms that allow 6G to operate seamlessly across all spectrum types (exclusively licensed, shared licensed, and unlicensed)

These recommendations aim to maximize spectrum efficiency while addressing the reality that over 80% of mobile data originates or terminates *indoors*, and that displacing incumbent spectrum users is increasingly difficult.

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Cross-Technology Signaling for Dynamic Coordination: Extending the Sharing-Native 6G Framework

WiFi 6/7 CTS (Clear to Send) Extensions

•**Enhanced Cross-Tech NAV (Network Allocation Vector)**:

- Extends WiFi's protection mechanism to be understood by 6G systems & vice-versa
- Addresses identified CBRS secondary coexistence issues
- Enables better spectral efficiency in dense deployments

WiFi 7/8: Advanced Coordination Mechanisms

•**C-TDMA (Coordinated Time Division Multiple Access)**

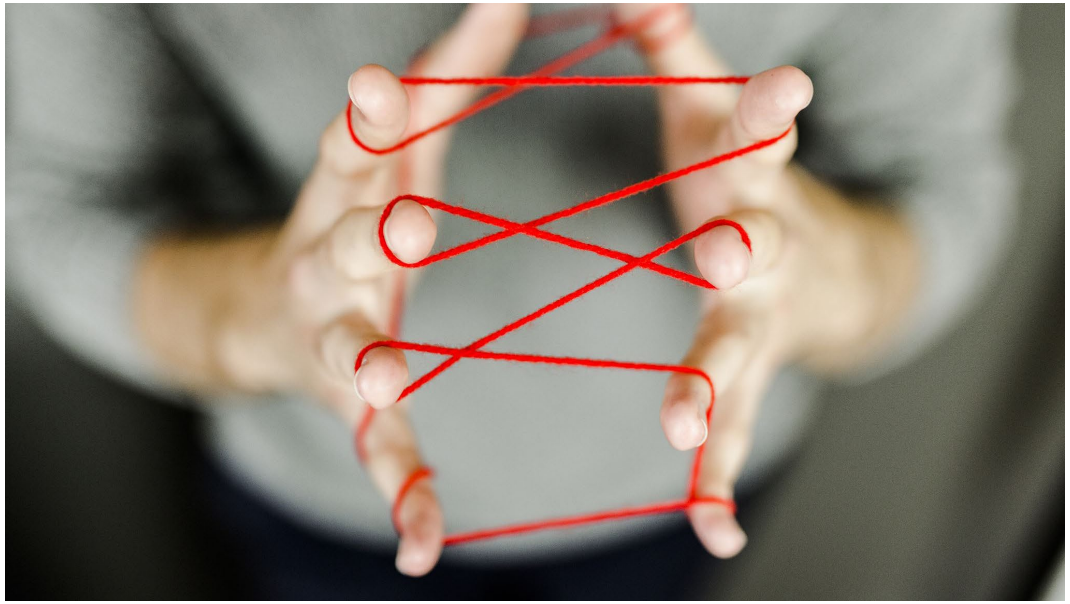
- Synchronizes 6G "quiet periods" (Ghosh recommendation) with WiFi transmission windows
- Reduces adjacent TDD interference by 85-90% compared to current CBRS deployments
- Real-time dynamic slot allocation with 1ms negotiation overhead

•**C-Spatial Scheduling with ML-Enhanced Prediction**

- Coordinated beamforming between technologies reduces mutual interference
- ML algorithms predict usage patterns for proactive resource allocation
- Key enabler for vision of high-density indoor deployments

INTELLIGENT SPECTRUM SENSING: THE FOUNDATION FOR 6G-ERA SHARING

TRANSFORMING SPECTRUM AWARENESS FOR DYNAMIC ACCESS



Multi-Technology ISAC for Intelligent Spectrum Sensing
Converging Domains for Advanced Sharing

•ISAC Integration Across Technologies

- Unified sensing & communications across WiFi, 5G/6G, UWB, Radar, Other platforms
- Standalone as well as Federated/Collaborative sensing between commercial and mission-critical systems
- Enhanced spectrum awareness through multi-domain sensor fusion

•Beyond Traditional Boundaries

- Moving from protected incumbents to active collaboration
- Spectrum sensing as a service between commercial and government/defense users
- Shared environmental awareness improving efficiency for all users

•Technical Foundations

- Distributed sensing networks with common lowest common denominator information-elements and models
- Cross-technology coordination protocols
- Federated sensing architecture with privacy/security guarantees

Low Latency O-RAN Interfaces for Cross-Technology Coordination:

Implementing the Sharing-Native Vision Through Open Architecture

Next-Generation O-RAN Interface Enhancements

Next-Generation O-RAN Interface Enhancements

O-CU (Centralized Unit) Interface Extensions

- **Latency**: Reduces coordination latency
- **Sensing Integration**: Direct pipeline for sensing data
- **Spectrum Decision Engine**: Physics-enhanced ML-based accurate interference prediction

O-DU (Distributed Unit) Real-Time Coordination

- **Enhanced E2 Interface**: Supports cross-technology management with low response time
- **Multi-RAT Coexistence Protocol**: Standardized signaling between WiFi/6G/IoT/Other systems
- **Implementation Timeline**: 2026-2028 aligned with early 6G deployments

•**O-RU (Radio Unit) Sensing Capabilities**

- **Integrated Spectrum Sensing**: augmented whole-system sensitivity
- **Directional Incumbent Detection**: Maps protected zones with high spatial resolution
- **Key Technology**: Enables Ghosh vision of "quiet periods" for distributed sensing, while mitigating duty-cycle tradeoffs in real time via closed loop AI optimization

Potential Benefits and Use Cases:

•**Industrial IoT**: Critical guaranteed QoS while maximizing spectrum efficiency
•**Dense Enterprise Environments**: potential capacity increase for indoor private networks
•**Public Venues**: Enables harmonized operation between neutral host 6G and venue WiFi
•**Deployment Cost Reduction**: lower CAPEX through shared spectrum access

THANK YOU

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