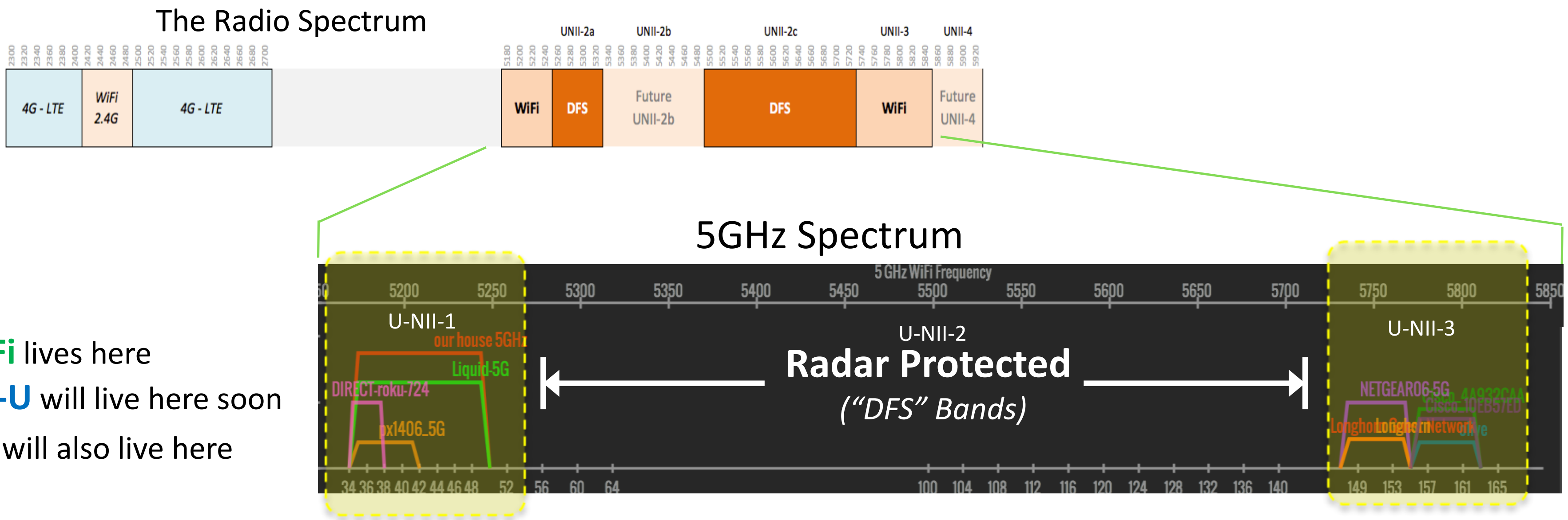
Ignition Design Labs

New Technologies to Modernize DFS

MIC MRA International Workshop 2017, Tokyo **23 March 2017**

Terry Ngo, CEO

The Need for DFS Spectrum



WiFi lives here
LTE-U will live here soon
5G will also live here

Crowded !!

Not Available or Crowded !!

3x more Public Spectrum than Licensed Bands

… more than 75% of it (and all new Spectrum) is ***Radar-Protected***

80% of all Internet Access today is primarily thru WiFi

Bad WiFi during peak periods is # complaint of consumers to their ISP ... Getting Worse!

98% of Consumers using less than 35% of Available Spectrum ... 65% is going unused

75% of air-time(1) is wasted due to collisions … WiFi becoming victim of it’s own success!

Note: (1) survey of moderate-dense urban areas, between peak internet usage period 8pm and 12am

What is DFS spectrum and its difficulty

More than half of 5GHz band for WLAN system is **radar priority band**.

Then before using a channel, the system needs to monitor for a minute if radar doesn't exist or not (we call it **CAC: Channel Availability Check**).

After the system clears CAC, it can start using the channel.

Also while using the channel, the system needs to monitor the channel if a radar come into the channel (we call it **ISM: In Service Monitoring**).

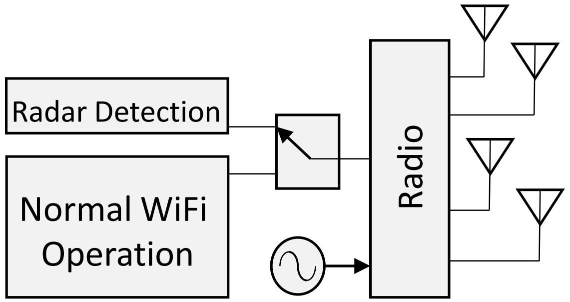
If the system detect a radar in service, the system has to stop using the channel in 10 sec (**CMT: Channel Move Time**) and aggregated transmission time shall be in 260 ms (**CCT: Channel Closing Time**).

We call the band as DFS band usually because above features are implemented using **DFS (dynamic frequency selection**) technique.

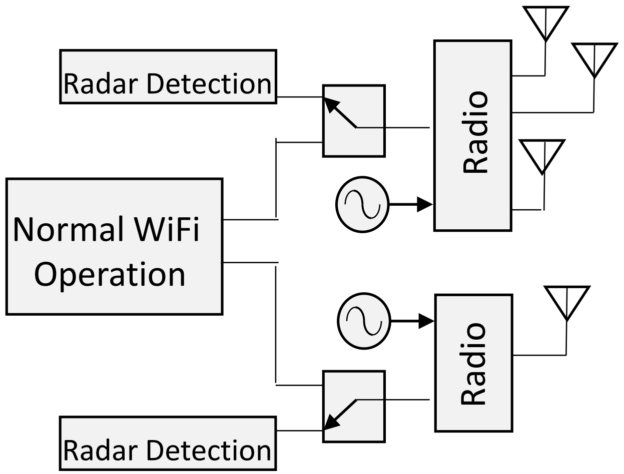
<u>Use case example (the case that Wi-Fi user enjoy YouTube video with DFS channel);</u>

If the system detects radar, then channel has to move to another channel. If the target channel is also the DFS channel, target channel can be used after 60 second monitoring (CAC). That means the video stops for 60 sec suddenly in standard implementation.

DFS Today – Challenges & Limitations



Technique #1 *"Background Scan"*



Technique #2 *"Stream Stealing"*
(aka "zero wait")

Conventional Radar Detection Techniques used Today

Background scan re-use existing WiFi radio to time-multiplex radar detection and normal WiFi Operation

- Enables single DFS channel.

Stream Stealing use 1 of N WiFi streams to "look ahead" CAC+ISM a secondary DFS channel

- Enables a primary DFS channel, and zero-wait change to secondary DFS channel
- Relies on use of "off-channel CAC" rules; not avail in US or Japan

Limitations of Conventional Techniques

- *Inconsistent implementation*, left up to individual equipment maker
- Susceptible to *False Detects* and *False Negatives (missed radar)*
- Performance *compromised by WiFi operational loading*
- Low Usage of DFS Spectrum today … complex, long time-to-market
- What happens next? DFS spectrum is over-used becomes crowded

Off channel CAC(in ETSI terms only); AP is periodically and non-continuously going off the home channel to look at another channel as part of the CAC process. The process is called off channel CAC.

DFS Future – The Need for Better Radar Detection

Standardized Methodologies

- Eliminate risk and inconsistencies of individual implementations by each equipment makers

  Example Risks: Consumer tampering and/or Vendor disablement of radar detection.
  Operational Mode vs Test Mode ("Volkswagen" problem).
  False Negatives (missed radar)
- Standardize Performance and Assured Compliance … towards a "gold standard"
- Reduce cost and streamline compliance testing …. towards "pre-certified" or "modular" certification?

Improved Performance

- Reduce False Detection, and Eliminate missed radar
- Eliminate differences between Operational vs Test Mode.

Simplified Implementation, Streamlined Compliance

- Reduced development and compliance testing cost.
- Faster Time-to-Market. Enable more wide-spread use of DFS Spectrum

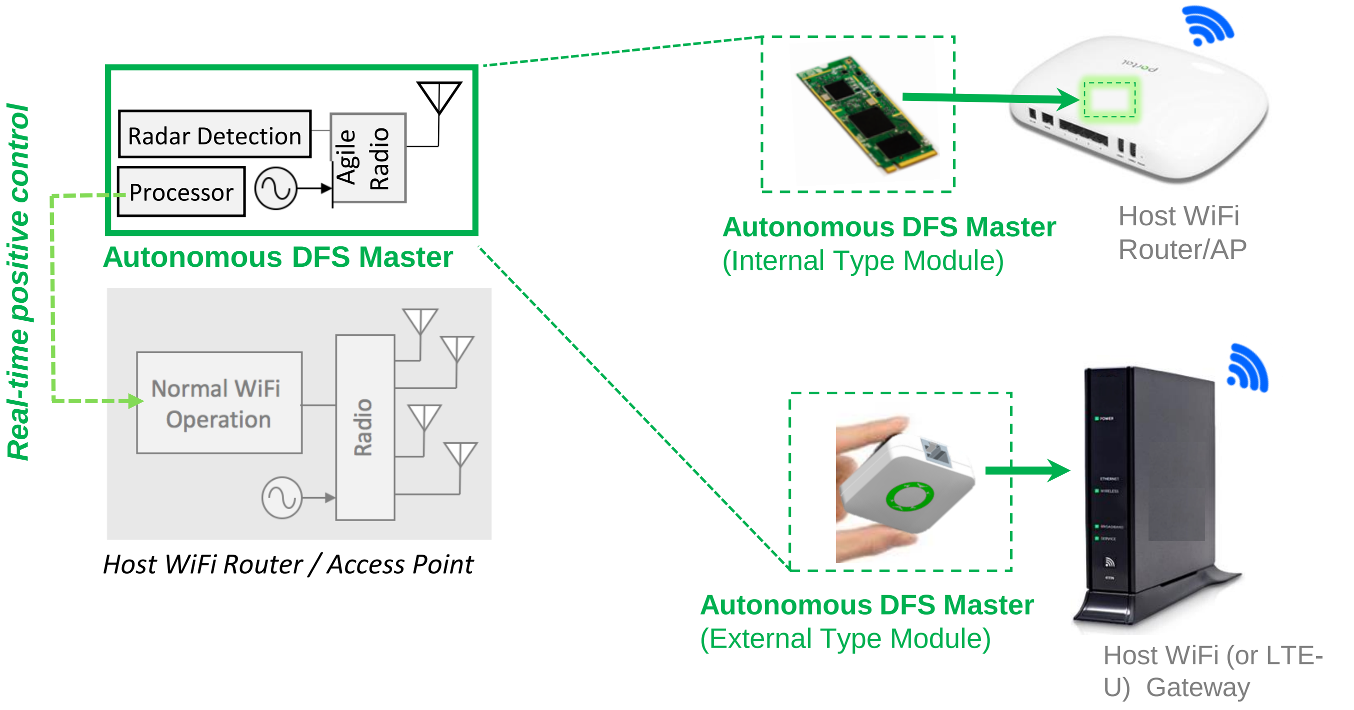
Improved Spectrum Efficiency

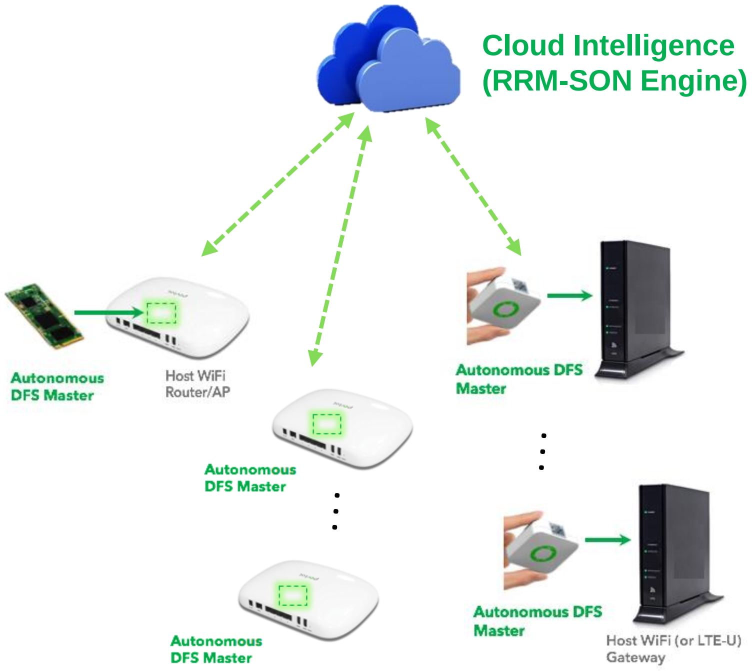
- Better coordination between devices using DFS channel
- Avoid gridlock and "new highway" syndrome

A New Approach to DFS

Autonomous Modular DFS Master

- Dedicated & Continuous Radar Detection
- Independent of Host WiFi Radio & Processor
- Standardized Methods and Implementation
- Modular Self-Contained
  … towards Pre-certification

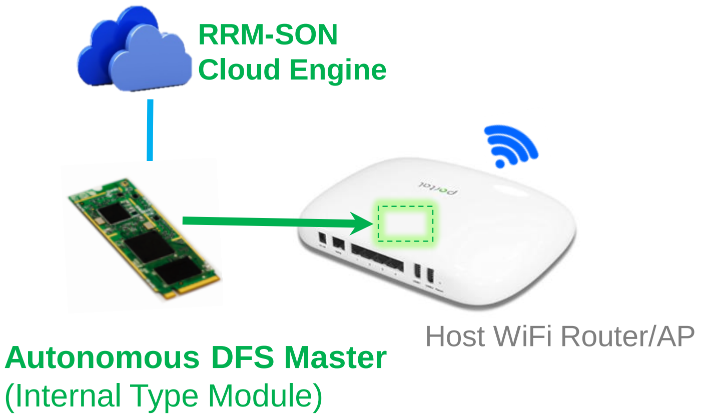


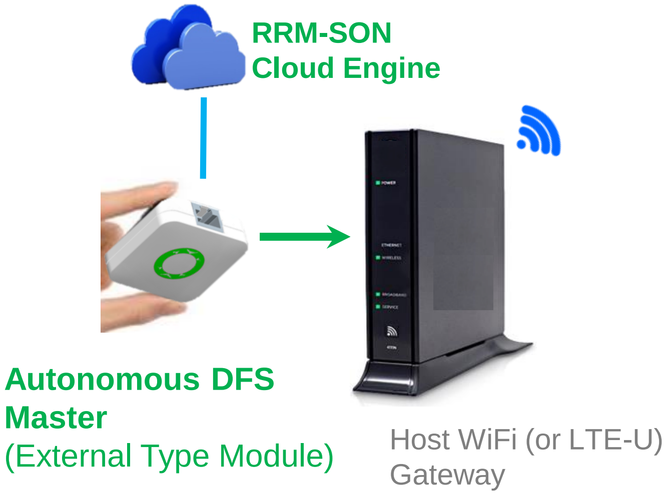


Cloud Networked

- Computational assistance and persistent memory
- Advanced Techniques not possible in purely embedded architecture: Data Fusion, Machine Learning, Dynamic Environment Adaptation.
- Continuously updating and "Self Learning"
- Wide area coordination
  - Efficient Channel Re-use, Self-Organizing, Self-Healing

An Autonomous Modular DFS Master





Dedicated Radar Sensor

- Independent of Host WiFi System … no sharing of radio or processor resources
- Not affected by loading of host WiFi system … reduced false-detection
- Continuous Real-Time Radar Detection … higher accuracy, inherent redundancy
- Wideband and Multiple Simultaneous Channels.
- Standardized Methods, Deep library of patterns, continuously updating, self-learning
- Multiple simultaneous regulatory regions … assured compliance worldwide.
- Future: “umbrella of DFS Coverage” to multiple devices over an area.

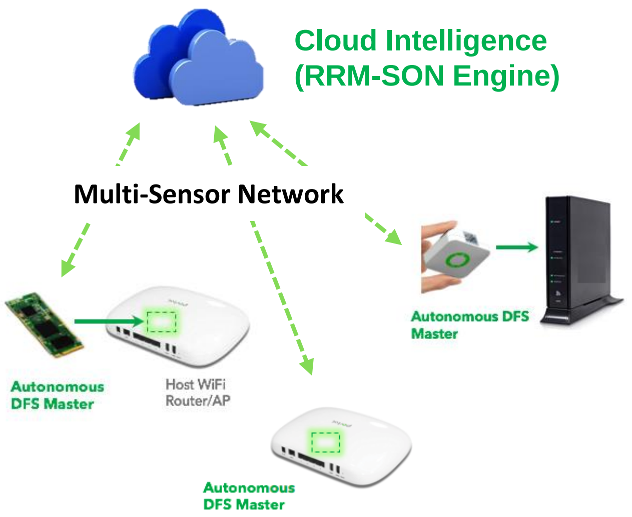
Independent DFS Master

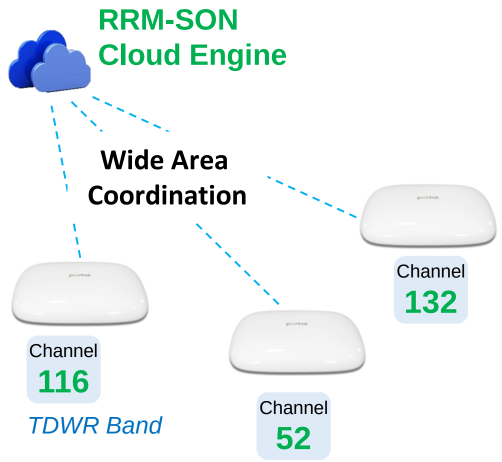
- Independent detection, decision, control, compliance functions are de-coupled from host system
- Uniform Consistent Implementation … towards a “gold standard”
- Streamlined Compliance: Certify Once, Use Anywhere.
- Modular … Simlified Implementation, Lower Cost, Faster Time-to-Market.
- Tamper Resistant: Cannot be disabled or compromised by consumer.

Standardized Sensor Networking

- Standardized Method to coordinate with other radar sensors for improved sensitivity, reduced false detection, reduced false negatives (missed radar).

A Spectrum-Aware Cloud Network





Computational Assistance

- Leverage vast memory and massive processing capabilities of cloud
- Advanced signal processing techniques augment limited capabilities of embedded radar detector in local sensors (ie. each autonomous DFS masters)
- Improved convergence: combined Real-time (embedded) + non-real-time (cloud)
- Reduction of false detection rate. Elimination of false negative (missed radar)
- Continuous updates: new radar patterns, new algorithms, new limits, etc…

Multi-Sensor Network

- Multiple Autonomous DFS Masters report radar detection readings to cloud
- Advanced Data-Fusion merges over-lapping sensor readings.
- Leverage geo-location and other information
- Improved detection sensitivity.
- Improved adaptation to environment. Self-learning, self-healing

Wide-Area Spectrum Coordination

- Coordinated channel allocation. Dynamic channel agility.
- Geo-fencing to eliminate false negative (missed radar), etc...

Summary

Improved Access to DFS Spectrum critical for growth of Consumer Internet

Current Radar Detection Techniques are Inadequate

Better Radar Detection Methods Needed

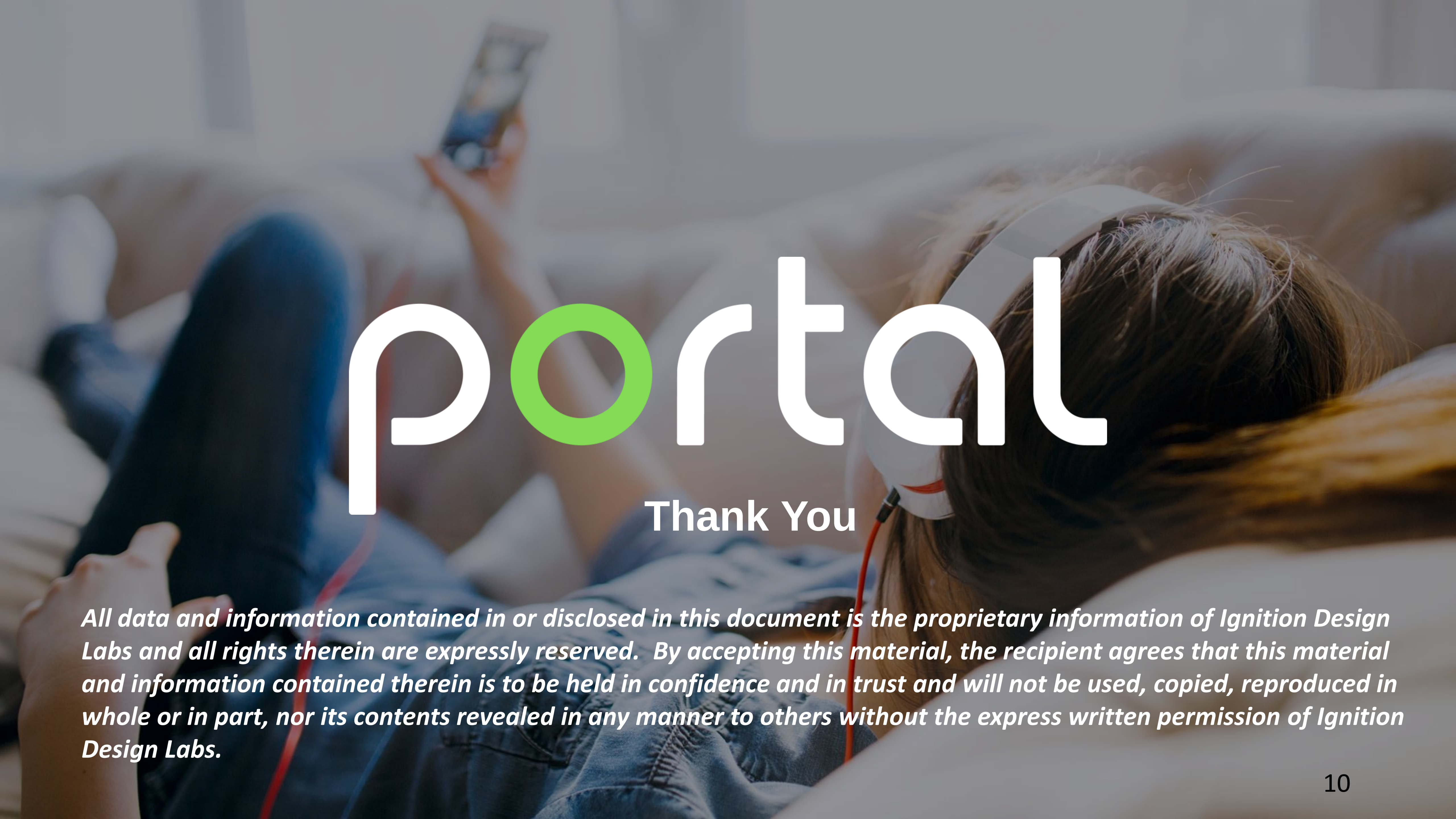
- Standardized Methodologies
- Improved Performance
- Simplified Implementation, and Streamlined Compliance
- Improved Spectrum Efficiency

A New Approach to Modern DFS

- Autonomous Modular DFS Master + Spectrum-Location Aware Cloud Network
- Standardized Implementation, Improved Performance (improved sensitivity, reduced false-detect, reduced false negative), Tamper Resistant, Eliminate gap between operational vs test mode.
- Faster Time-to-Market, Streamlined Compliance

Proven in Commercial Deployment

- FCC/IC (North America), MIC (Japan), ETSI (Europe)



portal

Thank You