Challenges to Commercial Use of TVWS

1. Government Regulatory Spectrum Policy
   • Regulatory approval needed to use TVWS

2. Geolocation Database
   • Need to allocate available bands

3. Baseband
   • Need standards-compliant baseband ICs

4. RF Front-End – Aviacomm’s Focus
   • Wideband and frequency agile to cover all bands
   • High-linearity to meet regulations for non-interference
   • Low-power for mobile devices
   • Mass production RF CMOS process
TVWS Dynamic Spectrum Access

Dynamic Spectrum Access Requires Breakthrough Wideband RF Front-end Transceiver Technology
Aviacomm Focuses on Delivering Commercial-Ready RF Front-end Solutions for TVWS
Aviacomm Wideband TVWS RF Front-end

- **New** Aviacomm TVWS RFIC Front-end
  - Flexible operation from 50 MHz to 3000 MHz
  - Meets the challenging FCC TVWS spectrum mask requirements
  - IEEE P802.11af & 802.22 compliant
  - *Only* TVWS RFIC transceiver on the market
  - Being used in TVWS system trials in Japan and by Ofcom in the UK

**ARF3000 Series for TVWS**

- **ARF3010** Wideband RF Transceiver IC

**Feature Summary**
- Broadband tunable RF transceiver
- Performance meets multiple standards
- 3G/4G/LTE, WCDMA, TD-SCDMA, TVWS compatible
- Direct Conversion, 2Rx, and 1Tx
- MIMO/Diversity support
- TDD/FDD operation
- Minimal external components required
- Fully integrated PLL synthesis
- No RX interference, SFM headless calibration functions
- RX DC offset correction
- TX LO isolation enhanced
- Programmable transmit filter
- SPI serial control interface
- Low power consumption

**Specification Summary**
- 

**System Diagram**

Aviacomm RF Front-end subsystem with ARF3010 RF CMOS Transceiver

Aviacomm TVWS TX Spectrum
ARF3010 RFIC Transceiver for TVWS Modems

Tunes to any TVWS band

TVWS Access Point

Long-range High Speed Data TVWS Signal

TV Broadcast Signals

TVWS guard bands between TV broadcast bands prevent inter-regional interference

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RFIC Transceiver Reference Designs

Aviacomm reference designs accelerate time to market

- **New** Aviacomm TVWS RF Modem Development Platform, ADP8010
  - Flexible operation over TVWS bands from 54 MHz to 790 MHz
  - Meets the challenging FCC TVWS spectrum mask requirements
  - Up to 200mW TX power output
  - IEEE P802.11af & 802.22 compliant
  - Flexible interface options: analog IQ, JESD204/207, DigRF

![ADP8010](image)
Aviacomm TVWS Projects

**NICT** – TVWS Field Trials in Japan and Ofcom have plans to use Aviacomm RFIC
  - Qualified Aviacomm’s ARF3010 TVWS transceiver
  - Systems and Baseband supplied by leading companies

**Japan (other)** – TVWS projects using Aviacomm RFIC Transceiver
  - A new TVWS application have been defined

**Microsoft** – TVWS Field Trial with Ofcom in the UK uses Aviacomm RFIC Transceiver
  - System & Baseband supplied by 6Harmonics & MediaTek

**Google** – TVWS Field Trial with Ofcom in UK uses Aviacomm RFIC Transceiver
  - System & Baseband supplied by 6Harmonics & MediaTek

6Harmonics Inc. and MediaTek
**TVWS System Equipment Concepts**

**Outdoor Master Access Point (MAP) – 3 sectors**
- Supports multi-nodes wireless mesh to Extended Access Points
- Max output power: +30dBm
- Range up to 3Km / Up to 120Km/h UE Speed
- IP68 enclosure for outdoor installation

**Outdoor Extended Access Point (EAP)**
- Wireless Bridging to Master Access Point (MAP)
- 802.11af and 802.11 compliant
- Range up to 1.5Km
- IP68 enclosure for outdoor installation

**Indoor Extended Access Point (EAP)**
- Wireless Bridging to Master Access Point
- 802.11af and 802.11 compliant
- Supports multiple simultaneous connections
Summary

- New TVWS spectrum provides **major** new market opportunities for Internet connectivity:
  - Devices based on Aviacomm RF technology are ready-for-market!
  - Municipal and commercial opportunities for TVWS are expected to **grow fast**!