Wireless Site Survey, Spectrum Monitoring and Interference Analysis

Tom Hoppin
Application Specialist

April 28, 2016

Co-Sponsored by

Gap Wireless

KEYSIGHT TECHNOLOGIES

Agenda

Introduction: Current Wireless Communication Situation

Spectral Control

Site Surveys

Spectral Monitoring

Interference Analysis

Conclusions

Introduction: Current Wireless Communication Situation

Communication Trends

- Rapid Expansion of Wireless Services
- Increasing Customer Needs and Expectations
- Increased Complexity of Signaling Types

Huge Economic, Social and Security Value

Undesirable Consequence

Spectral Crowding

Difficulty of Deployment of New Services

Increased Potential for Interference

Spectral Control

What is a Site Survey?

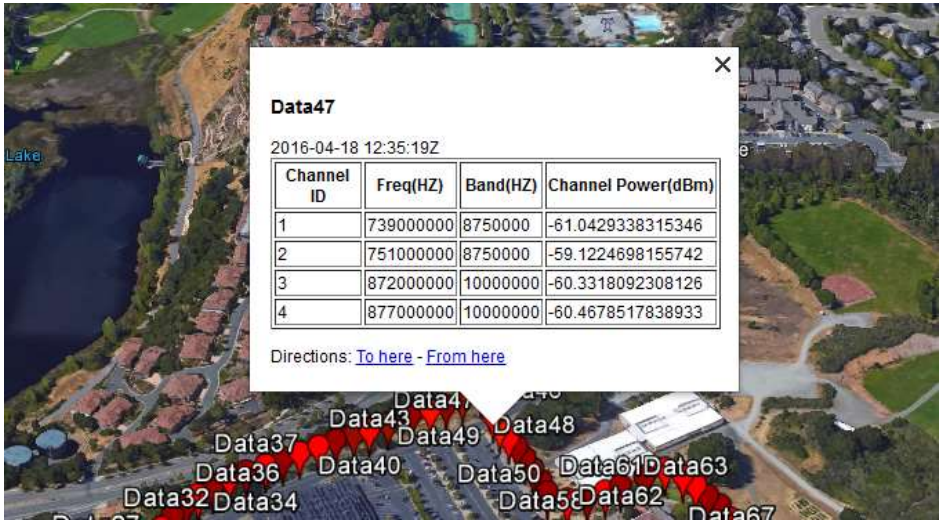
Collection of amplitude measurements as a function of frequency, time, and location

Measurement of the RF/microwave signal strength at one or more locations

Indoor and/or outdoor measurement locations

Site Survey in Google Earth ©

Site Survey Data Detail



Who Performs Site Surveys?

Military and Government

Wireless Service Providers

Hospitals and Universities

Site Characteristics

Surrounding environment will affect RF and microwave signal propagation

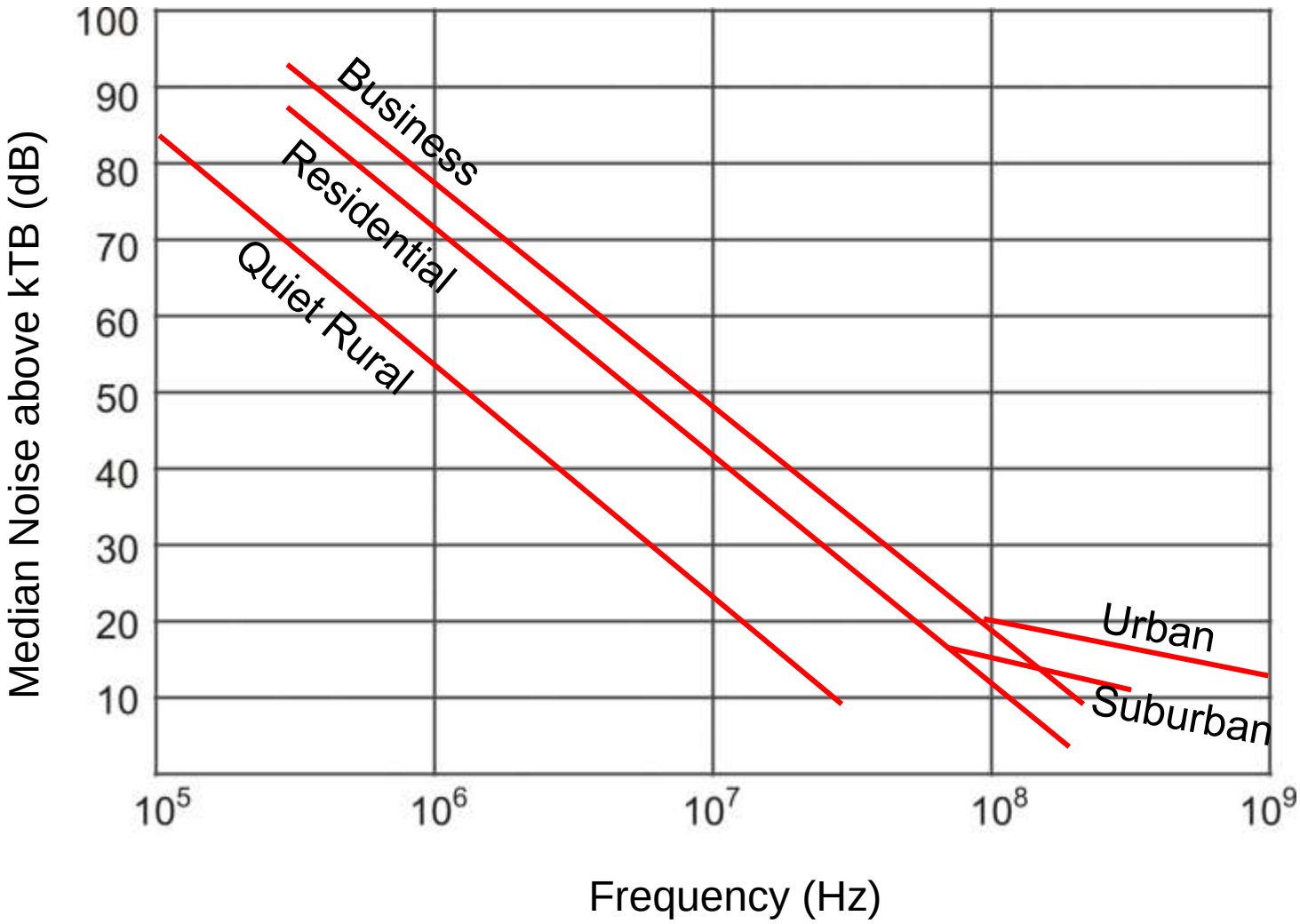
Reflection, scattering and diffraction from buildings, ground and metallic objects

Note location of active transmitters

Note location of buildings, fences, suspended power lines, dense foliage

Use GPS, time stamping and mapping software

Unintended Man-Made Radio Noise



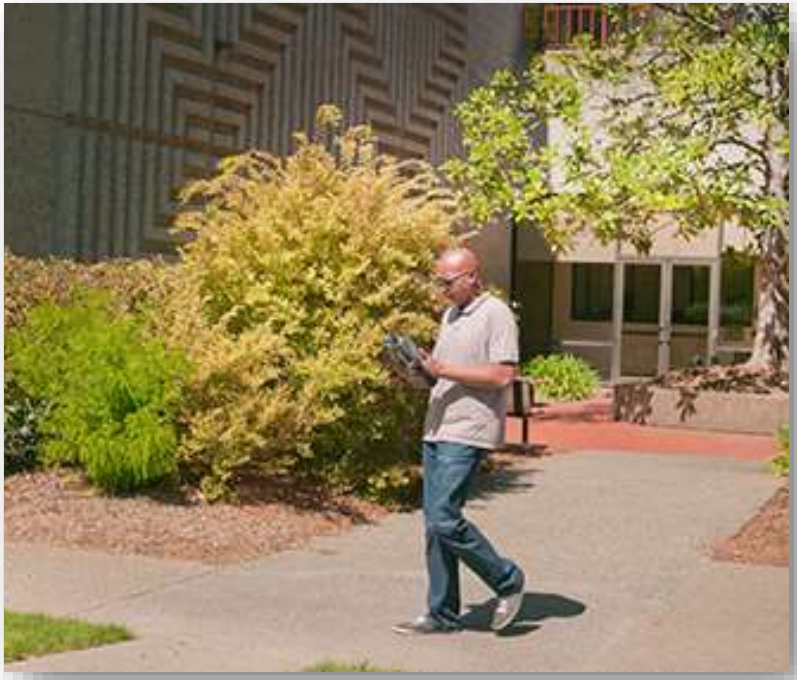
Site Surveys and Spectrum Clearing

Characterize site spectral content

Identify and locate sources of undesired/unlicensed transmissions

Signals can be continuous or transient

Site Survey



Interference Identification & Location

Key Analyzer Specifications for Site Surveys

Frequency range

Sensitivity (DANL), preamplifier function

Range of resolution bandwidths (RBW)

Potential for overload (TOI)

Spurious emissions

Channel scanner function

GPS receiver function

Cable and antenna correction capability

Site Survey Equipment

FieldFox Handheld Spectrum Analyzer with Interference Analyzer option & GPS Capability

Keysight N991xA, N993xA, N995xA and N996xA

Handheld Spectrum Analyzers
Models from 5 kHz to 4, 6.5, 9, 14, 18, 26.5, 32, 44 and 50 GHz

iOS Tablet with Mapping Software, e.g. Google Earth

Spectral Monitoring; Mobile and Fixed Systems

24/7 monitoring of spectrum

High POI to capture intermittent interference

Ability to accurately pinpoint interferers (triangulation, vehicle mounted sensors, handheld sensors)

Ability to identify and mitigate interferers (cellular, broadcast radio, wireless hot-spots, malfunctioning equipment, jammers, accidental transmissions etc.)

Ability to expand as needs change

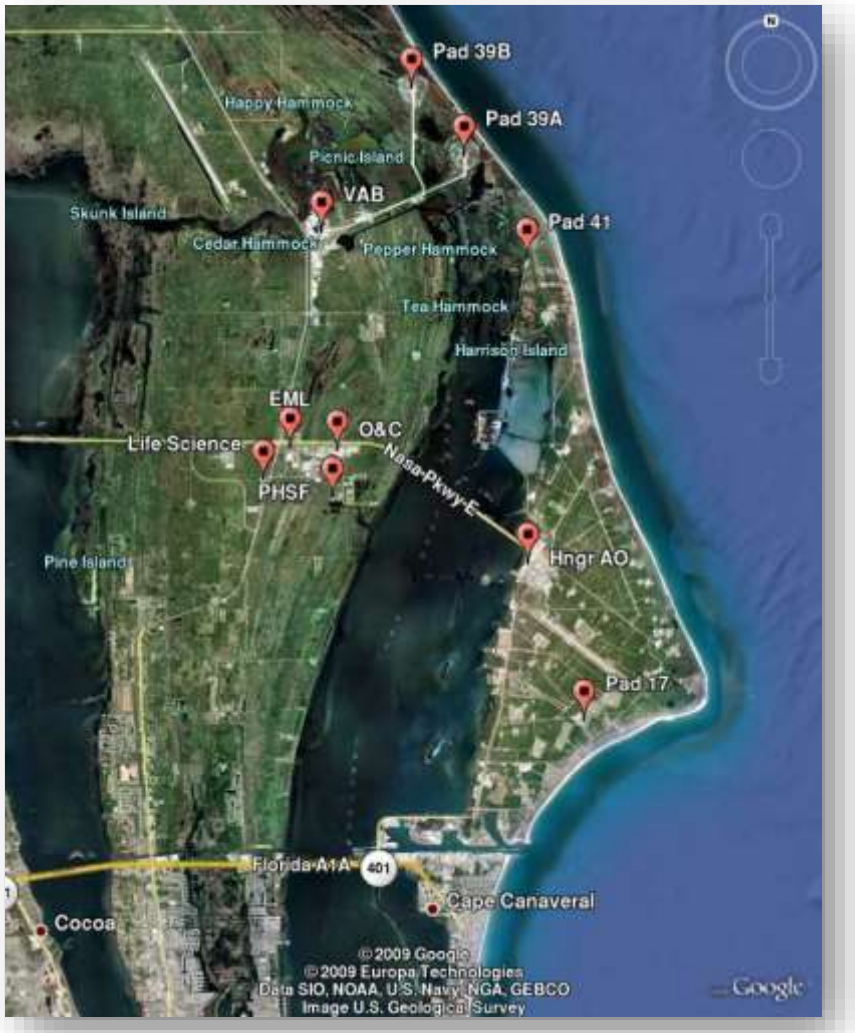


Image courtesy of NASA

Spectral Monitoring

Hardware Sensor N6841A

20 MHz to 6 GHz

Information BW: 20 MHz

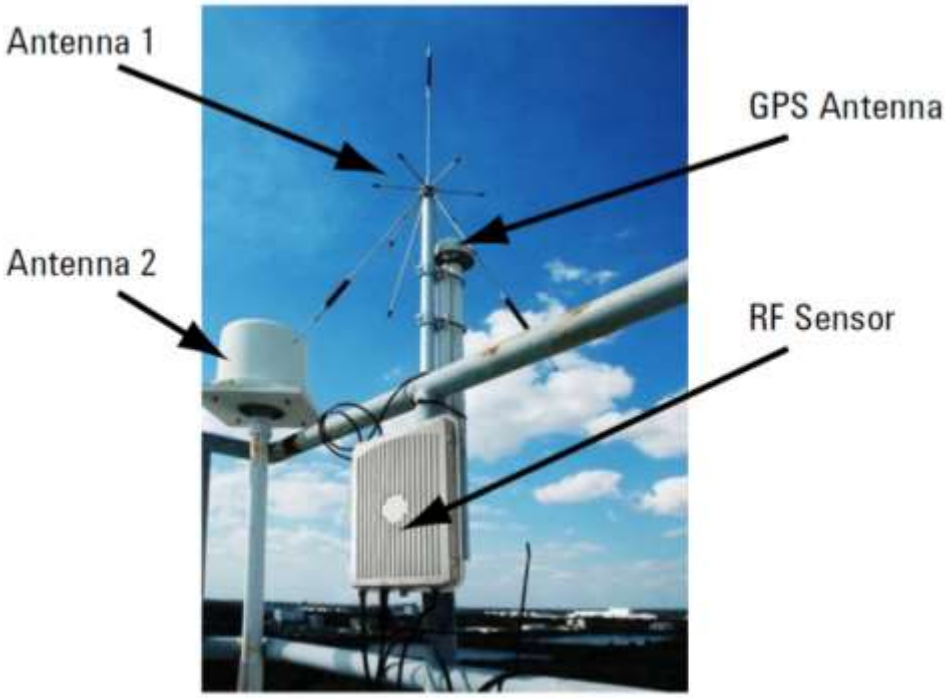
4.8 second look-back memory

Integrated GPS

Rugged

Remote control

FAST spectrum processing



RF sensor and antennas on rooftop installation

Spectral Monitoring

Software Tools

Capabilities

Planning

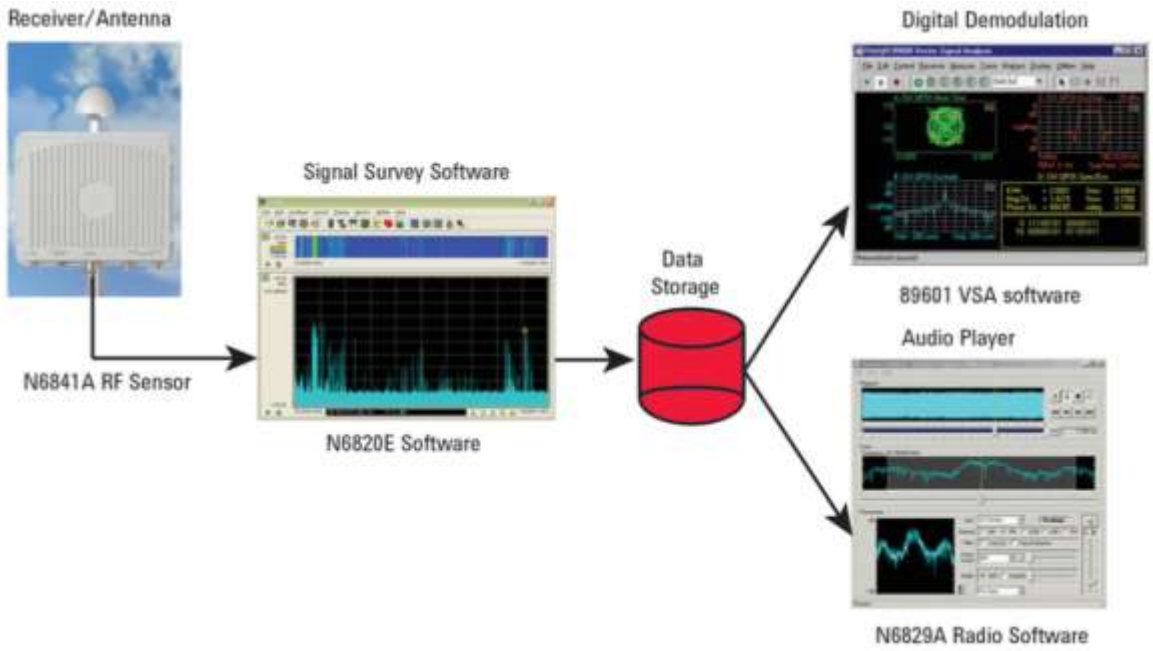
Deployment

Survey

Locating

Analyzing

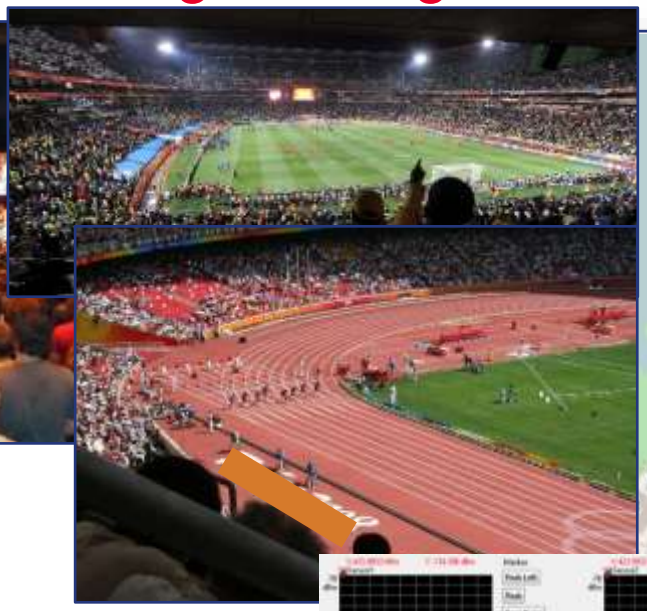
Reporting

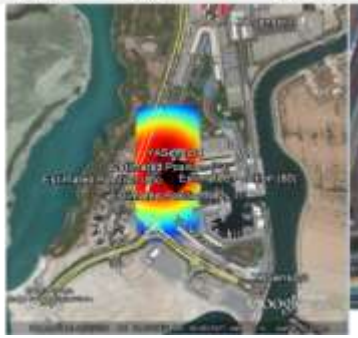


Signal monitoring automation software collecting time series data from receiver and data storage for post-processing

For more information see Keysight application note, *Techniques and Trends in Signal Monitoring, Frequency Management and Geolocation of Wireless Emitters*, Literature Number 5990-3861EN

Spectral Monitoring at Large Events





Hundreds of frequencies allocated for telemetry

Revenue stream from seamless high definition TV broadcast

Event attendee security

Installed spectrum monitoring system ensures smooth, incident-free event

KEYSIGHT TECHNOLOGIES

Interference Analysis

Spectrum Assignments

Why interference is important

Sources of Interference

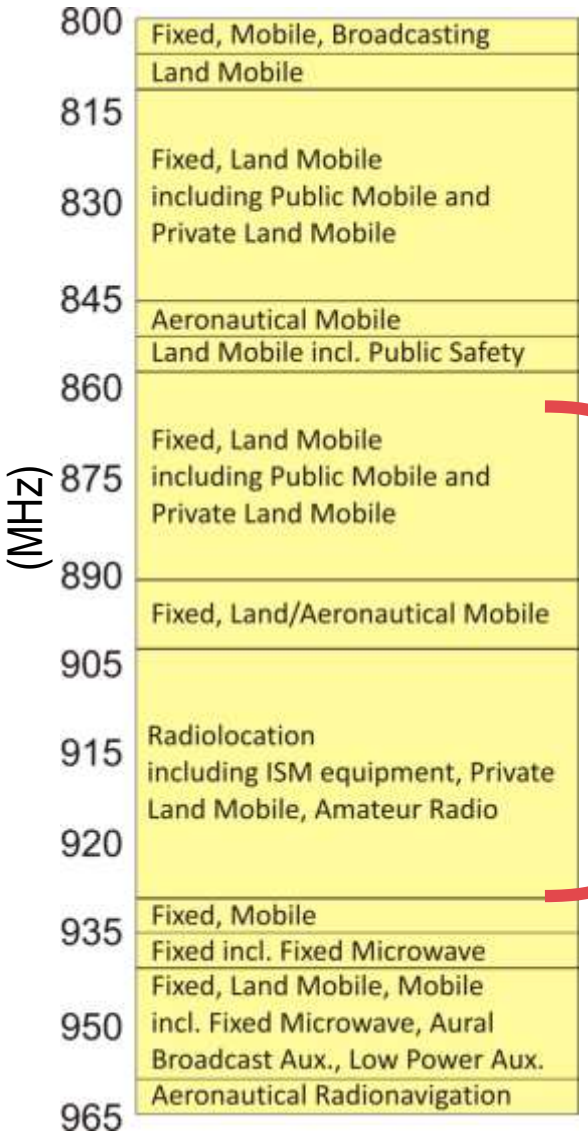
Interference Classifications

Analyzer Specifications

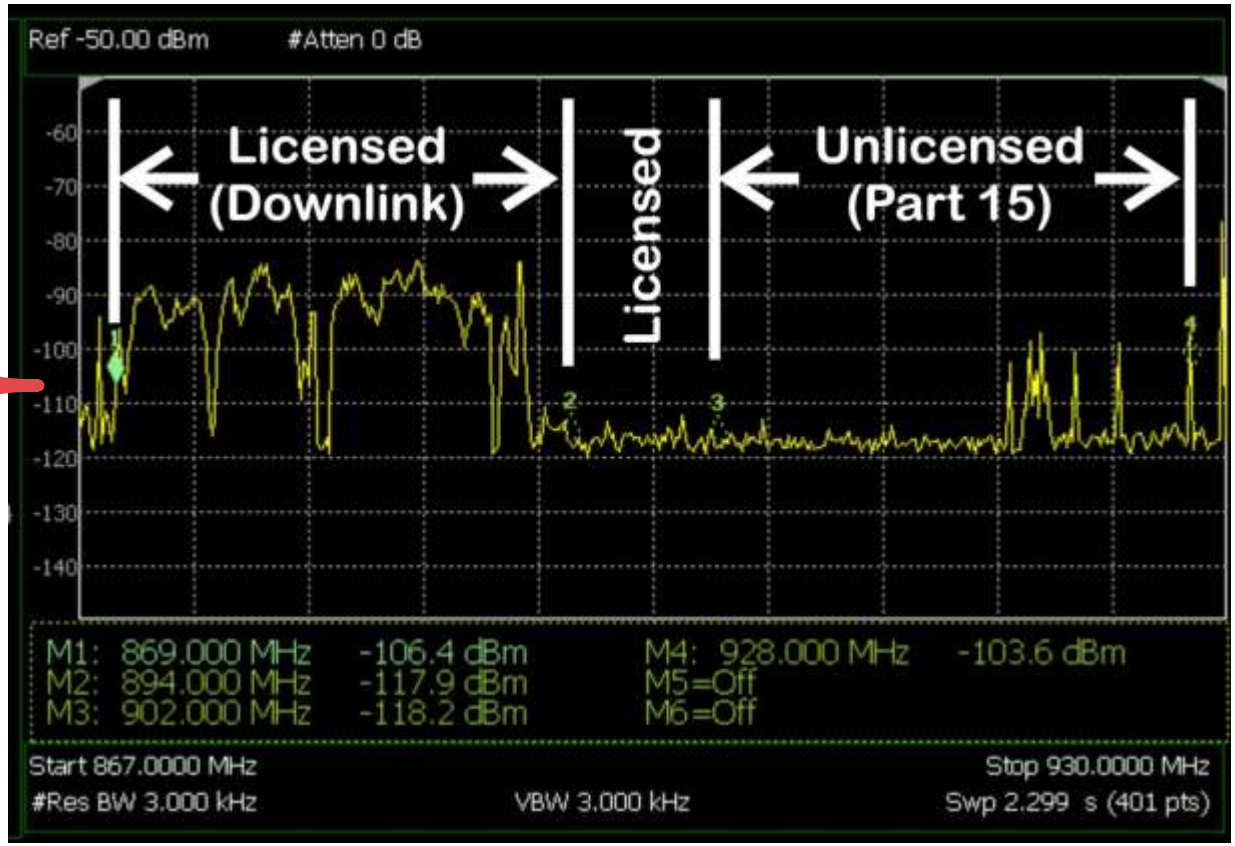
Antenna Specifications

Measurement Modes

Licensed and Unlicensed Spectrum



Licensed: Protected against harmful interference
Unlicensed: Expected amount of interference (Part 15 Rules)



Intentional, Unintentional, Incidental Radiators

Intentional radiators

Active transmitters

- Broadcast radio and television
- Cellular
- Satellite
- Radar
- Mobile radio
- WLAN
- Cordless phones

Unintentional radiators

Use RF but not for radio transmission

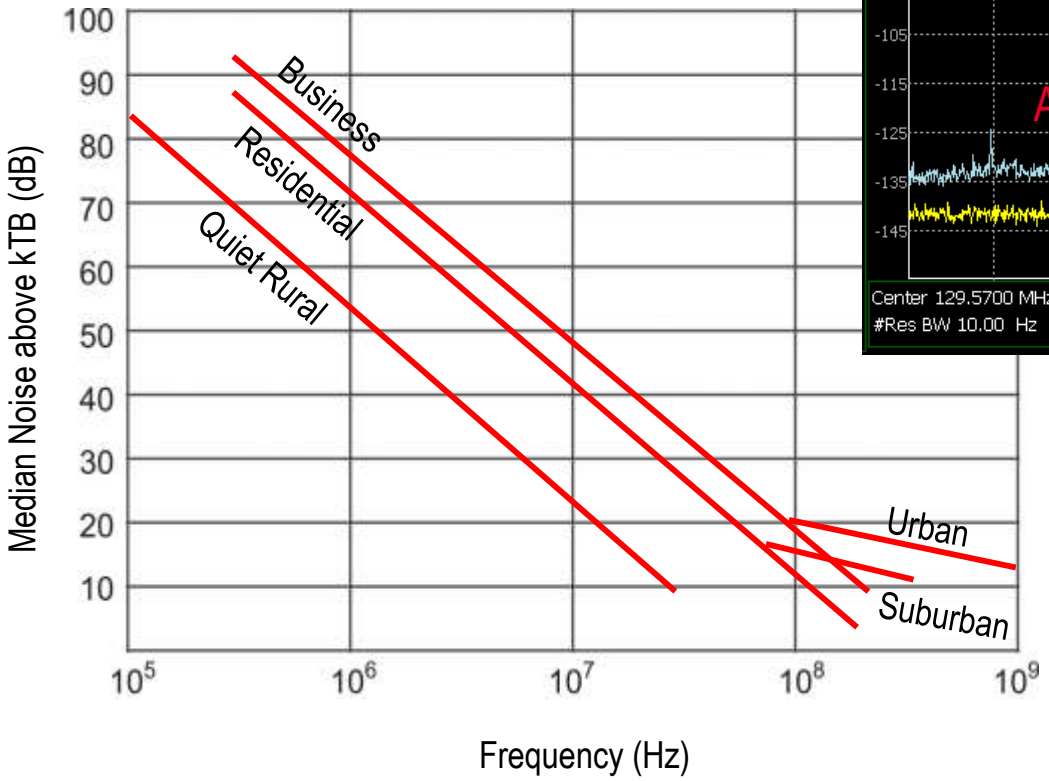
- Microwave ovens
- Radio receiver
- Industrial heaters
- MRI equipment

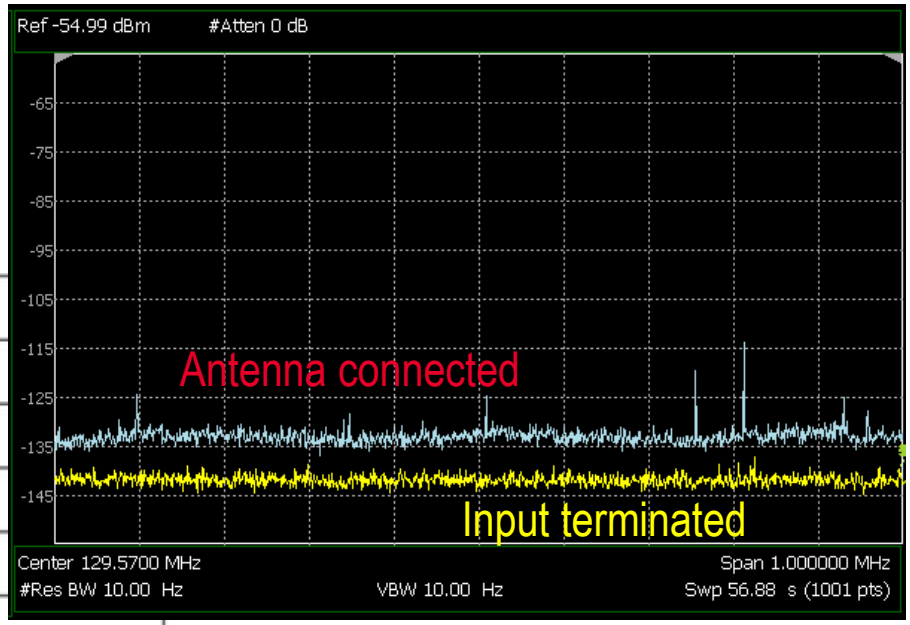
Incidental radiators

Do not use RF

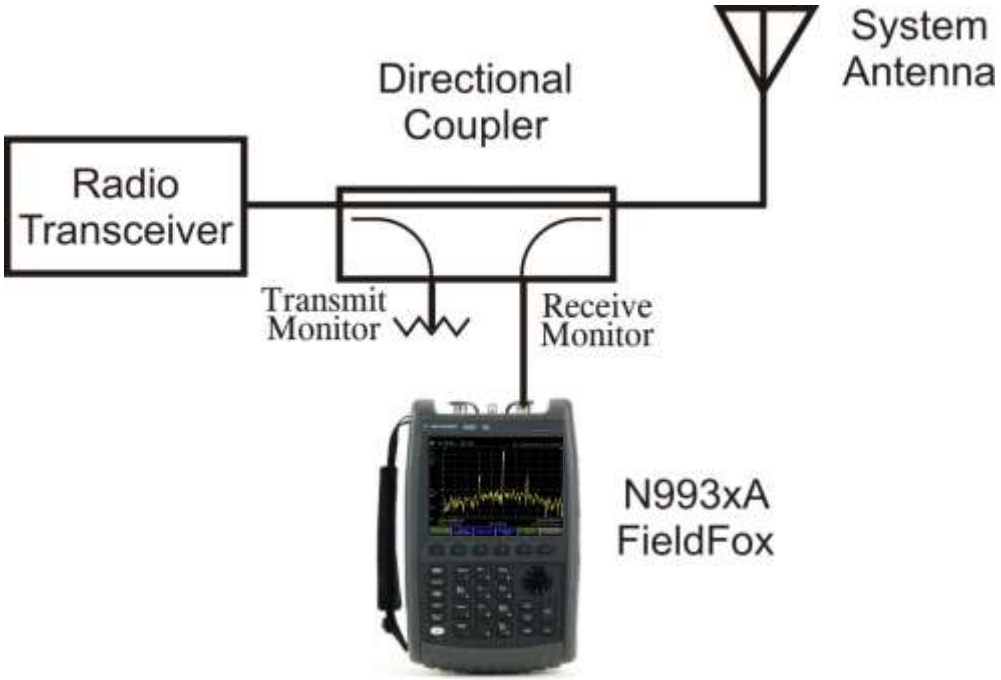
- Switching power supplies
- Clock and control signals
- Ignition motors
- Fluorescent lighting

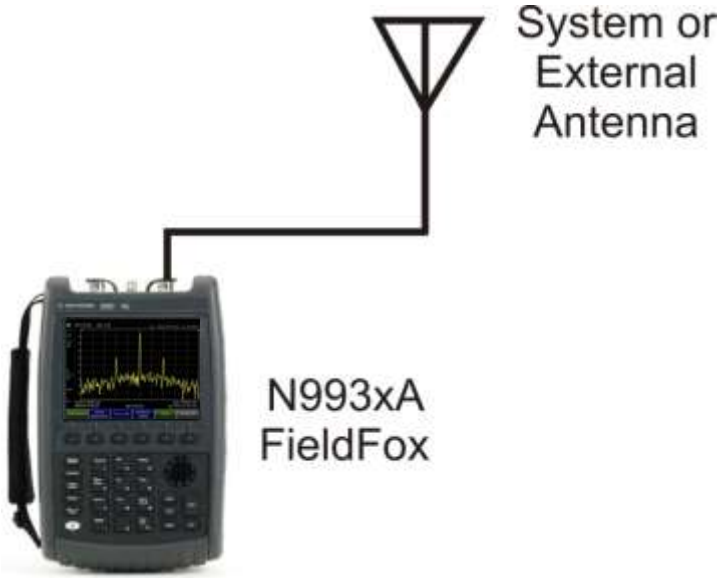
Ambient Man-Made Radio Noise





Interference Analysis Measurement Configurations





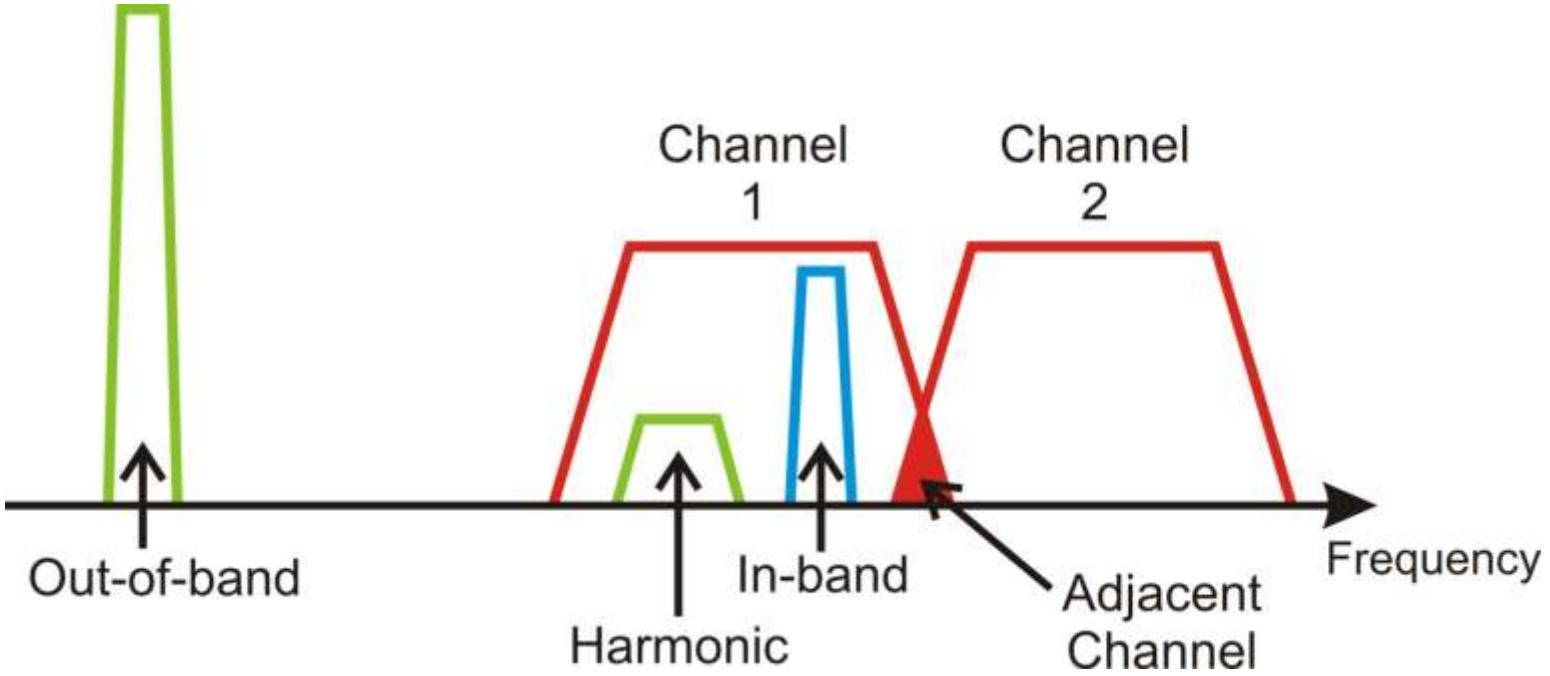
N993xA spectrum analyzer

N991xA spec/VNA combo

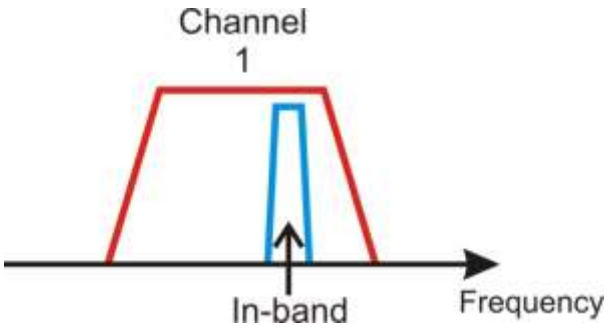
Interference Classifications

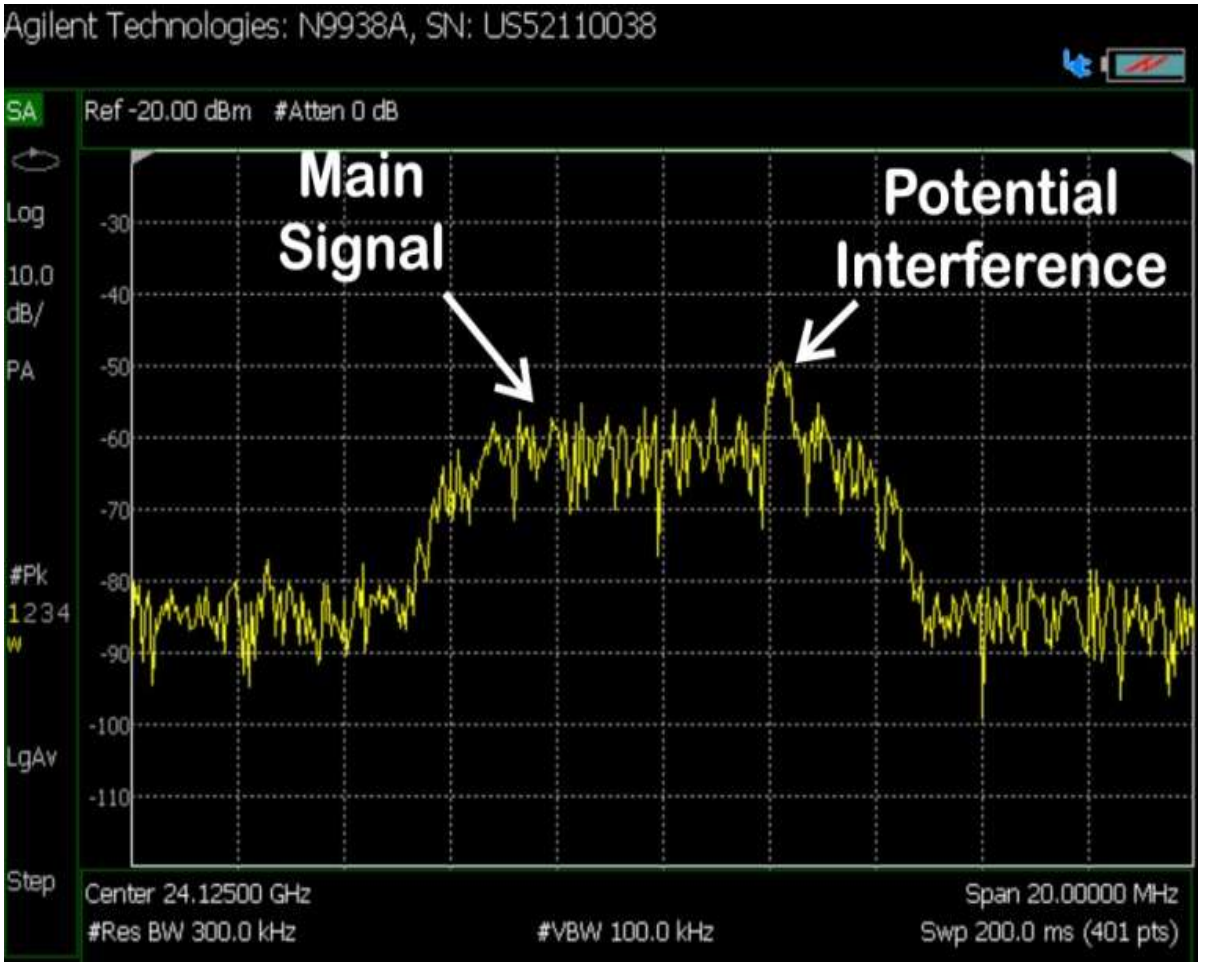
In-band interference
Co-channel interference
Out-of-band interference
Adjacent channel interference
Uplink interference
Downlink interference

Note: for detailed measurement examples see Keysight application note, *Techniques for Precise Interference Measurements in the Field,* literature number 5991-0418EN

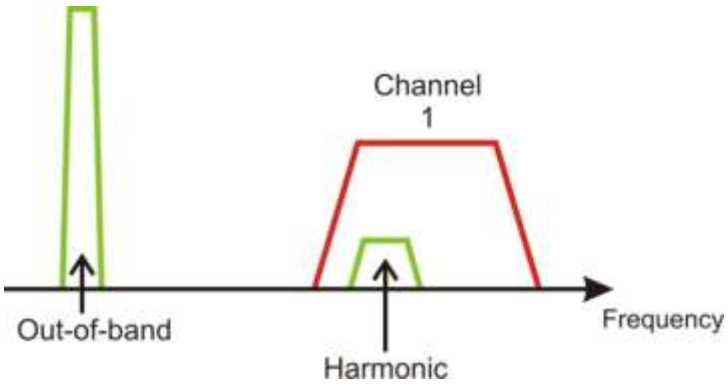


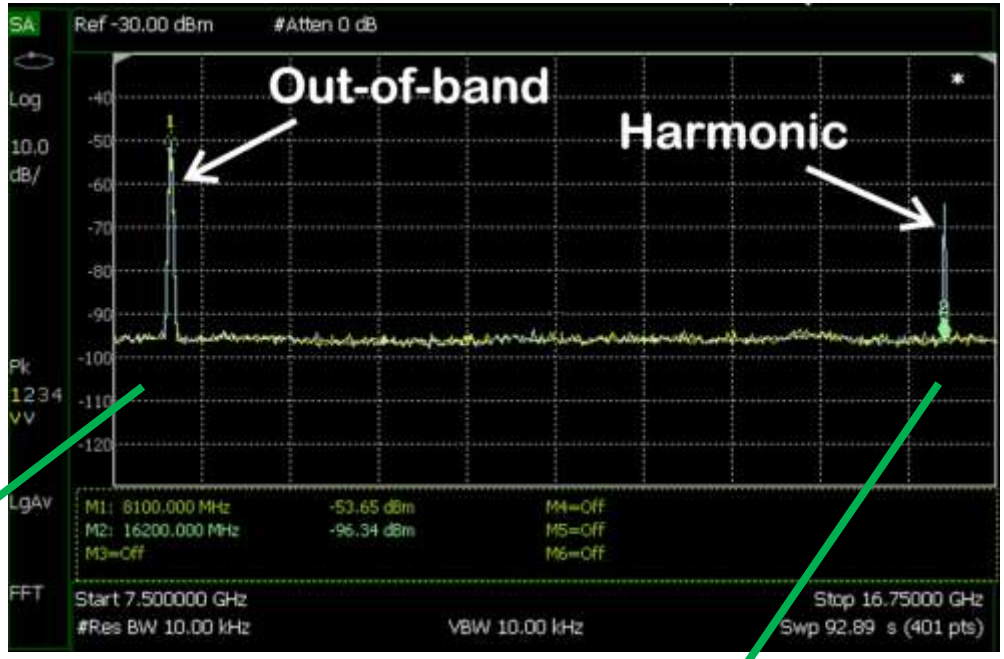
In-Band and Co-Channel Interference

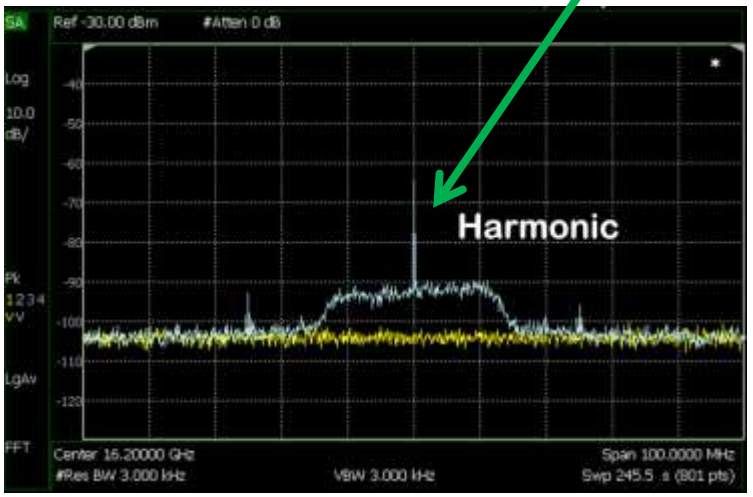




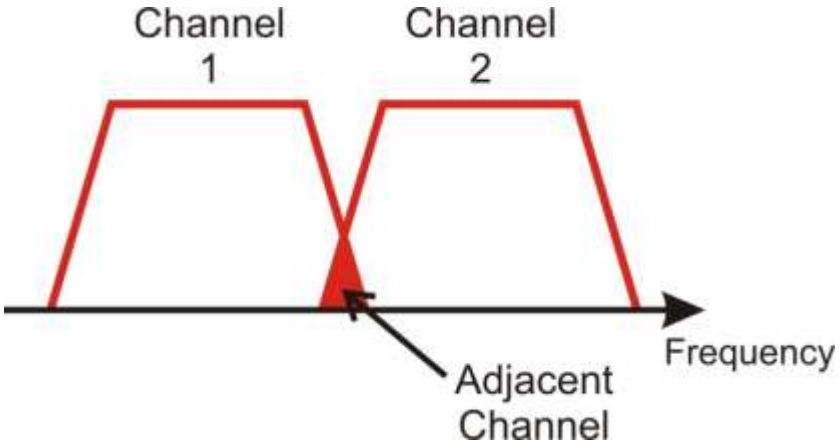
Out-of-Band Interference





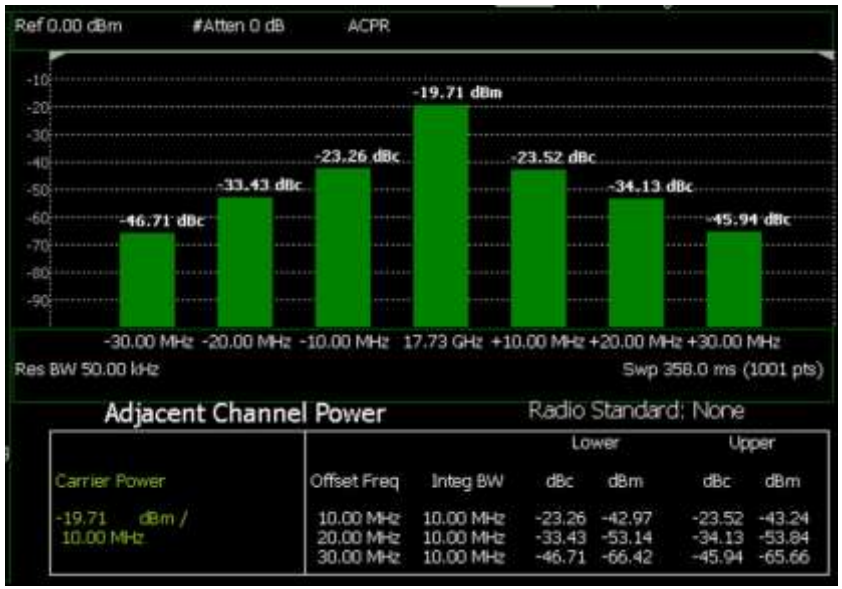


Adjacent Channel Interference

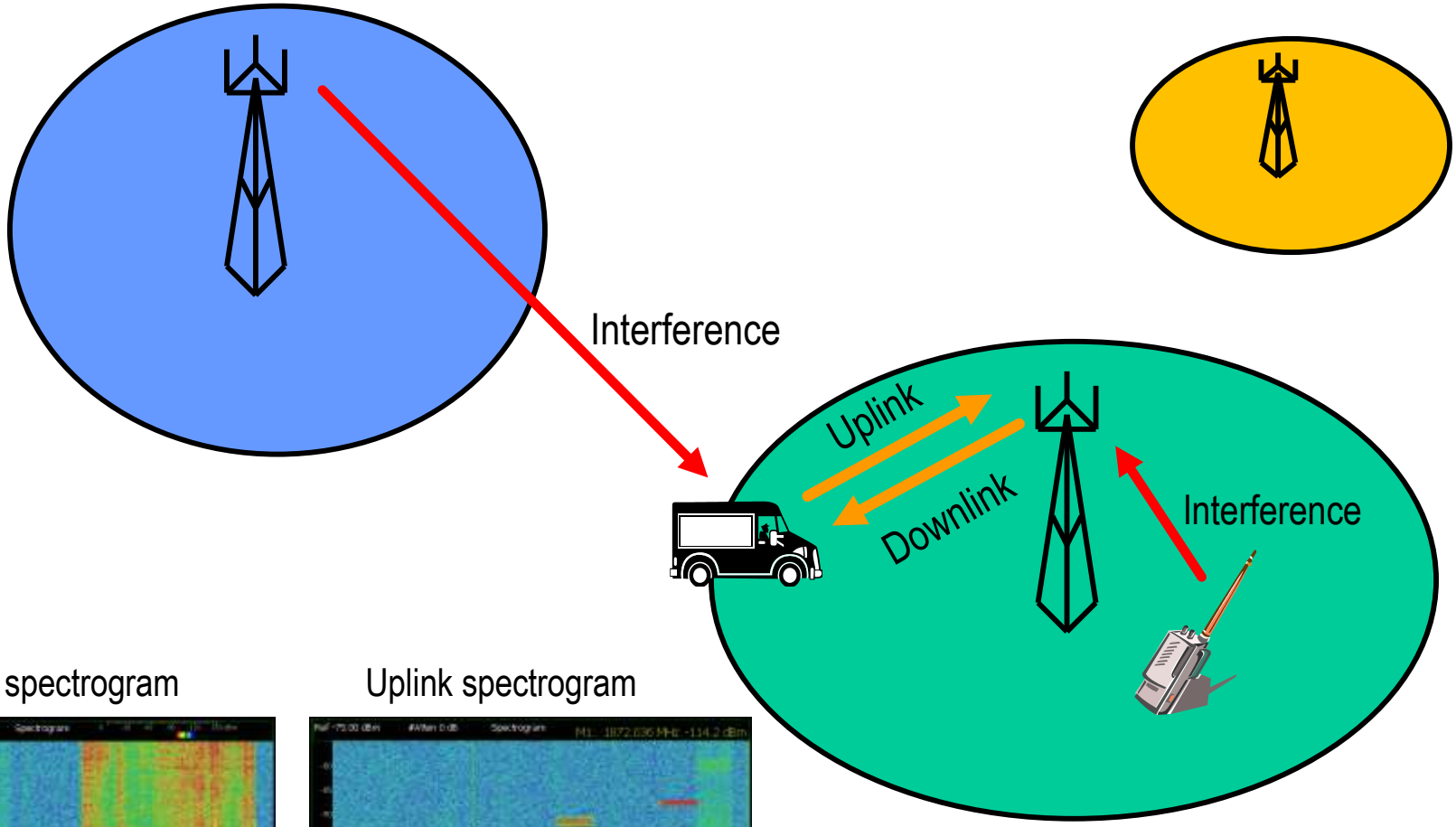


Channel power

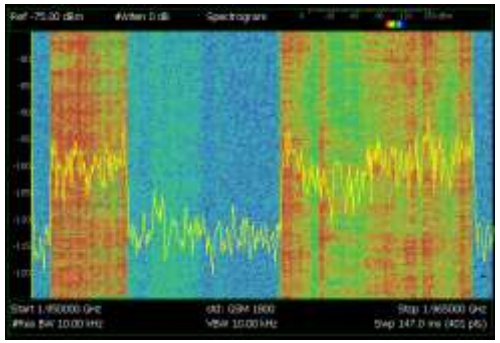
Adjacent channel power



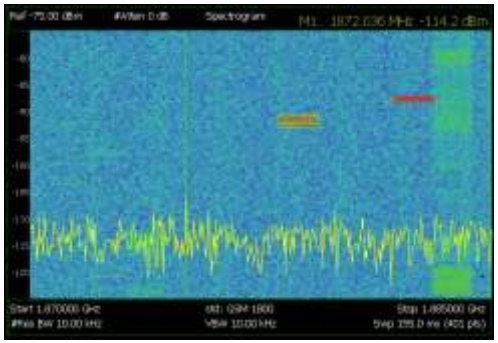
Downlink and Uplink Interference



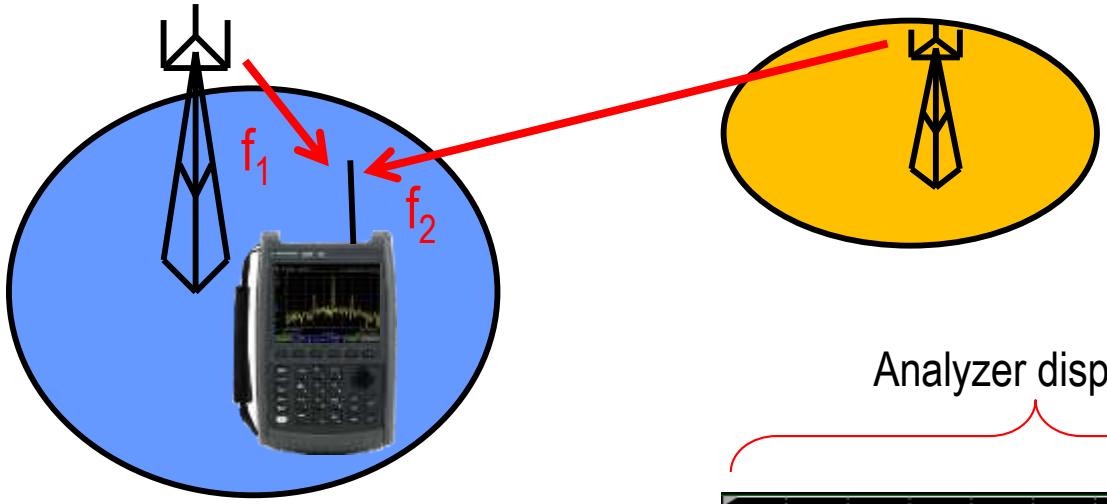
Downlink spectrogram



Uplink spectrogram

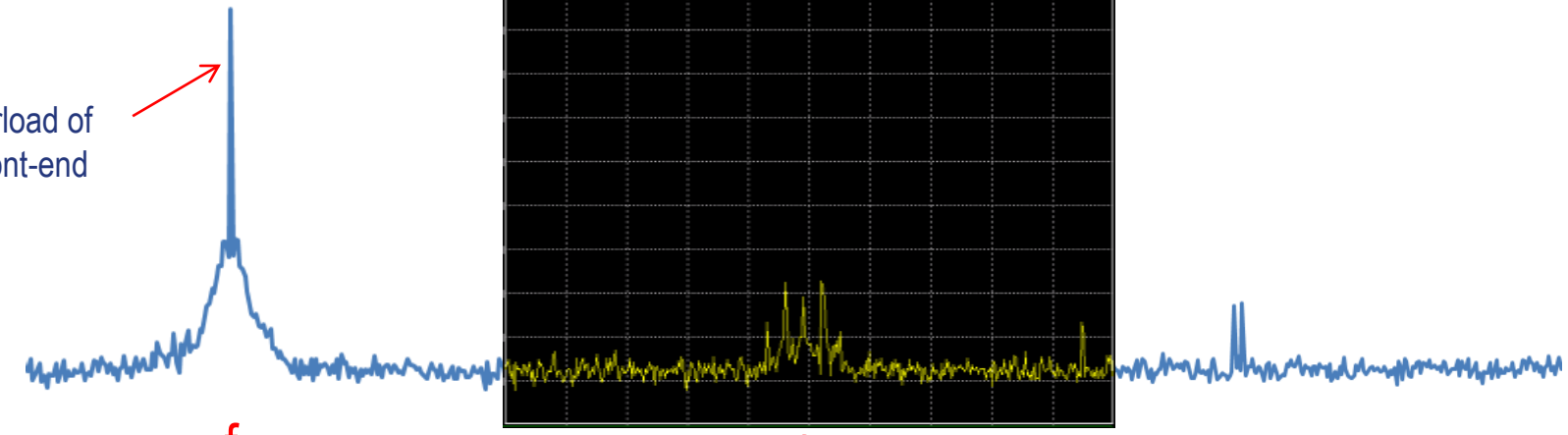


Near-Far Conditions



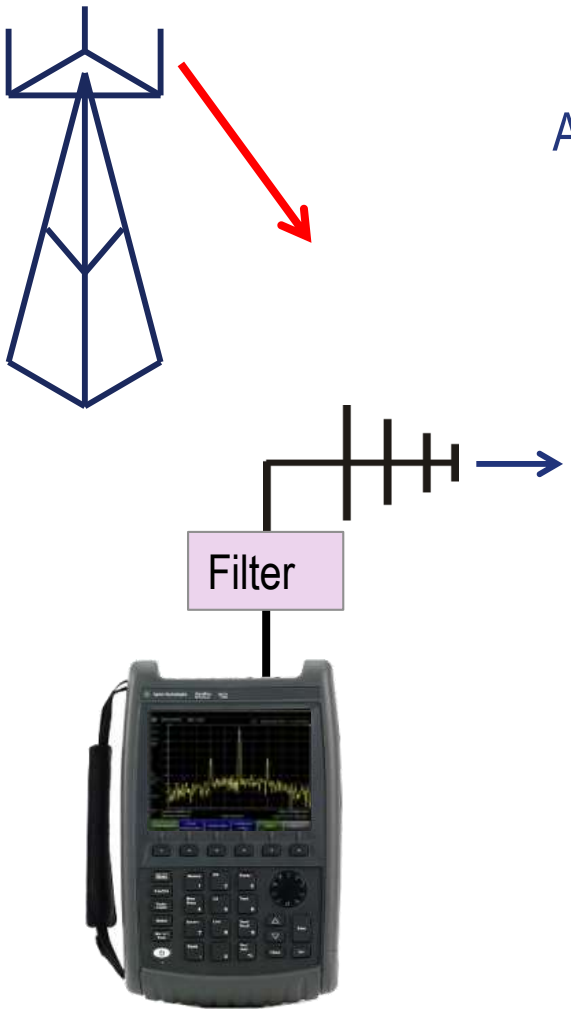
Analyzer display

Potential overload of analyzer's front-end



All signals enter analyzer's front-end

Techniques to Avoid Analyzer Overload



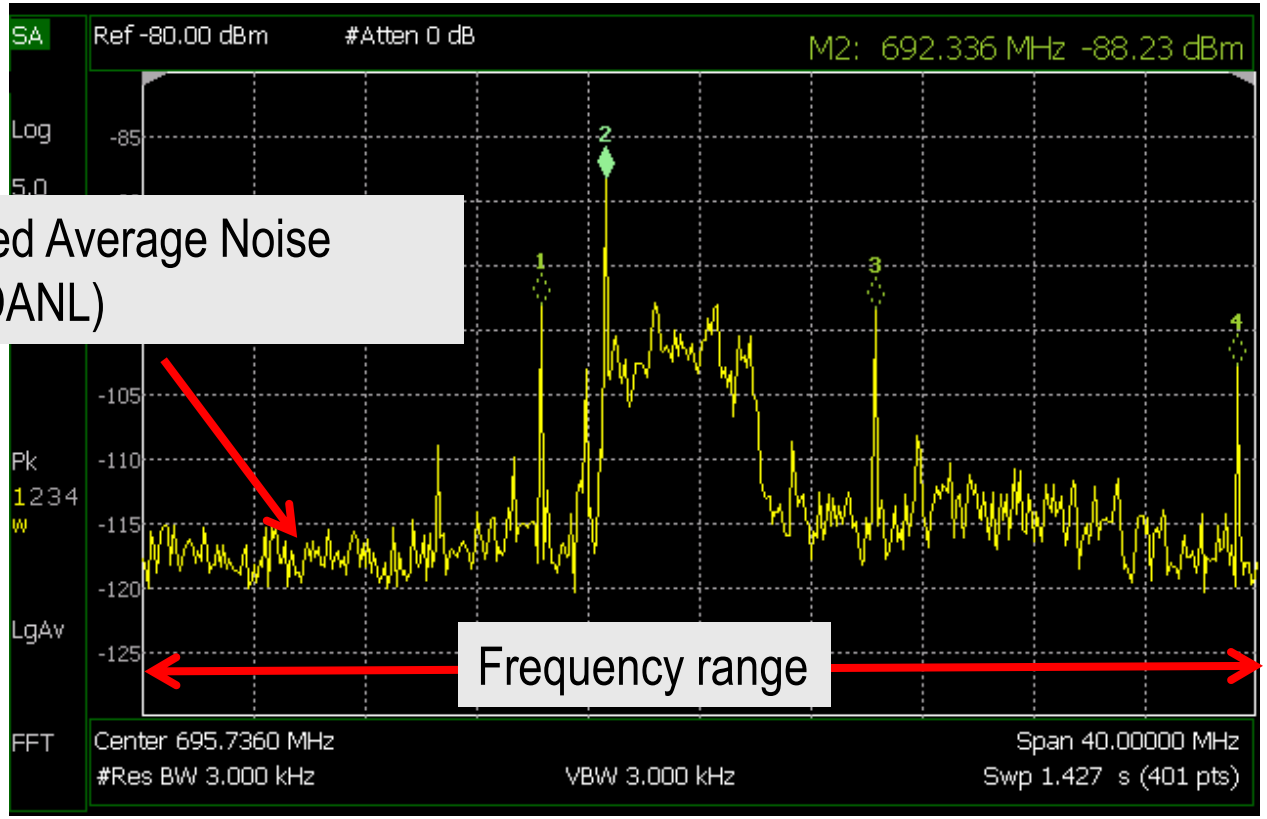
Avoid saturation and overload of the analyzer

Connect with bandpass filter to filter out strong signals

Do not point the directional antenna towards the transmitter

Turn off preamplifier and increase attenuation (if the sensitivity allows)

Key Analyzer Specifications

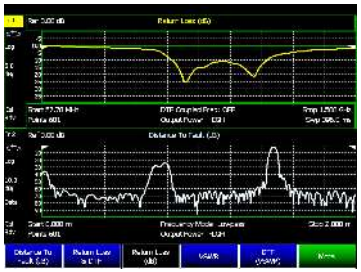


Also

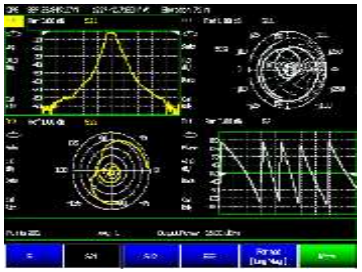
- RBW filter
- Preamplifier
- Third order intercept
- Phase noise
- Spurious

Most Comprehensive Measurement Capabilities

Field upgradeable, software enabled



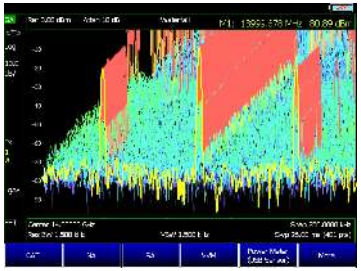
Cable and antenna analysis



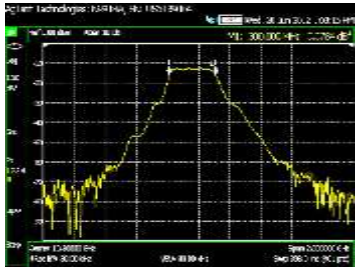
Vector network analysis

Spectrum analysis

DC source & current monitor



Interference analysis

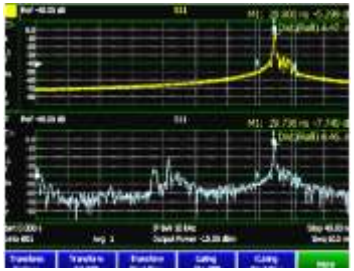


Full-band tracking generator

Vector voltmeter

Channel power measurement

Built-in power meter



Time domain

Channel scanner

Analog demodulation

Keysight FieldFox Spectrum Analyzer Family

N993xA: 9, 14, 18, and 26.5 GHz

N996xA: 32, 44 and 50 GHz

N991xA: 4, 6.5, 9, 14, 18 and 26.5 GHz w/Option 231, spectrum and VNA combination analyzers

N995xA: 32, 44 and 50 GHz w/Option 231, spectrum and VNA combination analyzers

Also available with options for cable and antenna testing (CAT)

Carry precision with you - Keysight-quality measurements

Full amplitude accuracy of ± 0.6 dB at turn-on, –10 to +55 °C

Weather resistant, MIL-PRF-28800F Class 2 design

7.1 pounds (3.2 kg)

Built-in GPS

3.5-hour battery life

FieldFox Accessories

N9910XA-822 log periodic directional antenna

N9910XA-821 whip antenna, 70 to 1000 MHz

N9910XA-823 cellular band antenna

N9311X bandpass filter

-550	814 to 850 MHz	-553	1845 to 1915 MHz
-551	880 to 915 MHz	-554	1910 to 1990 MHz
-552	1707.5 to 1787.5 MHz		

N9910XA-817 phase stable test cable, type N(m) to N(m)

Conclusions

Reviewed current wireless communication situation

Discussed why spectral control is important

Discussed site surveys; who, why and how

Reviewed spectral monitoring; mobile and fixed

Briefly reviewed interference types and analysis

Discussed spectrum analyzer attributes important for interference analysis

Introduced FieldFox as a rugged, lightweight field-ready analyzer, ideal for site surveys, spectral monitoring and interference analysis

For More Information

Web: www.keysight.com/find/FieldFox

Email: tom_hoppin@non.keysight.com

Literature and Webcast Registration: www.keysight.com/find/FieldFoxWebcasts

Thank you for your time

Any Questions?

Co-Sponsored by

Gap Wireless

KEYSIGHT TECHNOLOGIES

References

Keysight application note, *Interference Testing with Handheld Spectrum Analyzers*, literature number 5990-9074EN

IEEE Std 473-1985, IEEE Recommended Practice for an Electromagnetic Site Survey (10 kHz to 10 GHz), Approved December 13, 1985, Reaffirmed May 6,1992.

Keysight application note, *Interference Testing with Handheld Spectrum Analyzers*, literature number 5990-9074EN

Keysight application note, *Techniques and Trends in Signal Monitoring, Frequency Management and Geolocation of Wireless Emitters*, literature number 5990-3861EN

Keysight application note, *Techniques for Precise Interference Measurements in the Field*, literature number 5991-0418EN

Keysight Application Note 150, *Spectrum Analysis Basics*, literature number 5952-0292EN