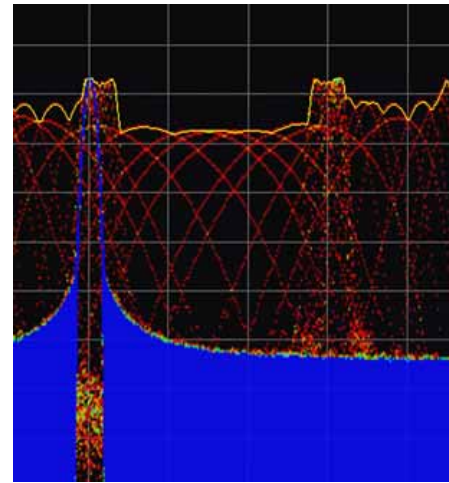


Part 1:

如何從 Time Domain來解決EMI問題-即時頻譜分析儀

Discover and View Signals Like Never Before

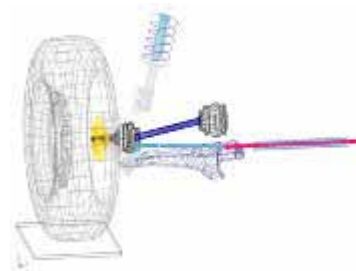


Definition of Real-time Signal Processing

What is real-time?

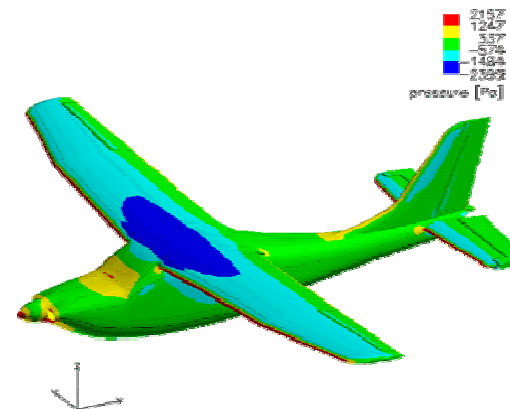
Real-time Definition

- A digital system *simulation* is said to operate in *real-time* if its operating speed matches that of the *real-time system* which it is simulating.



Real-time Signal Analysis

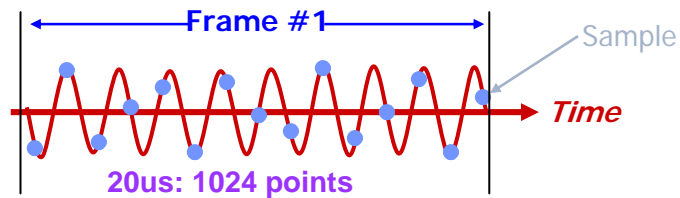
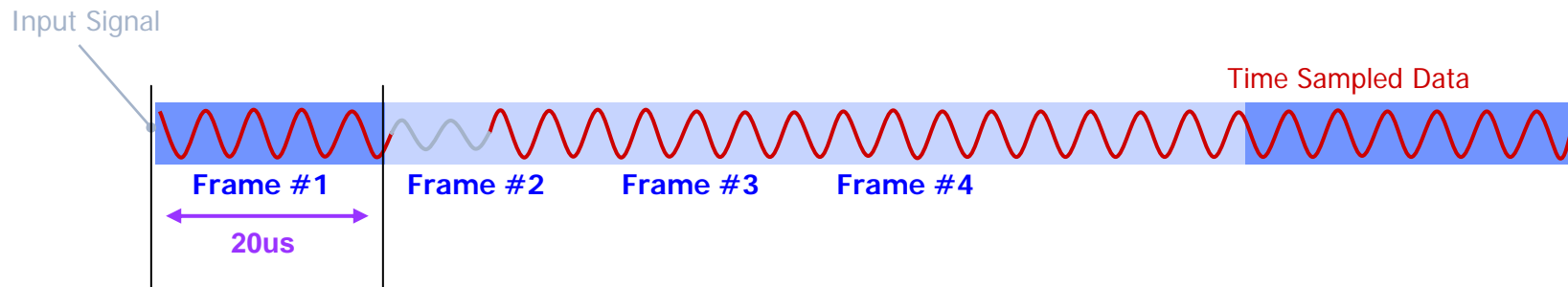
- Operations are performed fast enough to accurately process all signal components in the frequency band of interest.



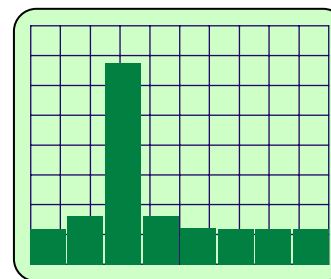
Real-time Analysis Criteria

- Continuously sample the **input** signal fast enough to satisfy Nyquist criteria.
 - >2X bandwidth
- Perform computations continuously at a fast enough rate for the output of the analysis to keep up with any changes in the input signal.

Real-Time Signal Processing

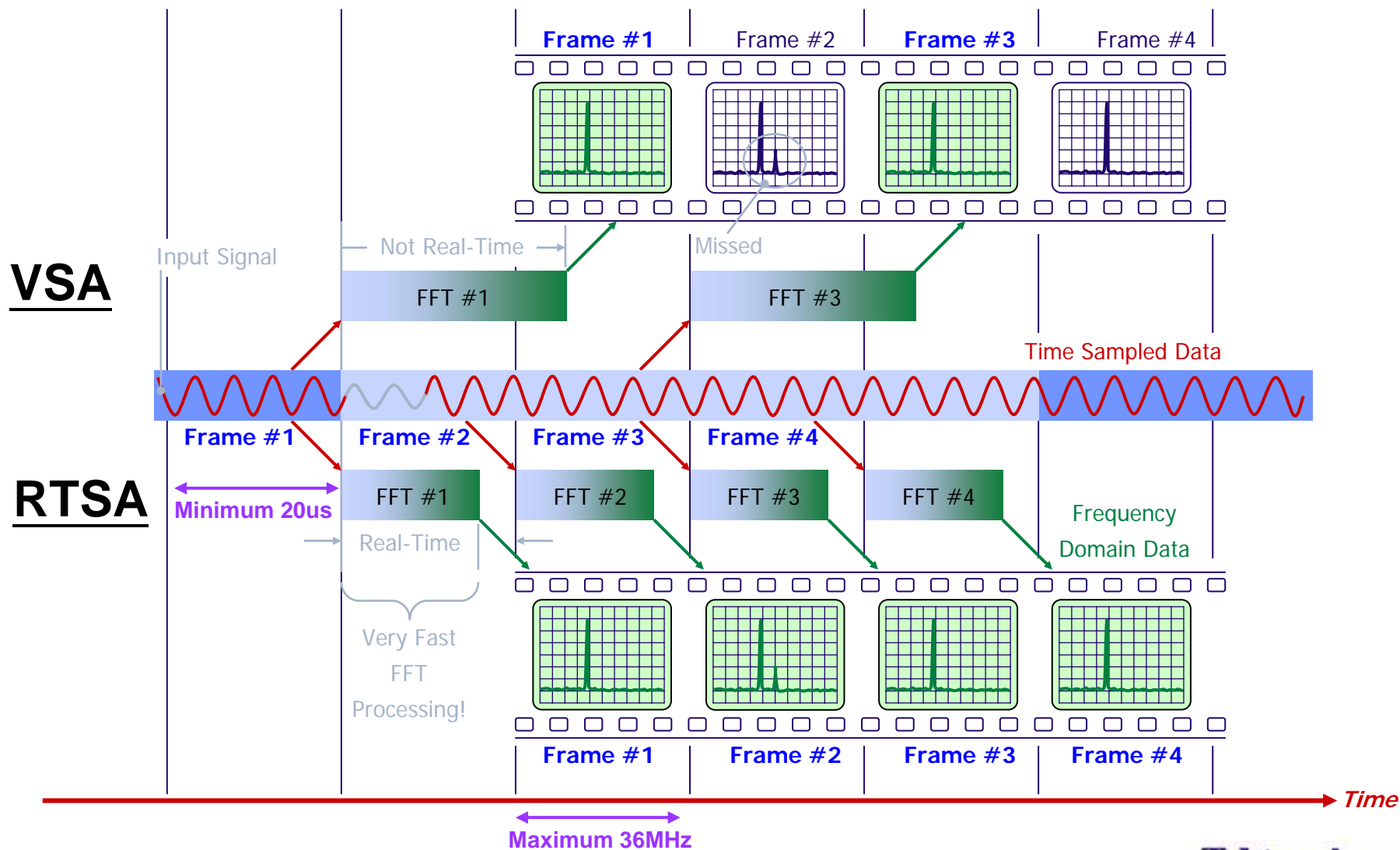


FFT

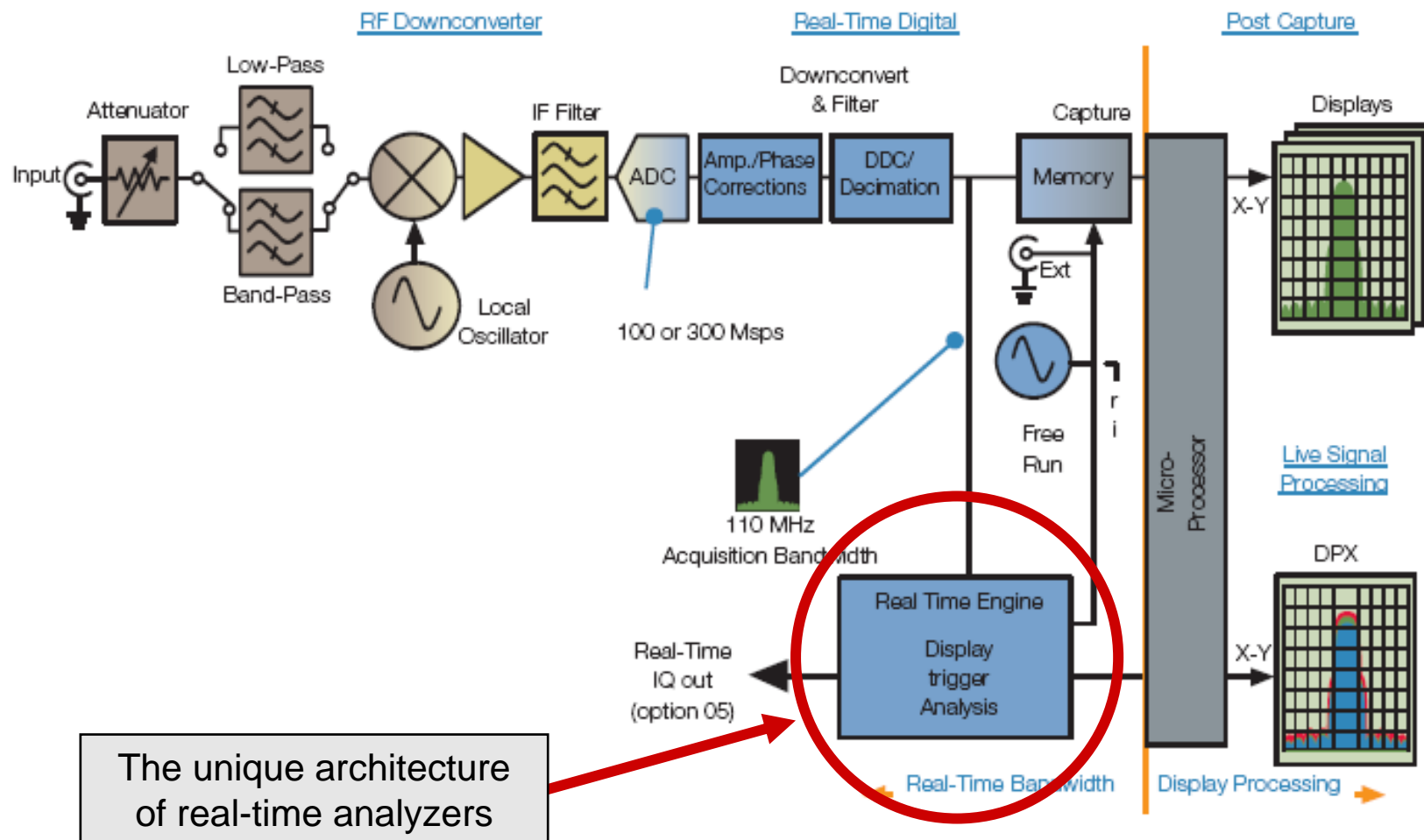


Frame #1 spectrum *Frequency*

Real-Time Signal Processing

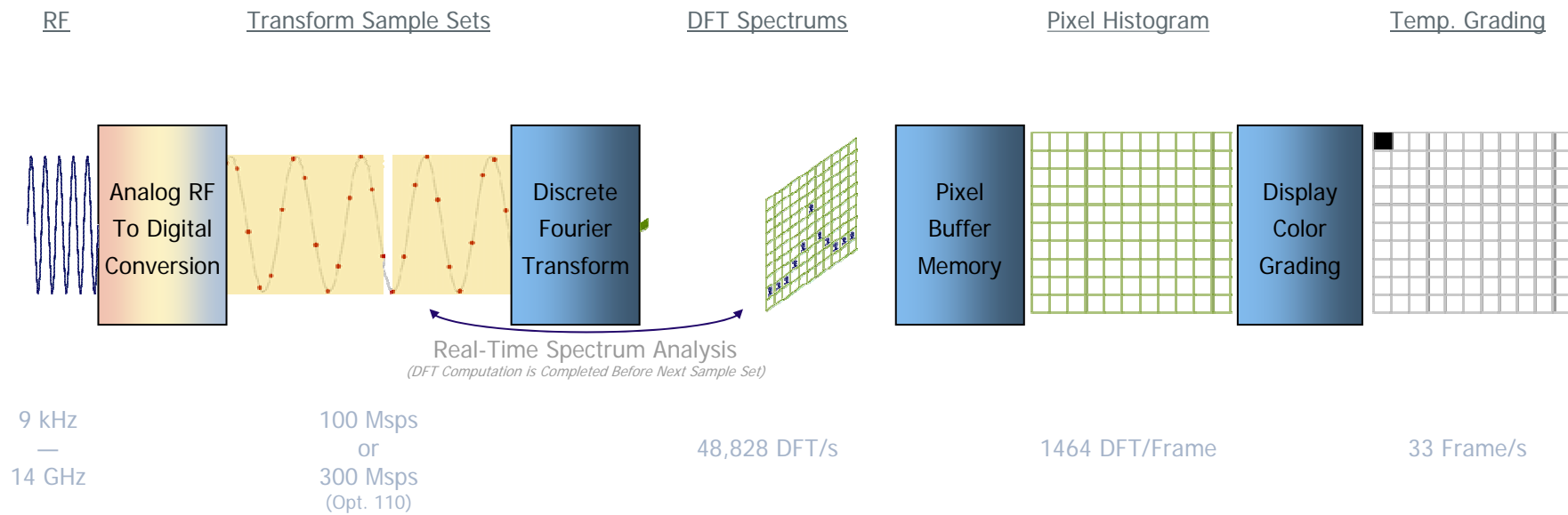


Real-time Architecture



The unique architecture of real-time analyzers

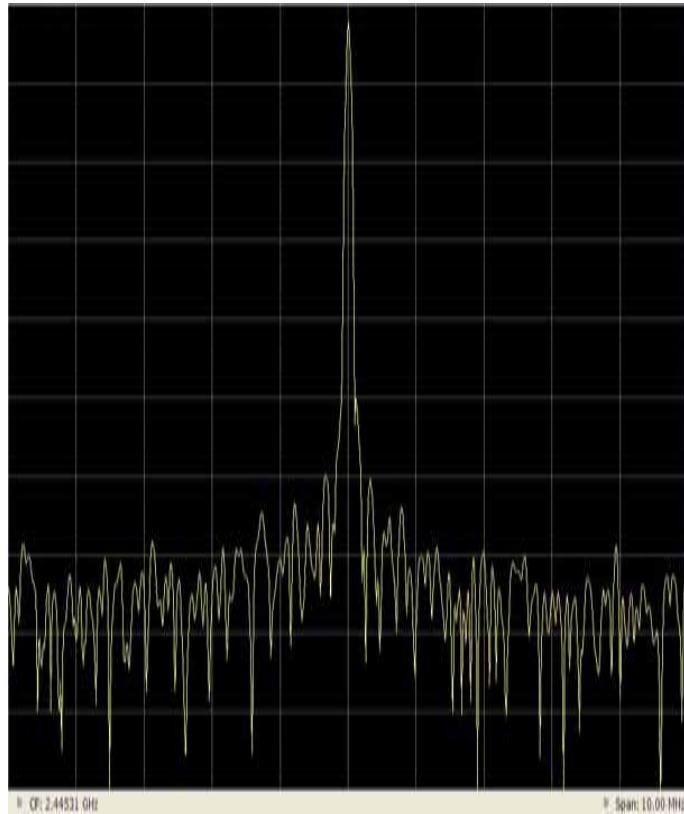
The DPX Transform Engine



主動元件效能檢查

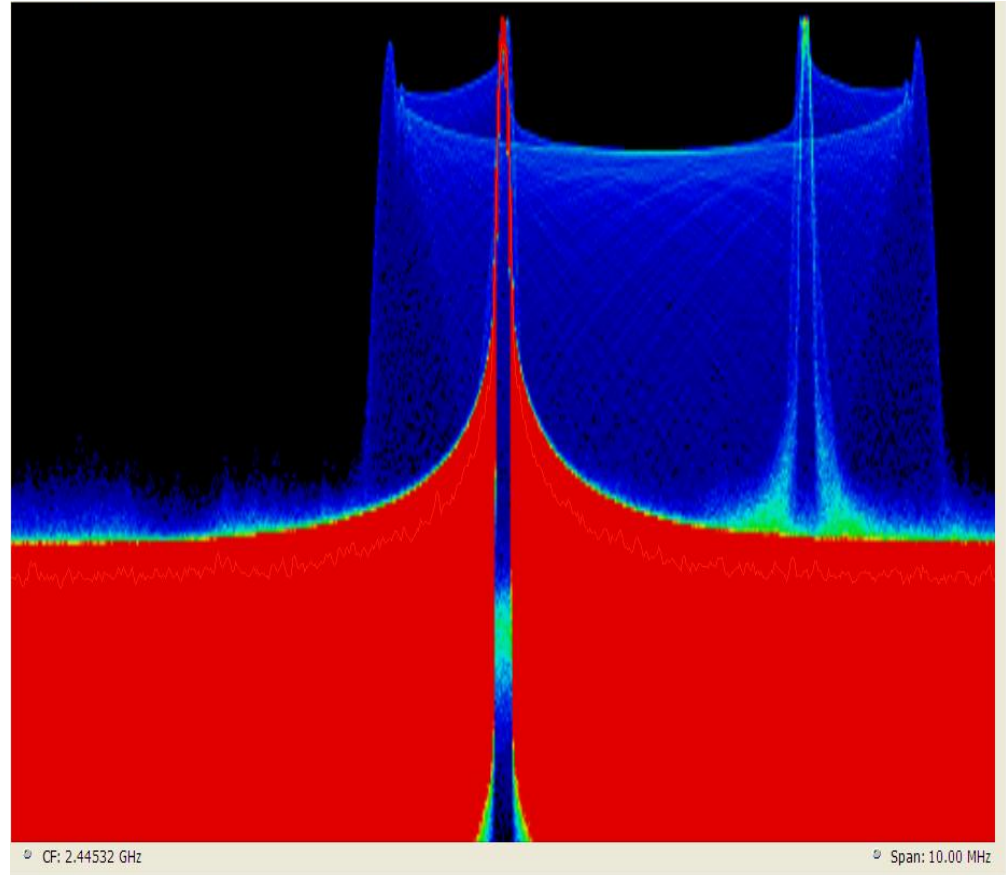
即時頻譜顯示(DPX)

傳統頻譜顯示畫面



掃頻不連續頻譜
每秒**60**張頻譜

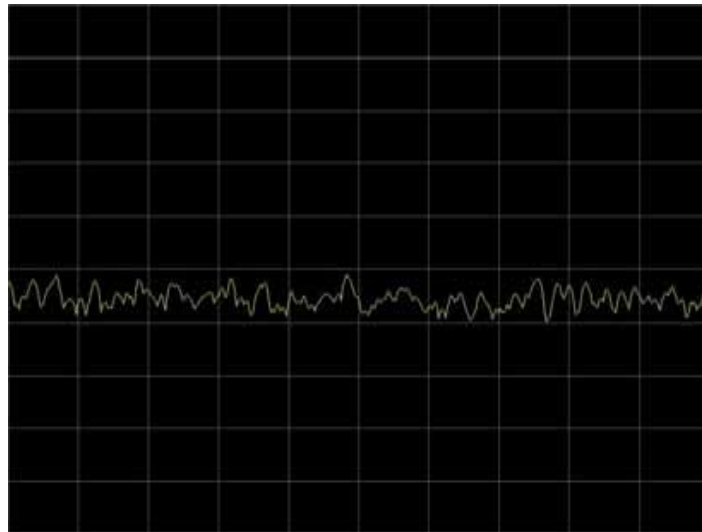
Tektronix RTSA即時頻譜看到的同一訊號異常現象



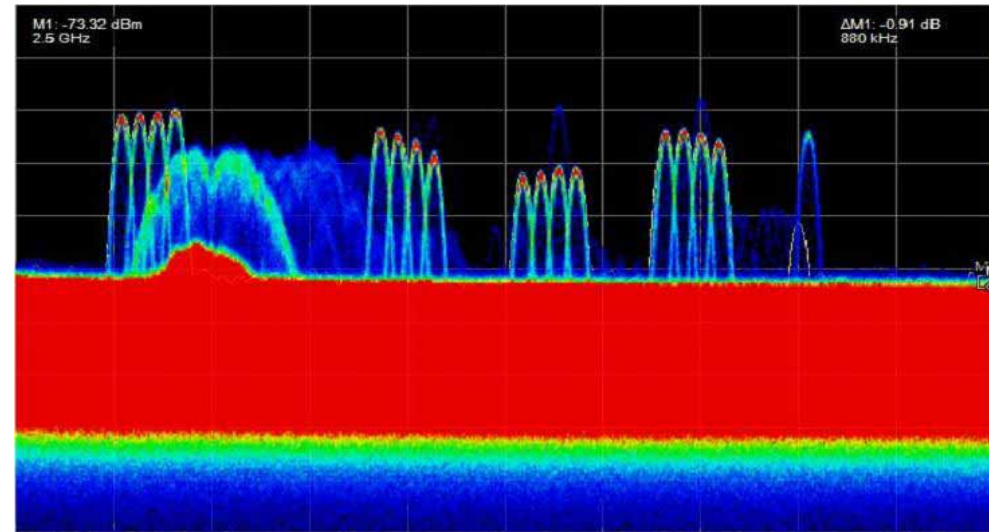
連續不間斷頻譜顯示
每秒**48000**張頻譜

即時頻譜顯示(DPX)

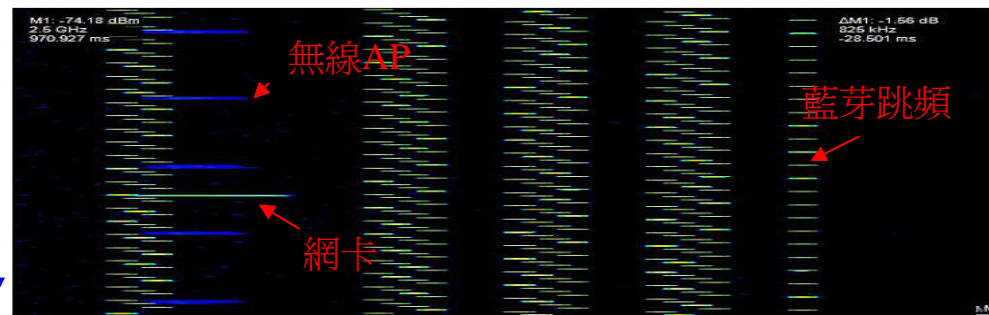
傳統頻譜顯示ISM Band



Tektronix RTSA即時頻譜顯示的ISM band

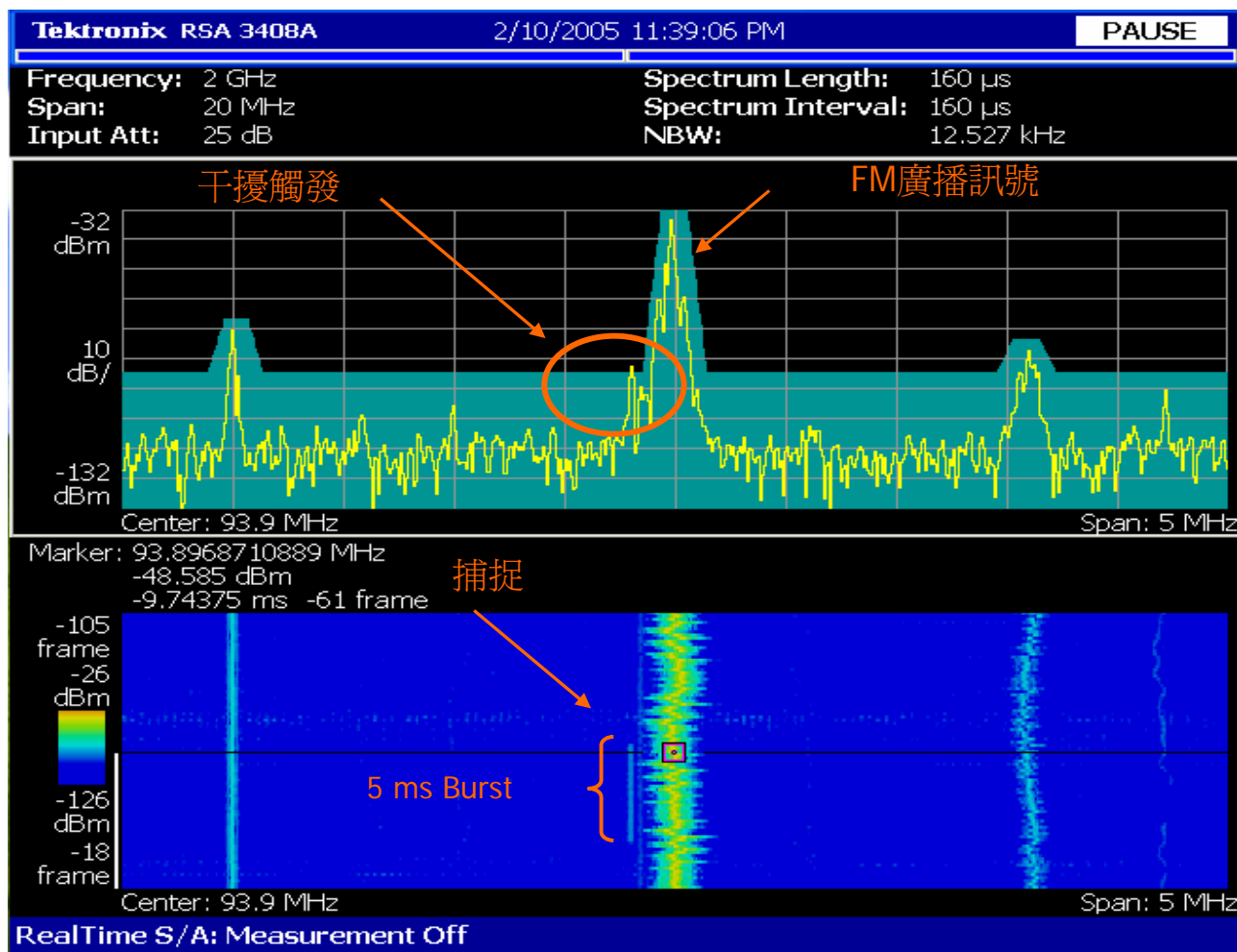


時間軸



即時捕捉干擾,EMI訊號

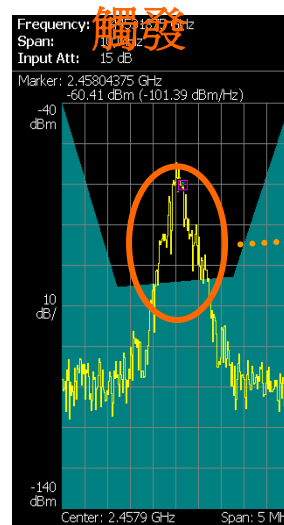
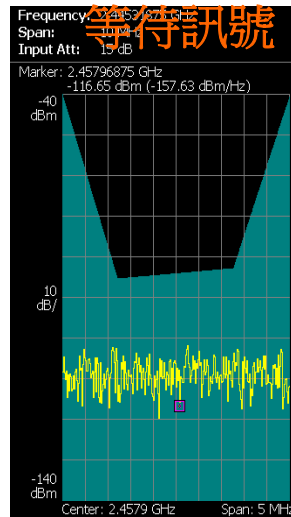
擷取FM頻道干擾訊號



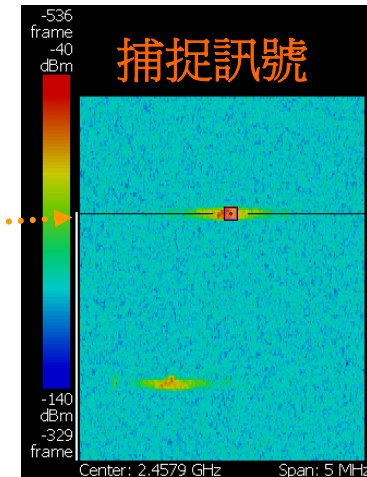
輕易抓出異常的訊號頻譜與干擾訊號!!

擷取通訊中之數位通訊訊號

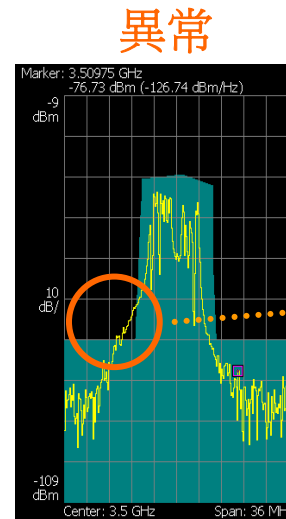
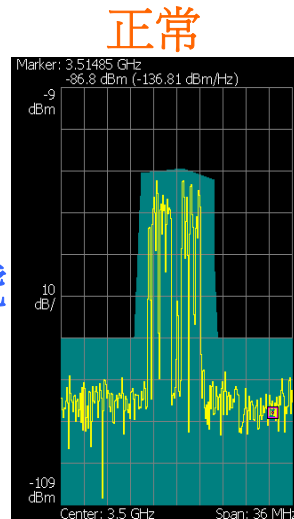
抓取藍芽訊號



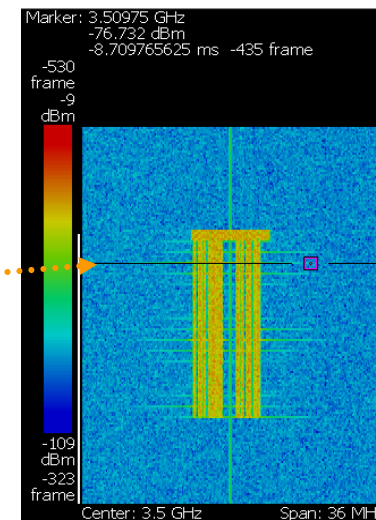
觸發點



檢查頻譜異常之WiMAX訊號

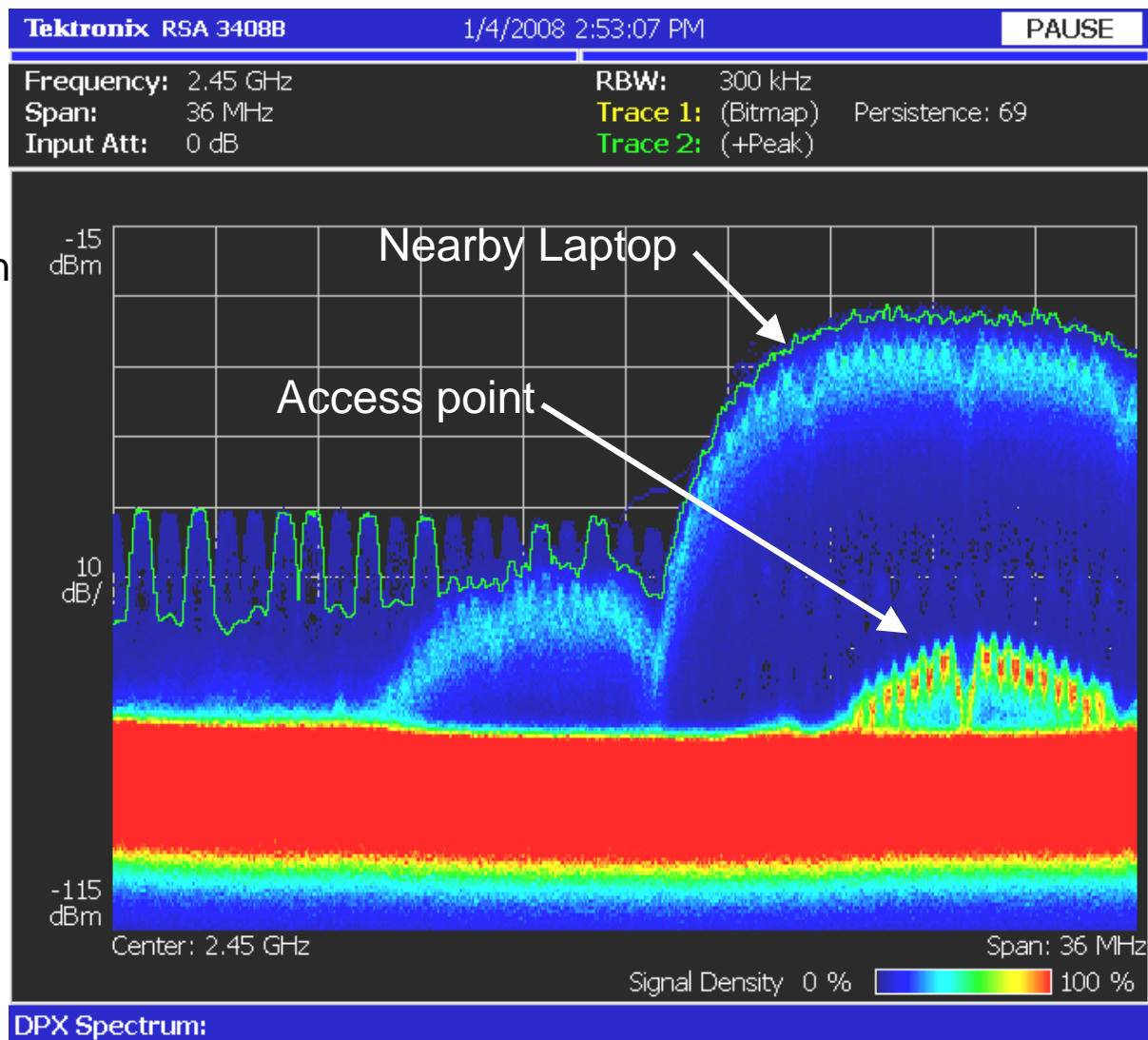


觸發點



DPX and the Crowded Spectrum

- **Time-Sharing Signals**
 - WLAN
 - Laptop and Access point on same channel
- **DPX sees both !**
- **Variable Persistence too**

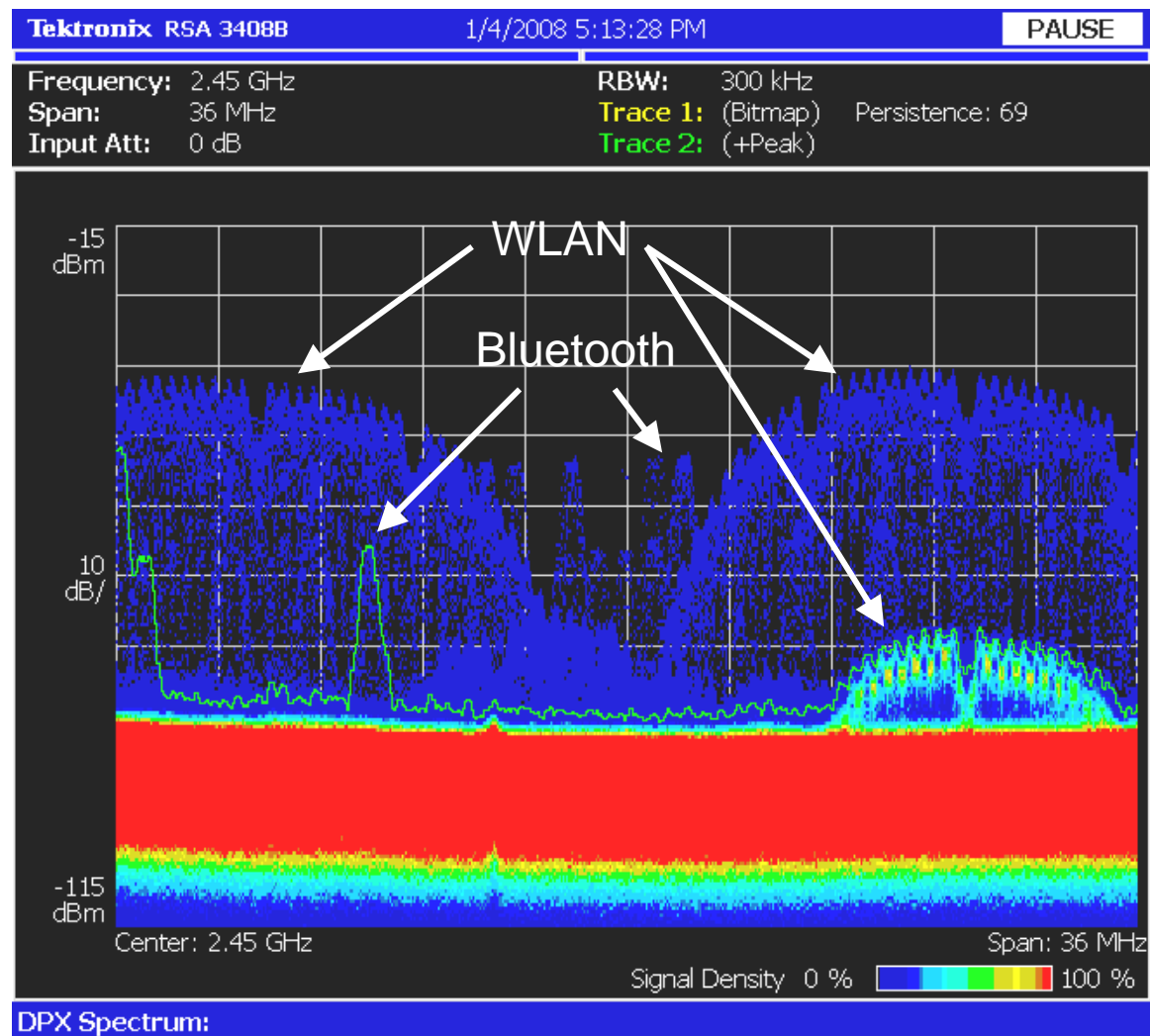


DPX and the Crowded Spectrum

■ Simultaneous Signals

- WLAN
 - Access point
 - Laptop
- Bluetooth
- All Together

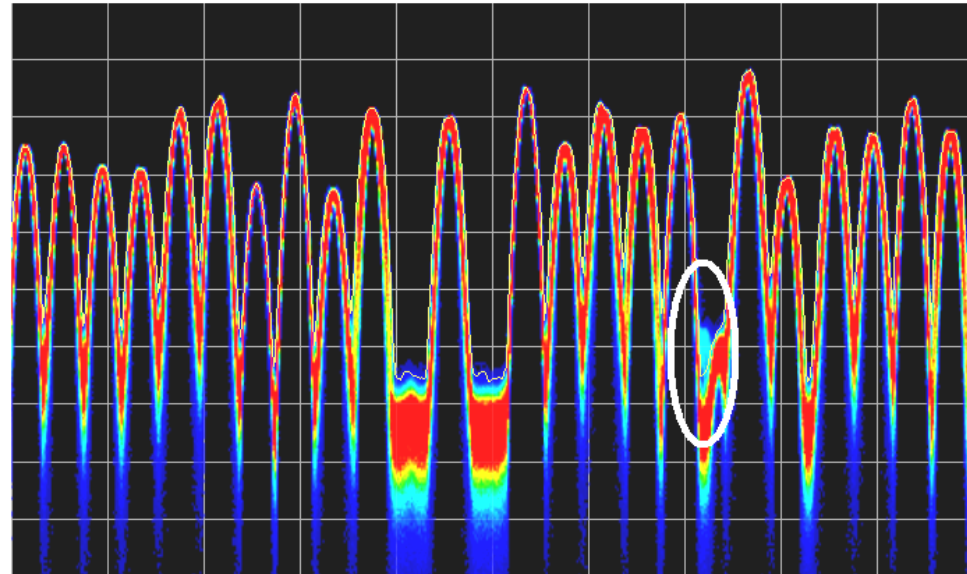
■ Time-varying Overlapping Signals can All be seen



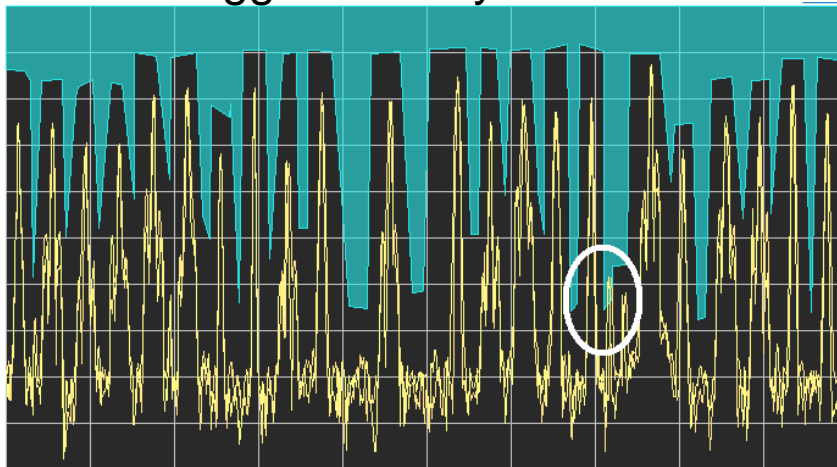
Monitoring Applications

- **Bug Hunting**
 - Store & Forward bursted Bug
 - Buried among FM signals
- **DPX to discover**
 - Then FMT to Capture
 - Spectrogram to Analyze

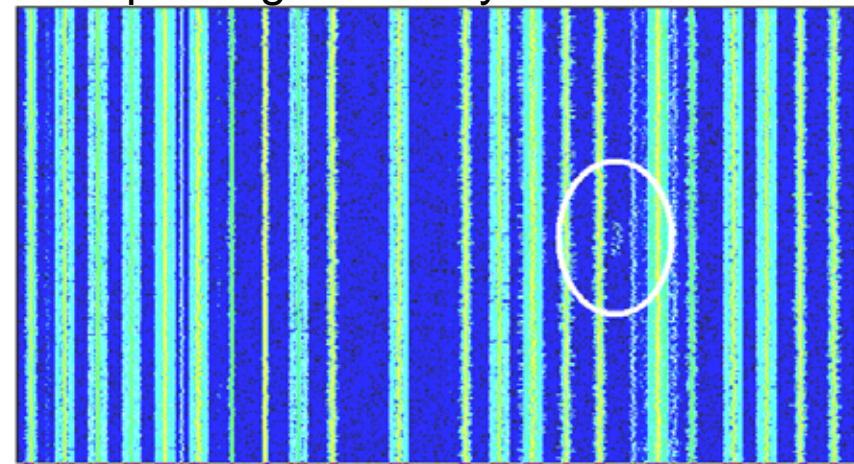
DPX Discovers the Burst Transmission



FMT triggers on tiny burst



Spectrogram Analysis of Burst



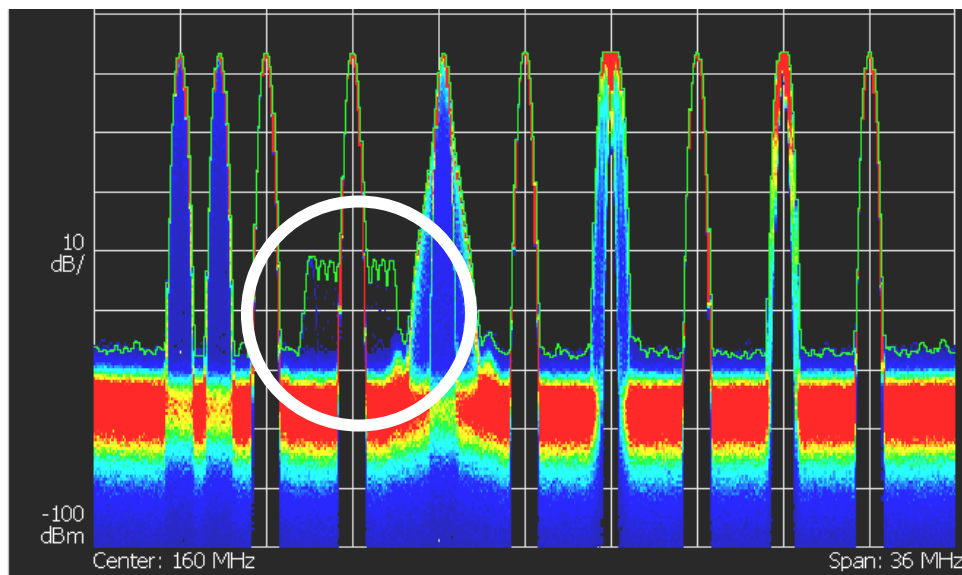
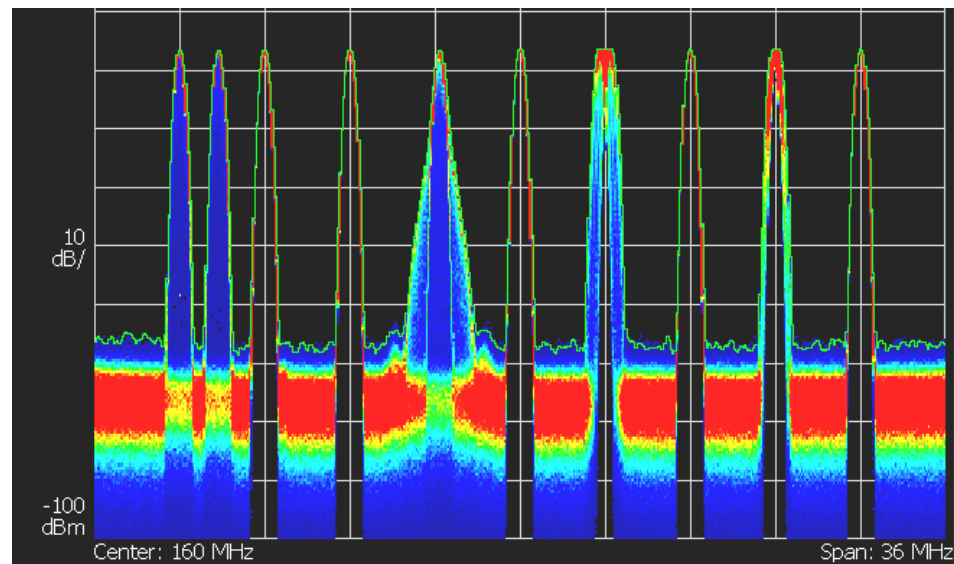
Practical Signal Identification

- **Nine carriers examined with DPX**

- Left is FSK (looks like 2)
- 4th is digital modulation
- Two others FM, and 5 CW.

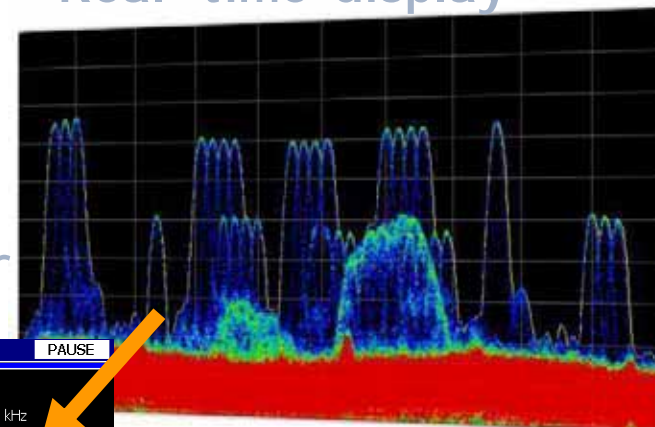
- **DPX (below) shows another !**

- Every three seconds a signal
- Sweeps through one carrier
- Small & Infrequent

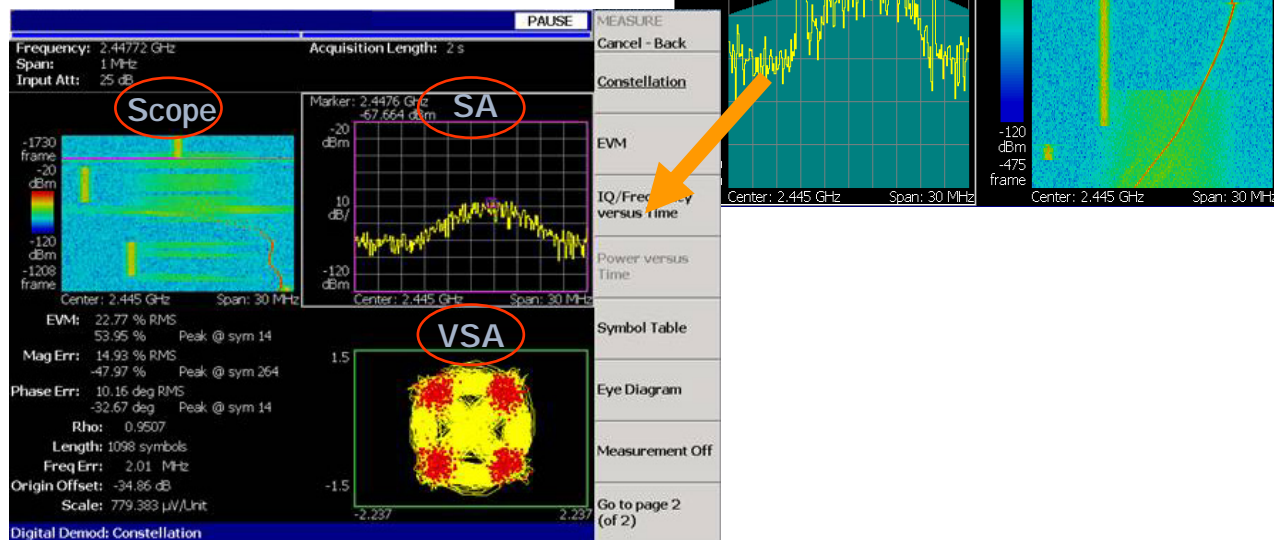


Real-time display

Freq Mask Trigger
Capture !!



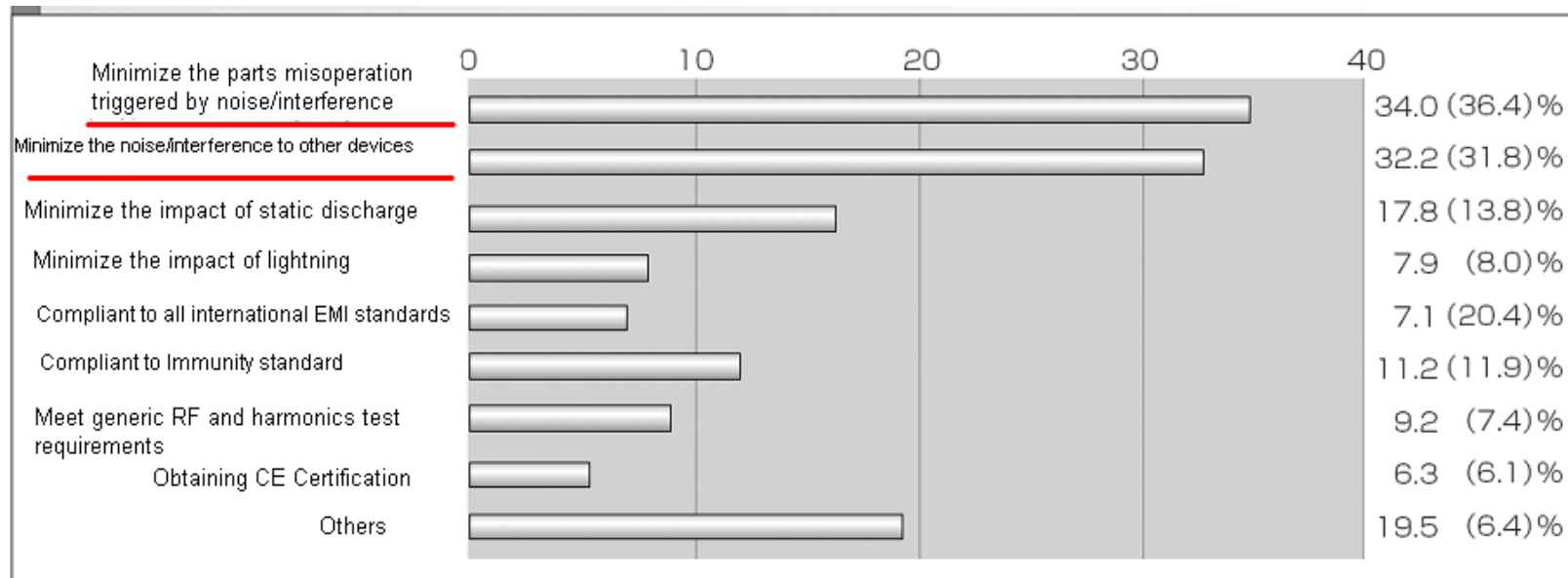
Muti-domain analysis



What Are The Key EMI Measurement Challenges Today?



- How to minimize the parts mis-operation caused by noise/transient interference?
- How to minimize the noise/transient interference emission to other devices?



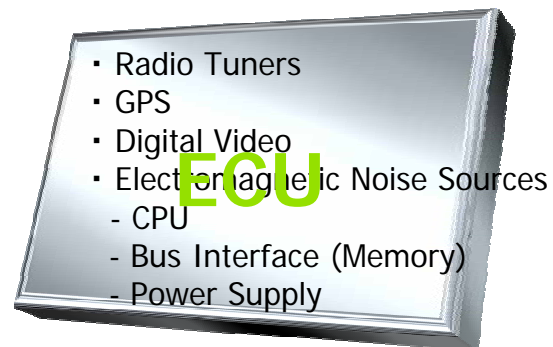
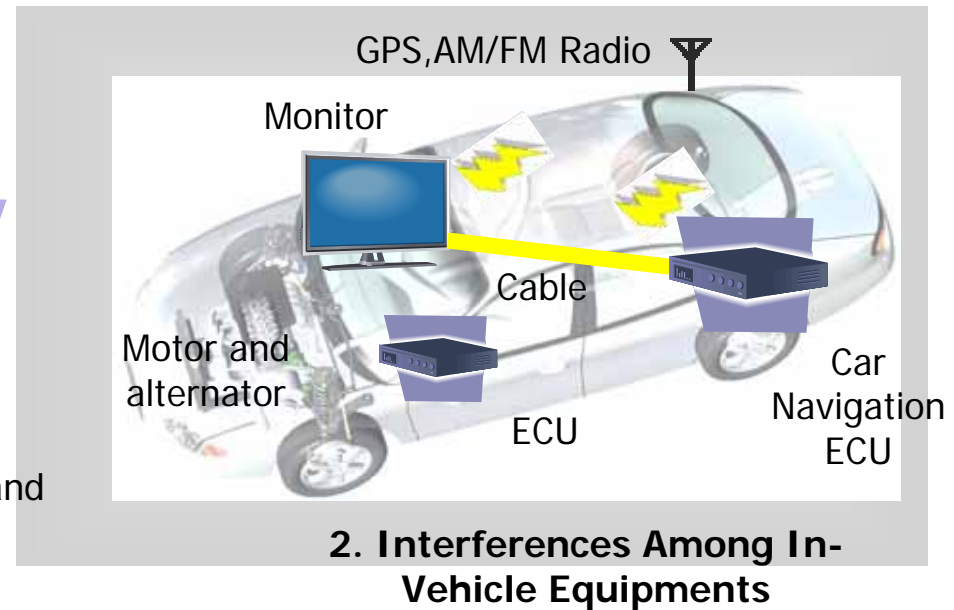
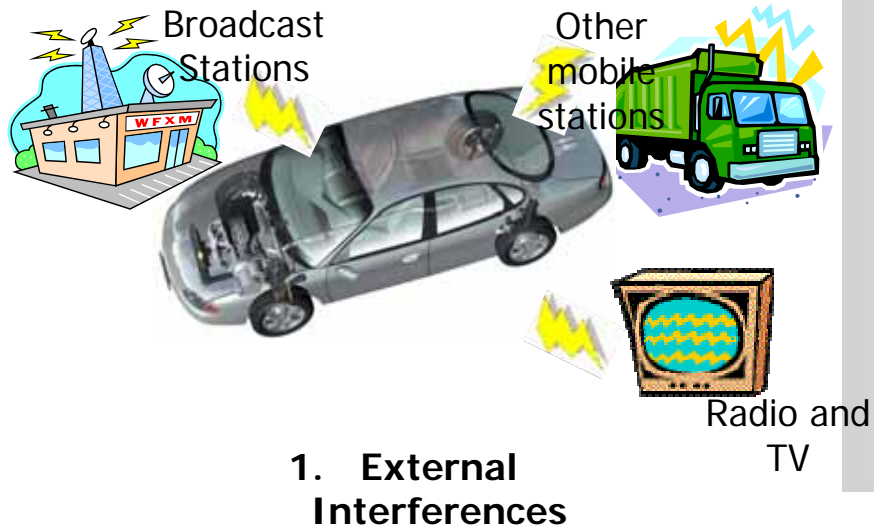
Reference: 2008 EMC-Noise Reduction Technology Exhibition Report

What's The New Problem?



- Modern system may include multiple noise sources, intentional radiators and multiple receivers in close proximity
- Transient noise can cause interference with integrated communications in a design
- Designs can meet regulatory EMI requirements but still not work correctly

Application Example#1: *Automotive Interference/Noise*



3. Interferences from Modules on ECU

Reference: Nikkei Electronics

Tektronix
Innovation Forum

Application Example#1:

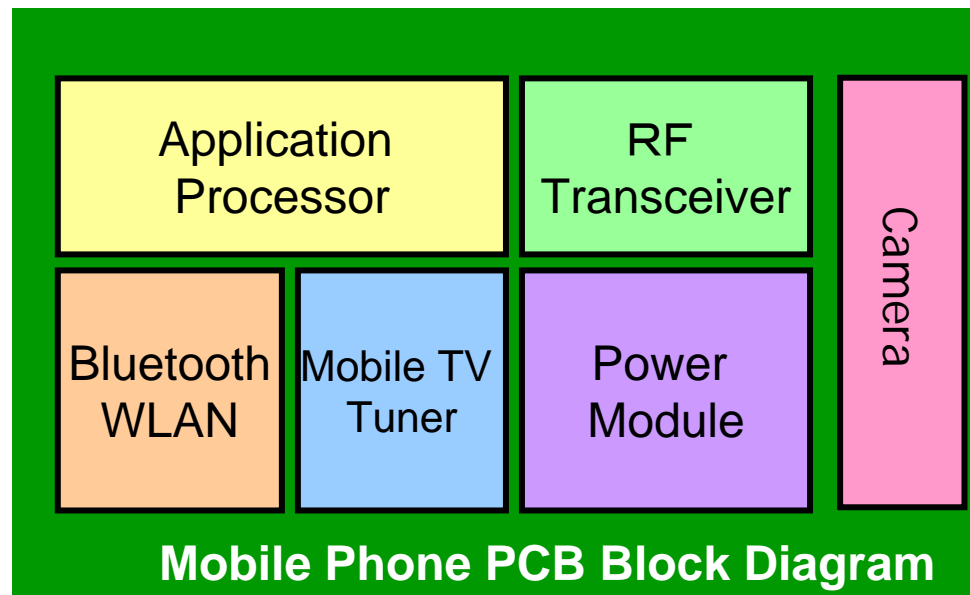
Automotive Interference/Noise (cont'd)

- **Wireless receiver path is heavily interfered by the transient noise generated from in-vehicle inter-module and intra-module sources, which results in reduced sensitivity and increased BER**
- **Common customer experience**
 - Slow internet connection speed, WLAN connection speed dropped by half or more
 - Unable to watch TV in car, no reception on the digital video broadcasted
 - Unable to navigate, GPS signal can not be correctly demodulated by ECU
- **Primary reasons of interference caused**
 - Increased in-vehicle wireless capability
 - Built-in WCDMA/HSPA service, WLAN, Bluetooth, GPS, digital terrestrial broadcasting tuner, AM/FM radio
 - Increased density of integration
 - Various wireless modules integrated on single main circuit board
 - Higher speed of LSI
 - CPU clock and interface bus speed

Application Example#2: *Consumer Electronics Interference/Noise*

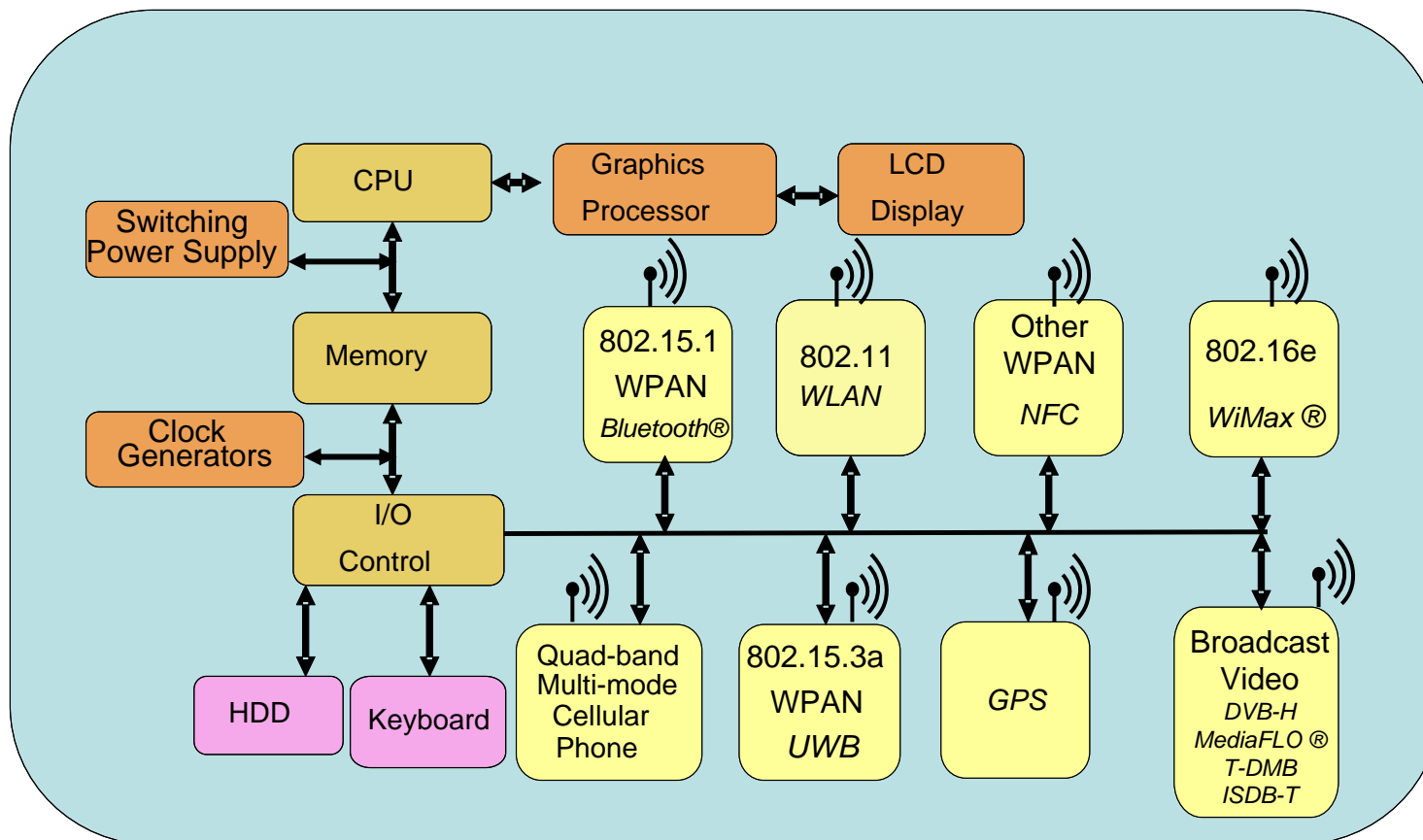
■ Cell Phone:

- The EMI noise sources adjacent to the wireless circuit typically cause the problem, even the interference signal is at very low level
- More built-in wireless modules with highly integrated LSI-chips and high speed -chip interfaces contributed to the noise/EMI interference to low level signal



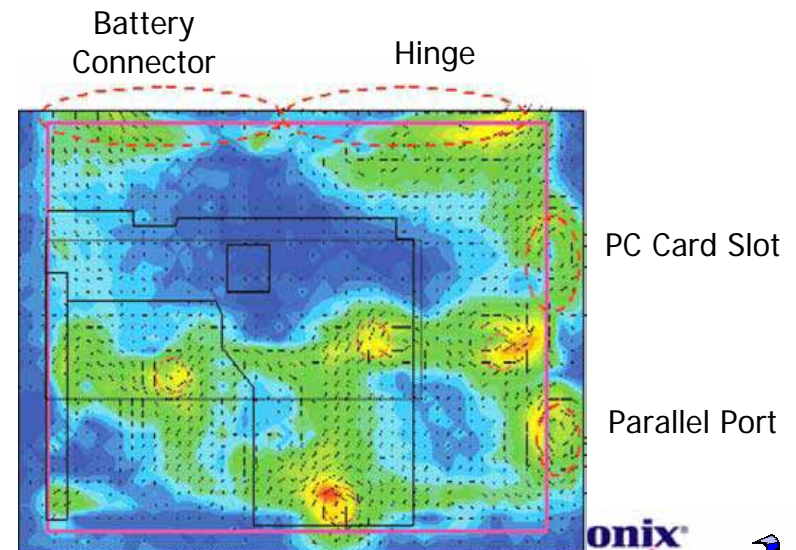
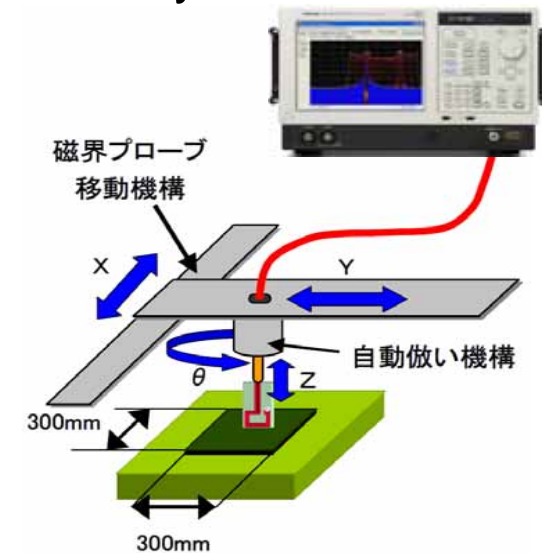
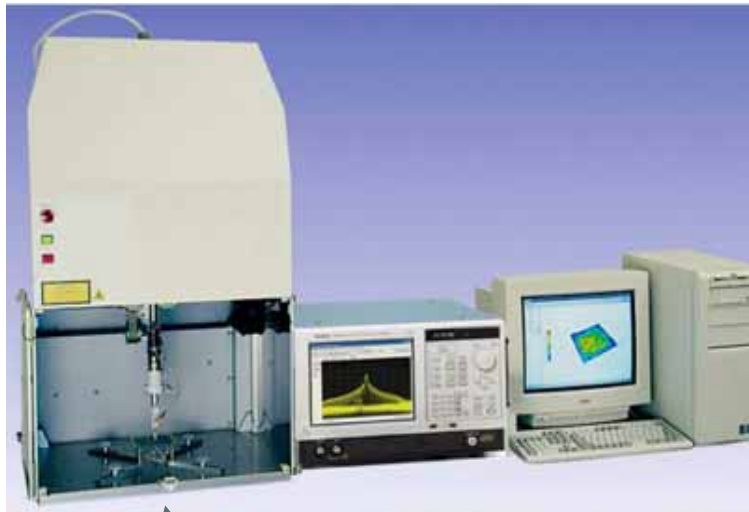
Application Example#3: *Consumer Electronics Interference/Noise*

■ Laptop PC:



Application Example#3: *Consumer Electronics Interference/Noise (Cont'd)*

- Hitachi EMV-200 Transient EMI Measurement System





However, The Old Problems Must Still Be Solved

- **Comparable results require agreed-upon tools**
- **Standards Bodies define receivers in terms of**
 - Frequency range
 - Resolution bandwidth
 - Detectors and averaging
 - Accuracy, sensitivity and dynamic range
- **Requirements vary by geography and application**
 - CISPR, ANSI, TELEC and MIL

EMI Measurements Approach #1: *Conventional Swept-Tuned Spectrum Analyzer*

- **Unable to give insights on the transient interference/noise**
 - Inability to discover and capture transient during common device state changes, e.g. mode change of the inverter, power on/off of the module
- **Very time consuming for wideband sweep with narrow RBW settings**
 - The wireless modules' interference signal is usually at low level (e.g. -13dBuV/-120dBm)
 - Swept spectrum analyzer has to use very narrow RBW (e.g. 1kHz RBW) in order to discover those low level interference signals



EMI Measurements Approach #2: *Real Time Spectrum Analyzer: Discover*

- **Discovering transient interference/noise in seconds with DPX technology!**

Example: Embedded system with frequent hard-drive access during some modes of operation

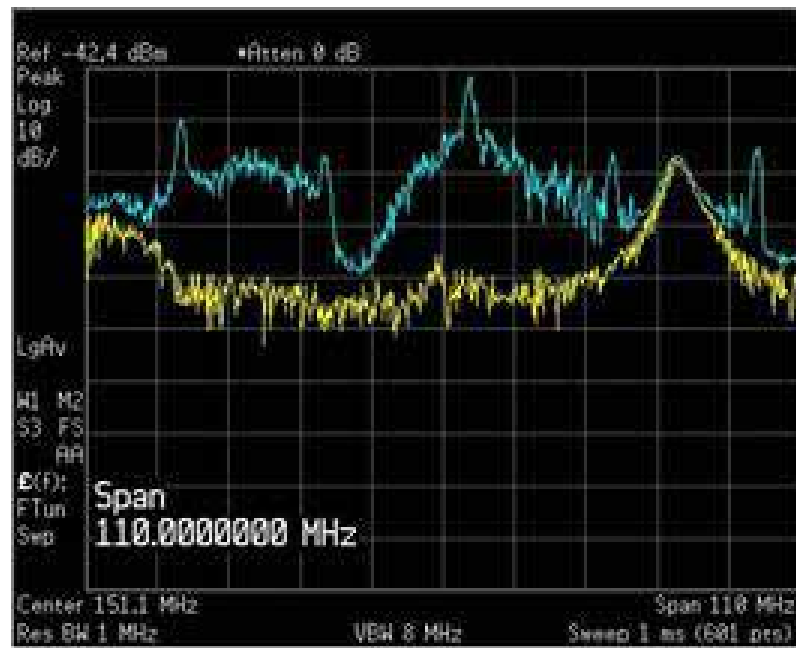


Figure 1: Transient EMI missed in peak scan with swept analyzer (yellow trace), found after 1 minute of Max-hold (blue trace) while DUT was cycled through disk-cache operation.

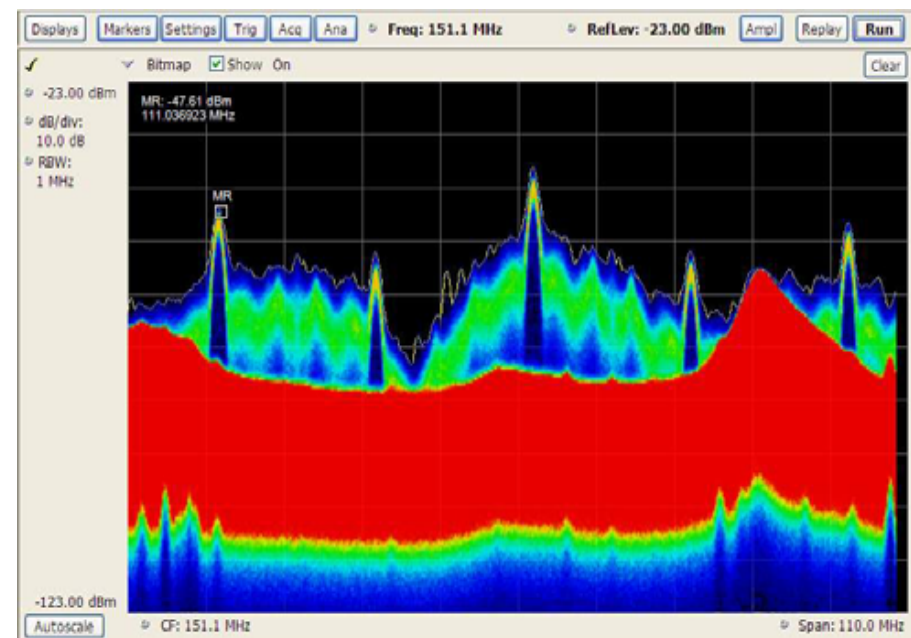
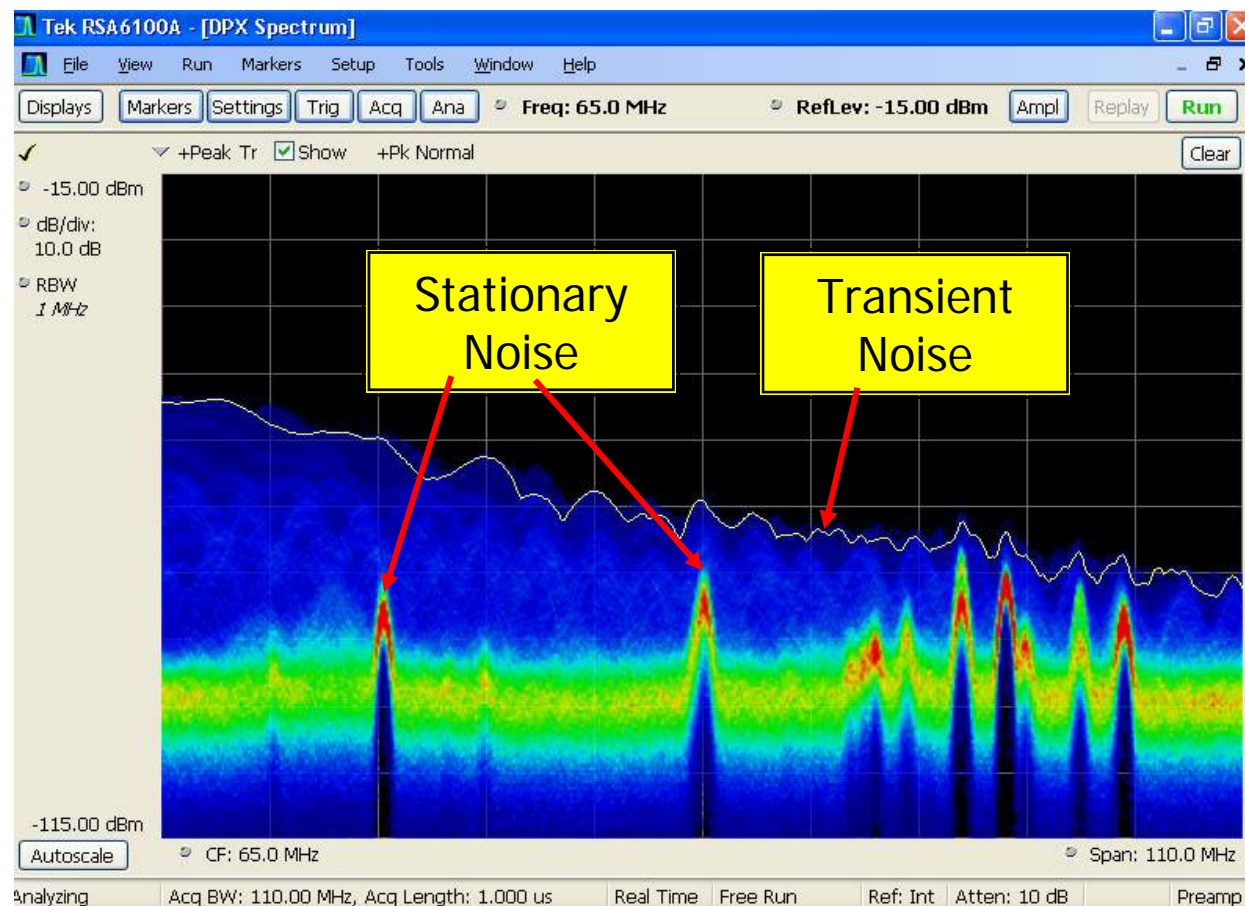


Figure 2: Infrequent transient discovered with DPX after 5 seconds. The red areas are frequently-occurring signals, and the blue and green portions are transients.

EMI Measurements Approach #2: *Real Time Spectrum Analyzer: Discover (Cont'd)*

- **Discovering transient interference/noise in seconds with DPX technology!**

Example: Switching noise which is buried by the stationary noise can be discovered instantly

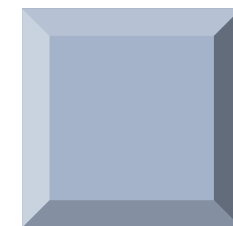
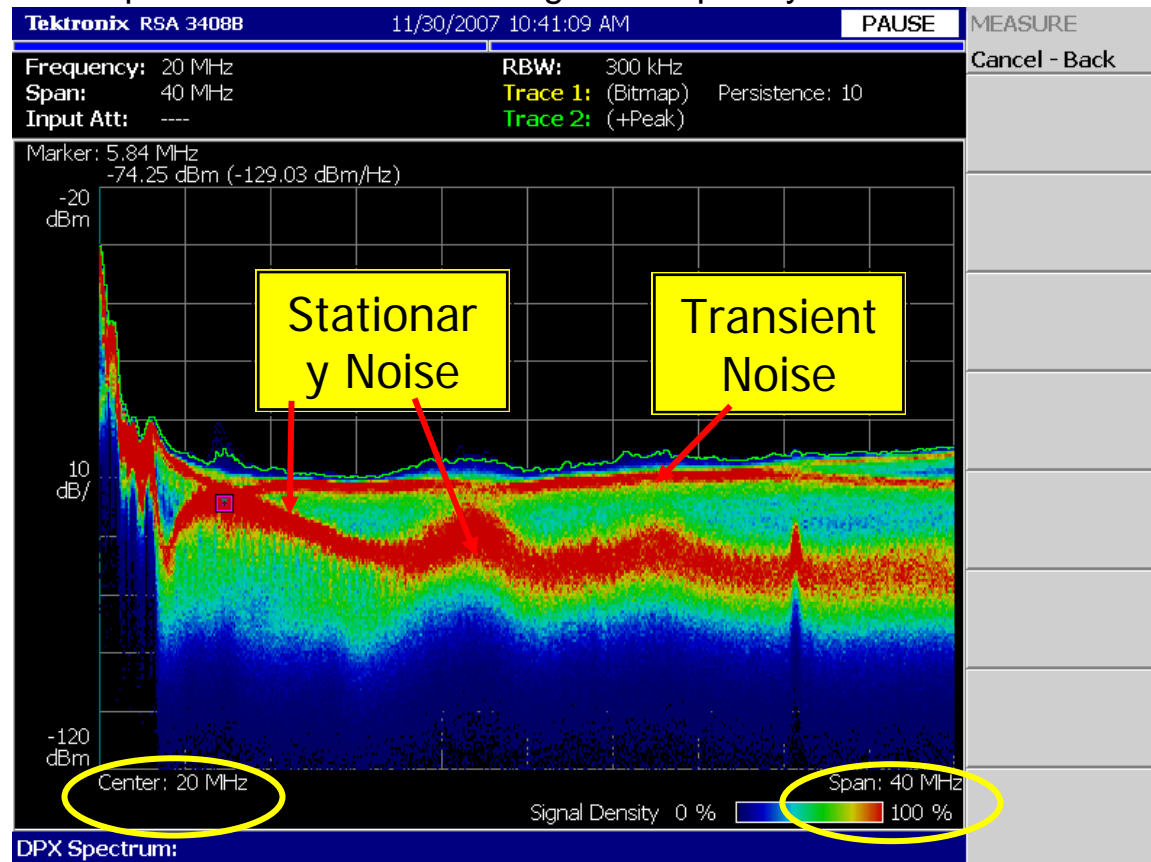


EMI Measurements Approach #2: *Real Time Spectrum Analyzer: Discover (Cont'd)*

- **Discovering transient interference/noise in seconds with DPX technology!**

Screen shot below: RSA3000B measuring low frequency interference/noise from LCD panel of laptop PC

Video Example: RSA3000B measuring low frequency motor interference/noise from DC

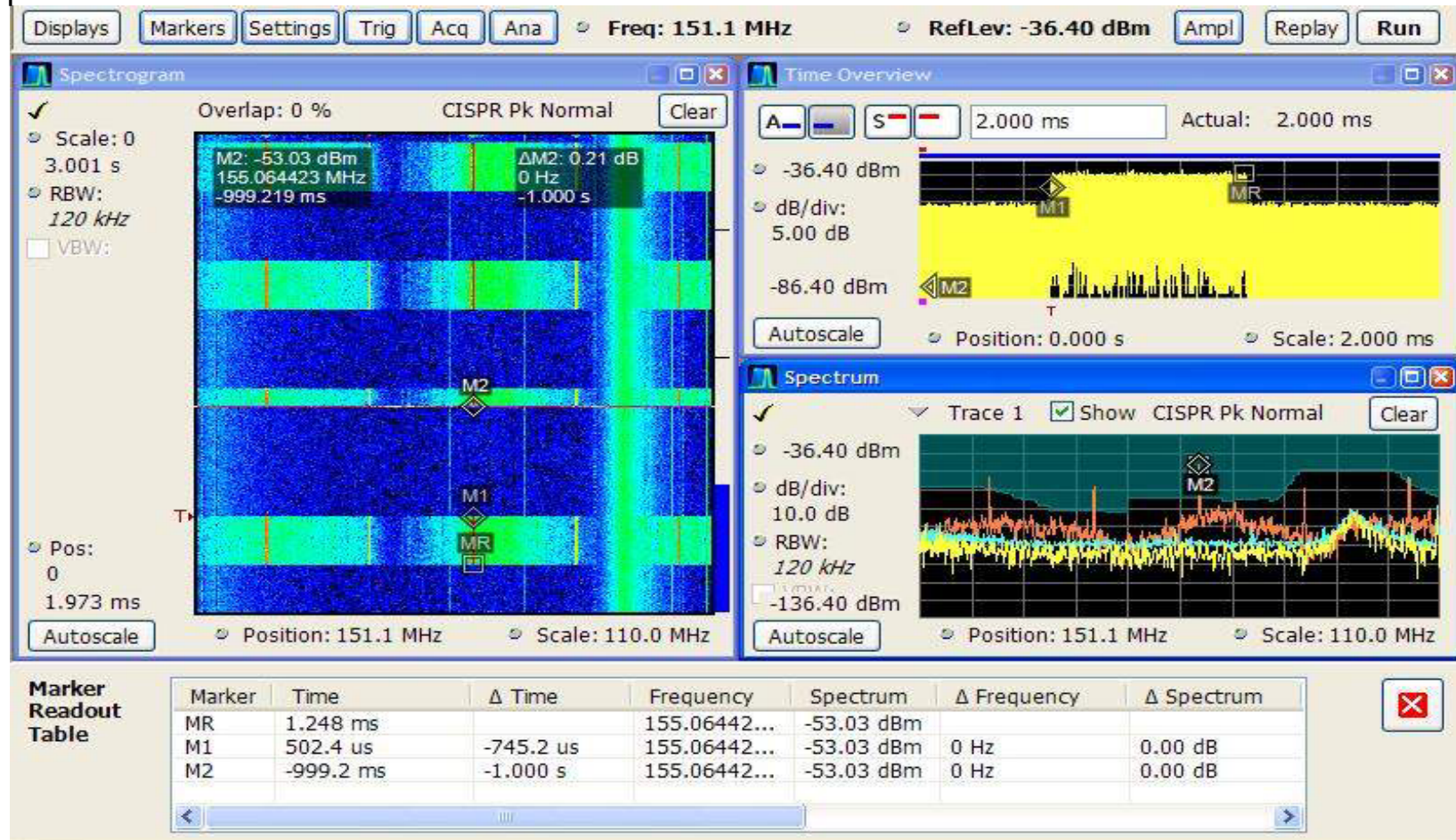


EMI measurements Approach #2:

Real Time Spectrum Analyzer: Trigger and Capture

- Complete transaction capture with exclusive frequency mask trigger (FMT), wide bandwidth, and deep memory

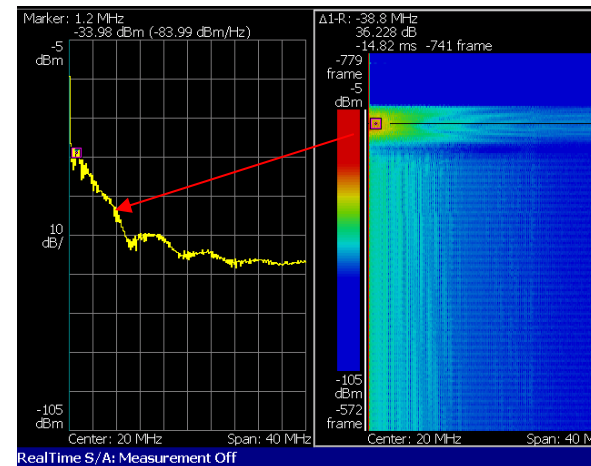
Example: FMT can be used to ignore always-on stationary signals and only captures data when transient happens



EMI measurements Approach #2: *Real Time Spectrum Analyzer: Analyze*

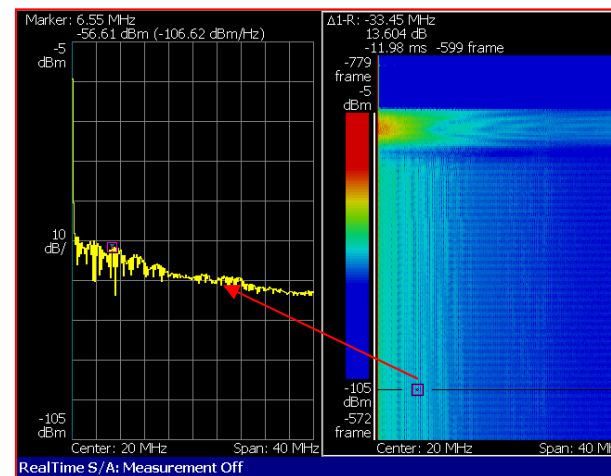
- **Correlated multiple domain analysis on the same set of acquired data makes the troubleshooting easy**

Example: RSA3000B analyzing the radiation noise when the DUT power is turned on



Real time
spectrum
display
when unit
power is on

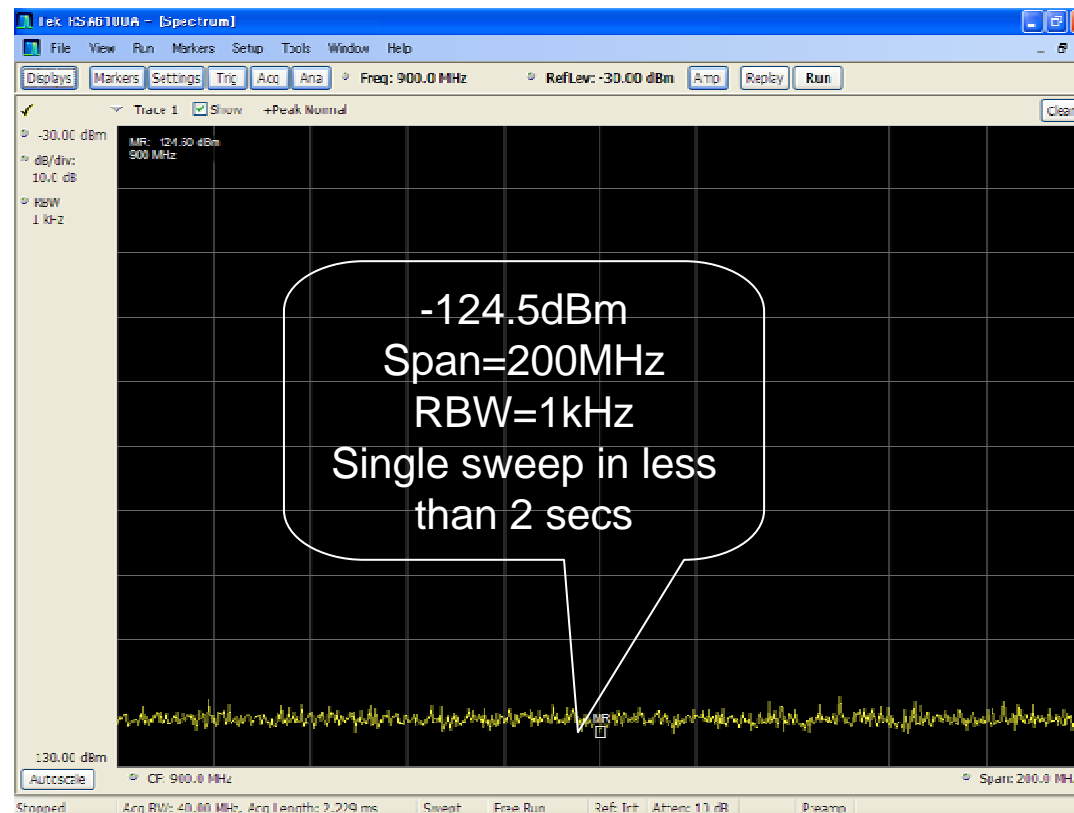
- **Noise emission trend displayed as 3-D in Spectrogram**
 - Frequency vs. Time with color coded power level
 - Correlated spectrum display across the whole captured signal



Stationary
emission
spectrum

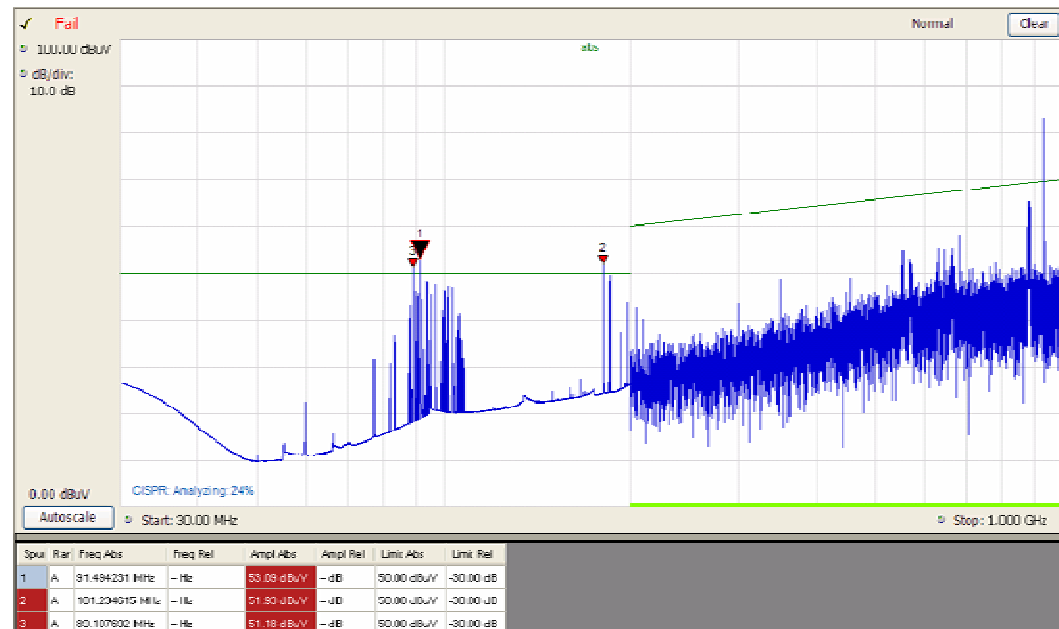
EMI Measurements Approach #2: *Real Time Spectrum Analyzer: Measurement Speed*

- **RTSA helps to shorten the system's EMI evaluation cycle**
 - Comparing with conventional spectrum analyzer that takes at least 4 minutes for a 200MHz 1kHz RBW sweep, RSA6100A Series makes the same measurements in less than 2 seconds!
 - By having 10 or several hundreds of measurements, the overall test time saved is enormous



RTSA Advantages and Limitations

- **Built-in transducer tables, spurious search routines can be used in pre-compliance applications as well as diagnostics**
 - Log sweep and multiple measurement ranges reduce the need for external software in occasional use, external software recommended for extensive testing
- **RTSAs can achieve faster results than conventional swept analyzers in some cases, but is slower in others**
 - Much faster in sweeping a range of frequencies with QP detector
 - No 'zero span' method of detection means slower single point measurements



Success Stories#1:

Automotive – Hybrid/Electric Vehicle

Customer: A Company

Application: EMI Diagnostics – Automotive

Customer unmet need or pain point:

- Needs a SA that can discover all the emissions for inverter motor in Hybrid/Electric vehicles, esp. **the transient emissions, that cause interference to equipments, like Digital TV/radios, ECUs, Car Navigation/GPS system**
- Conventional SA and VSA can not show all the transients

Why RTSA was chosen:

- DPX helped customer discover all the **transient emissions** in real time
- FMT and Real Time spectrogram greatly improved customer's **troubleshooting** productivity by reducing the test time from days to hours
- DC to 20MHz Base Band with DANL at less than -100dBm at 100kHz RBW captures low frequency **inverter noise**

Product /Value: RSA3308B and RSA3408B, followed by RSA orders from OEM part vendors

Voice of Customer: “I have said we didn’t need more demonstration of the RSA just after seeing the DPX Live Spectrum display and compared to three units of other SA vendors which show only noise floors. I will recommend my OEM vendors use your tester”



Success Stories#2: Consumer Electronics – Digital Camera

Customer: B Company

Application: EMI Diagnostics - Consumer Electronics

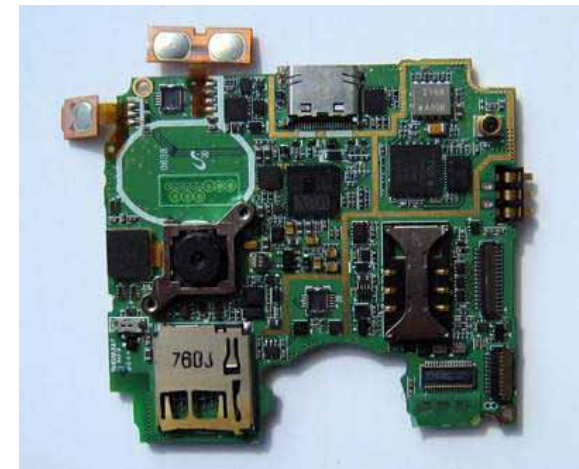
Customer unmet need or pain point:

- Needs a SA that can discover all the emissions, esp. the **transient emissions, that cause interference to other modules on PCB, WLAN channels and GPS receiver**
- Conventional EMC Compliance Tester/SA can not give full insights on all the transients

Why RTSA was chosen:

- DPX helped customer discover all the transient emissions in real time
- FMT and Real Time spectrogram greatly improved customer's troubleshooting productivity
- Wide 110MHz Acquisition Band which can discover any signal anomalies in 2.4GHz ISM band
- Built in QP Detector and CISPR filters helped with conventional EMC pre-compliance tests

Product /Value: RSA6114A +RSAVu



Success Stories#3:

Medical – Blood Sugar Monitor

Customer: C Company

Application: EMI Diagnostics – Medical Equipment

Customer unmet need or pain point:

- Needs a multiple-in-one box that demodulates Bluetooth/WLAN as well provides ISM interference analysis
- Lack of confidence for the design evaluation and troubleshooting of the built-in wireless modules that work in ISM band (Bluetooth and WLAN) in blood sugar monitor

Why RTSA was chosen:

- “DPX is the only tool on the market that gives you the closest view to what your receiver is seeing, and how your transmitter is interacting with other emitters in the ISM band”
- Bluetooth/WLAN signals could not be discovered with full insights by Conventional SAs
- FMT opened customer’s eyes by providing unprecedented fast debug capability, which shortened customer’s develop cycle
- All-in-one design with WLAN and Bluetooth demod options

Product /Value: 1 x RSA6114A



Success Stories#4:

Medical – 802.11n Wireless Video Camera

Customer: D Compnay

Application: EMI Diagnostics – Medical Equipment

Customer unmet need or pain point:

- Need to **survey operating rooms to ensure that no interfering signals were present.**
- Need to ensure compliance with IEEE 802.11n standard
- Need to **ensure** that their products **did not produce spurious emissions**

Why RTSA was chosen:

- DPX – Shows WLAN signals that other spectrum analyzers could not display the live signal.
- Supports 802.11n. Testing to the standard and documenting Pass/Fail performance.




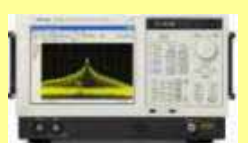
Product /Value: 1x RSA6114A +RSAVu

Voice of Customer: We may also have a need for surveying potential installation sites using the H600. We'll get you in touch with our installation/customer service department.



Real Time Spectrum Analyzer Product Family

- RSA3000B series and portable H600/SA2600 are ideal for all EMI diagnostics, esp. for low frequency transient interference troubleshooting
- RSA6000A series are ideal for all EMI diagnostics with the need for QP detectors, esp. for wide band transient interference troubleshooting

					
	SA2600	H600	RSA3300B	RSA3408B	RSA6000A
Frequency Range	10kHz – 6.2GHz	10kHz – 6.2GHz	DC – 3/8GHz	DC - 8GHz	9kHz – 6.2/14GHz
Analysis Bandwidth	20 MHz	20 MHz	15 MHz	36 MHz	40/110 MHz
DPX Live RF	✓	✓	✓	✓	✓
Signal Classification	✓ opt SC1	✓			
DPX 100% POI*	500 µsec Std 125 µsec Opt	125 µsec	41 µsec	31 µsec	31/24 µsec
Frequency Domain Triggering	Frequency Mask Available	Frequency Mask Available	✓	✓	✓

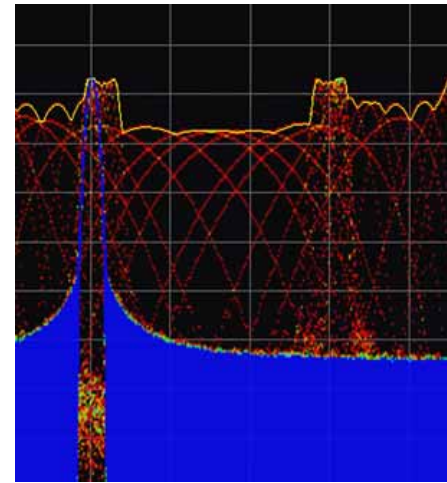
Summary

- **The RTSA is a great diagnostic tool for EMI – it's DPX and FMT that makes the difference, not the EMI filters/detectors**
 - signals have changed, and having the filters and detectors is not enough
- **Hopping, bursting and modulated signals that cause very low response to average or QP detectors are present in many designs**
 - They may even be missed by a peak detector if they are very infrequent
 - These signals might pass a compliance test, but could cause problems in your own equipment or others
- **DPX is the way to discover these signals**
- **FMT is the way to capture these signals**
- **Real Time Spectrogram and Multiple Domain Correlation are the ways to fully analyze these signals**
- **For more information, please refer to**

http://www.tek.com/Measurement/applications/rf/emi_emc.html

Part2:

讓您100%看見所有干擾訊號-場測用攜帶式即時頻譜分析儀



Discover and View Signals Like Never Before

name
title

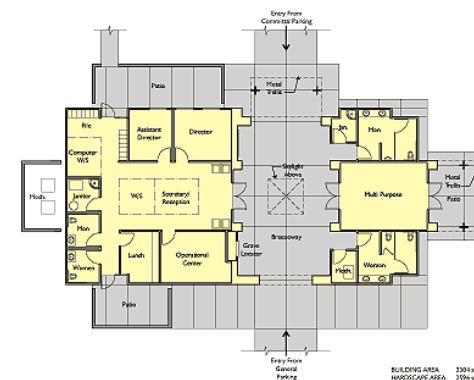
Challenges in Wireless

Different Environments

- In the Office/Home: WLAN, Wireless Phones, Bluetooth, UWB
- Commercial Broadcast: HDTV, HD Radio
- RF Sensitive Areas: Hospitals, Airports, Prisons

Different Challenges

- Establishing and maintaining reliable networks
- Continual re-allocation of spectrum (band clearing and coverage mapping)
- Discovery and mitigation of problem signals

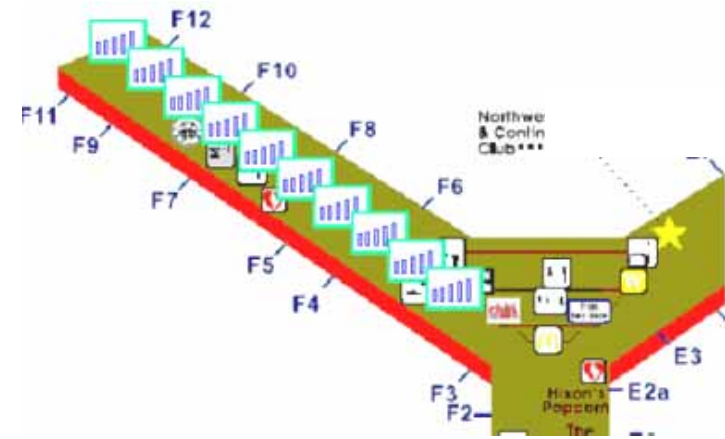


Challenges in RF Test

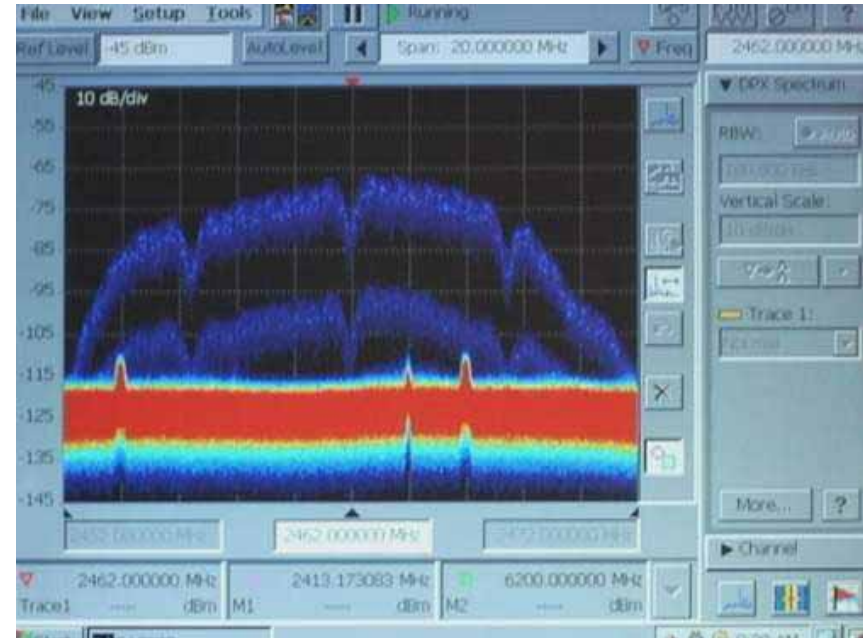
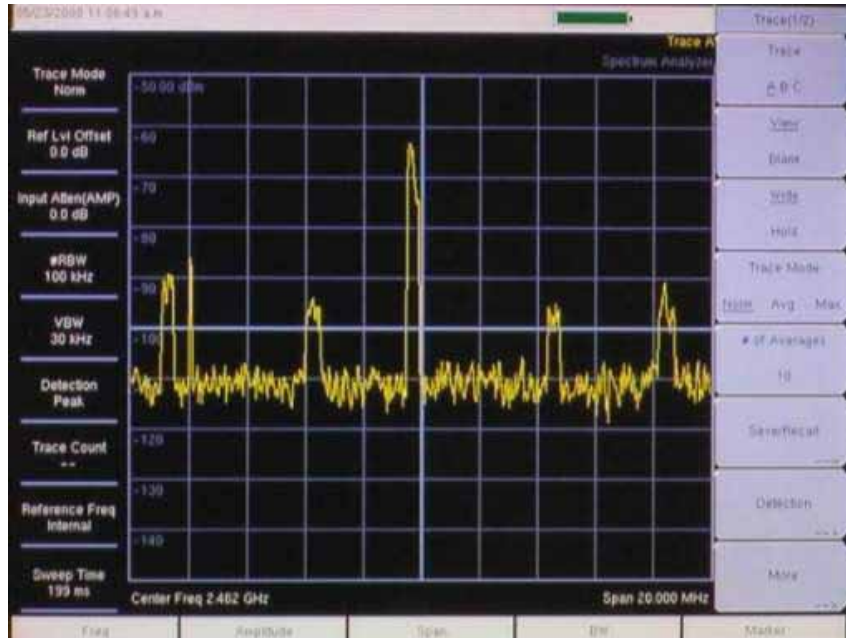
New wireless technologies utilize time varying signals; requires next generation test equipment for R&D and now in the field

Crowded spectrum requires more advanced and expert solutions

Increased need for spectrum mapping and interference detection



DPX Live RF in Action: Spectrum Management



Interference Troubleshooting Has Never Been So Easy

Industry Problem

- Detecting modern signals
- Finding sources of interference

Competing Solutions

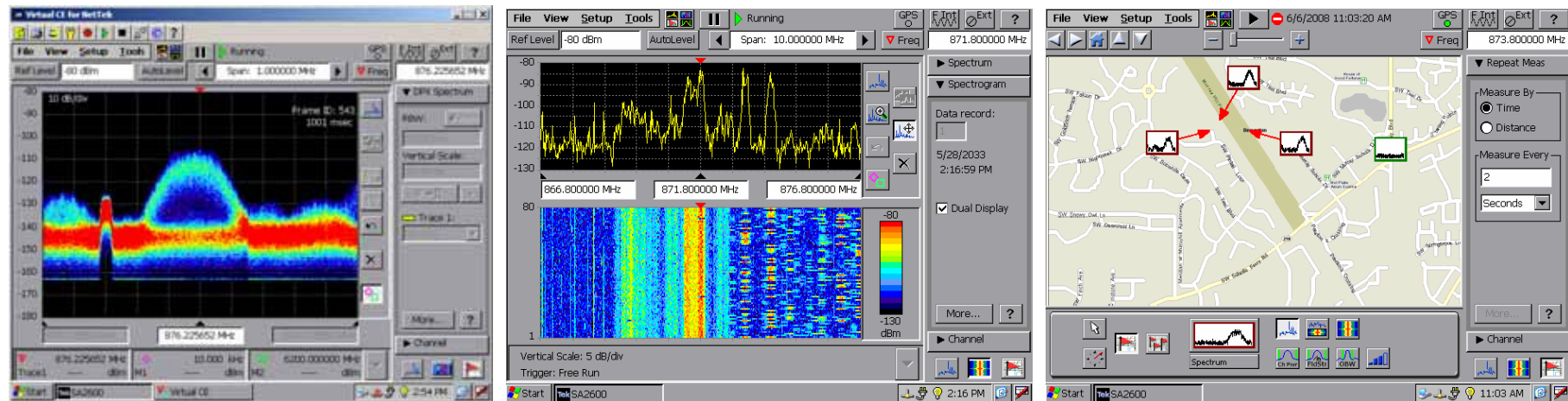
- Low Probability of Detection
- Can't see signals within signals

Tek Advantage!

- DPX: Discover problems with 100% probability
- See signals within signals

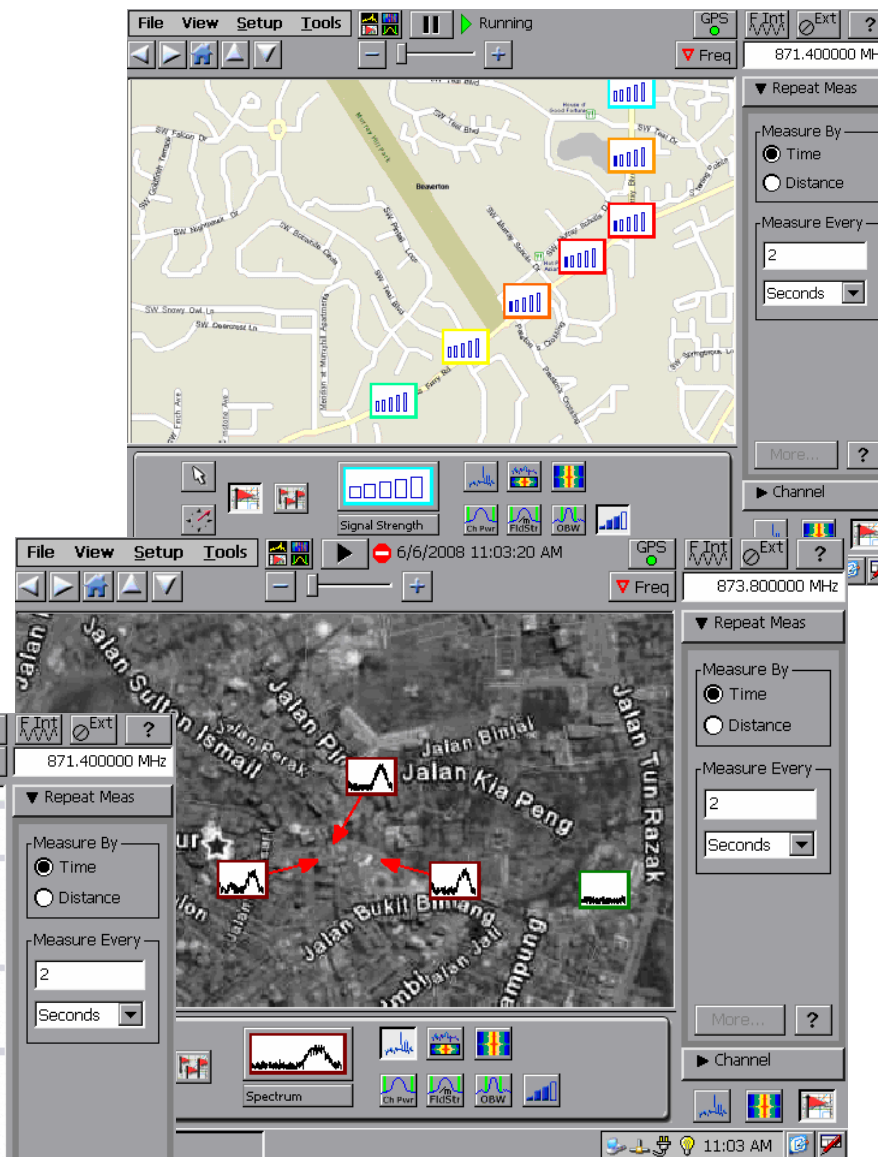
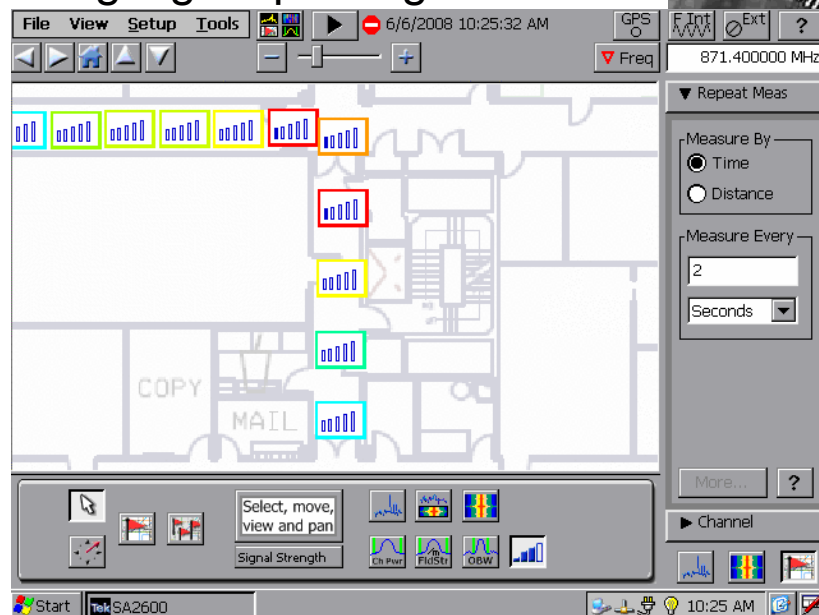
The SA2600 unique business value

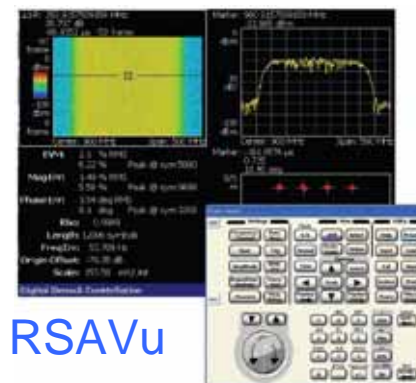
- Spectrum Analyzer with Mid-Range Performance
 - 10 kHz to 6.2 GHz range
 - 20 MHz Acquisition Bandwidth
 - 10000 spectrums/sec 每秒10000張頻譜量測, 100%保證捕捉125us訊號
- Rugged platform and long battery life in a handheld offers performance capability where you need it 電池可維持運作至5小時
- Integrated mapping allows for faster interference detection 內建GPS定位地圖



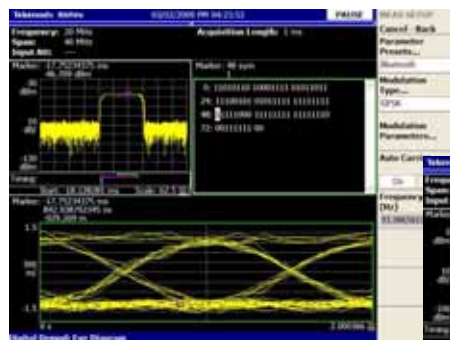
Locate

- Quick directional information with signal strength tone
- Fast antenna sweeps
- Manually add direction finding arrows on the map
- Geo-referenced bit maps for signal plotting
- In-building signal plotting

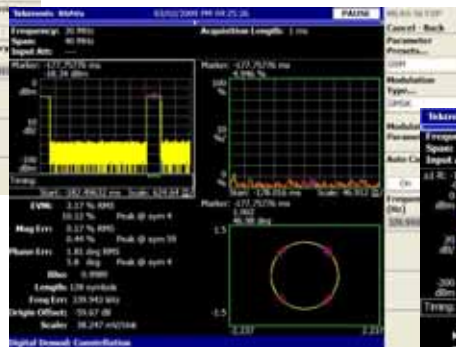




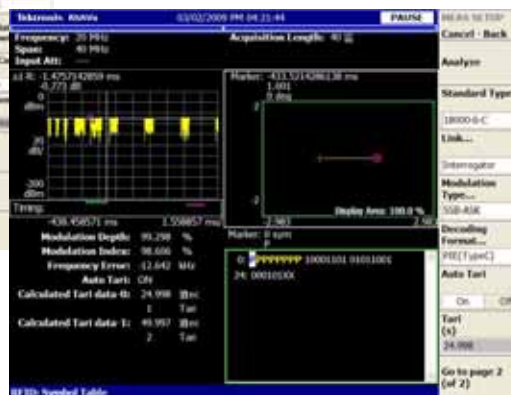
BT



GSM



RFID 18000-6-C

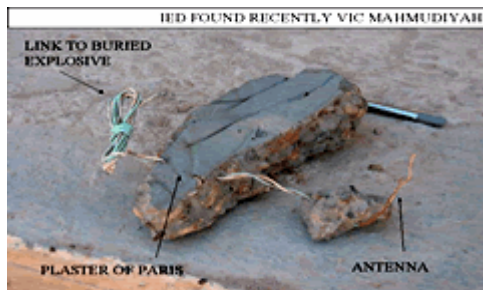


FSK

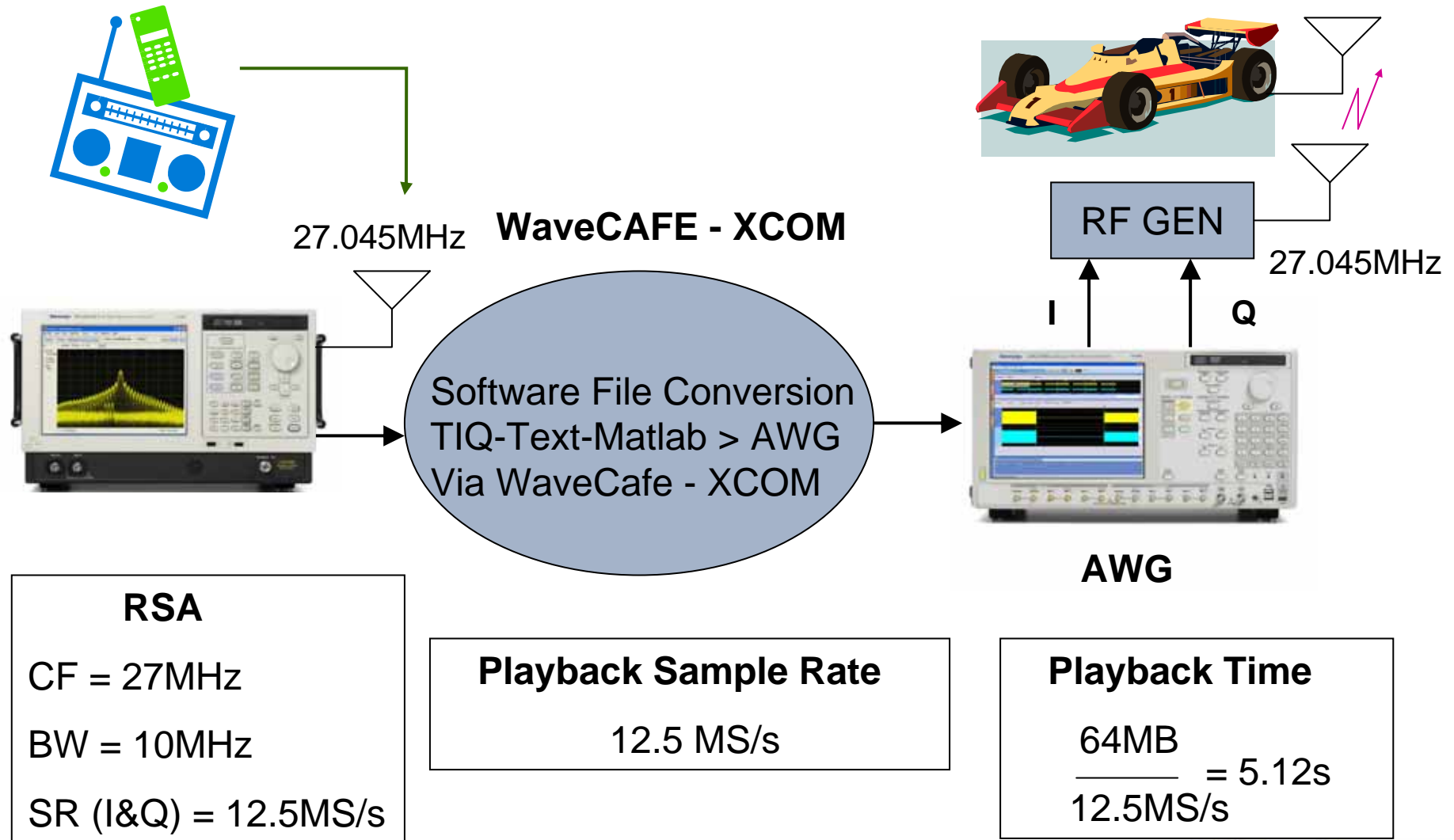


Application Example: *IED(Improvised Explosive Device)*

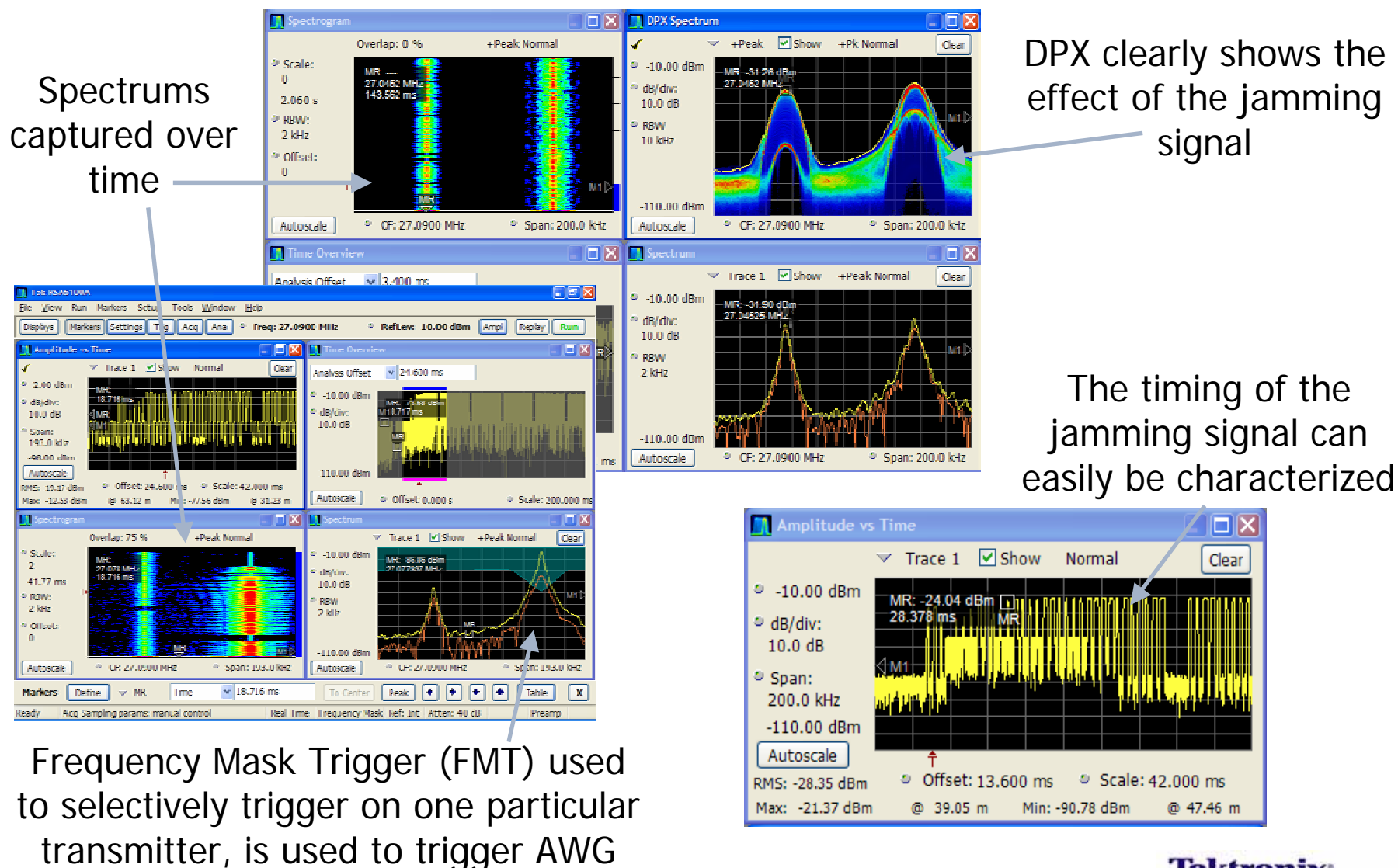
- Why do we need this capability?
 - RF System Development & Test
 - Electronic Warfare, Counter-measures
 - Detecting and Defeating RF Threats, i.e. IED's, etc.
- Focus on RF Threats...
 - Discover the existence and nature of the threat
 - Capture & Analyze the characteristics of the threat
 - Synthesize a signal that will jam the receiver
 - Characterize the timing and effectiveness of the jamming signal



RF Playback: I/Q Generation & Modulation



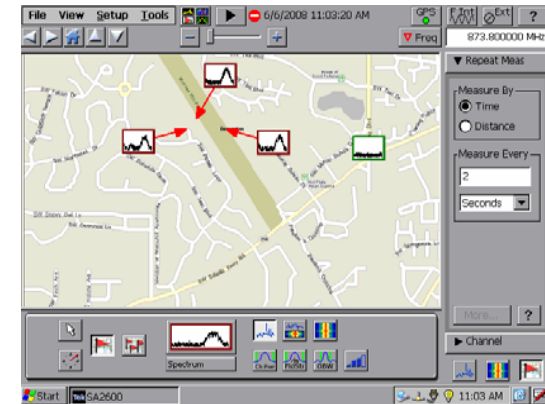
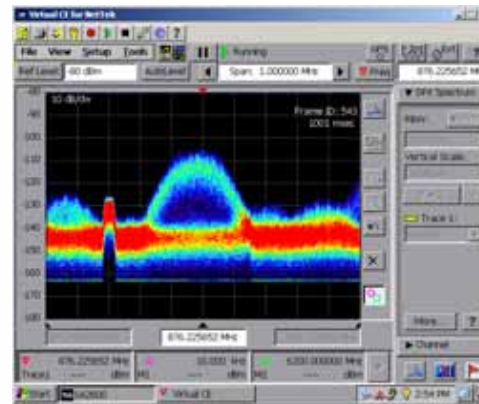
Example: Selectively Jamming an RC Car



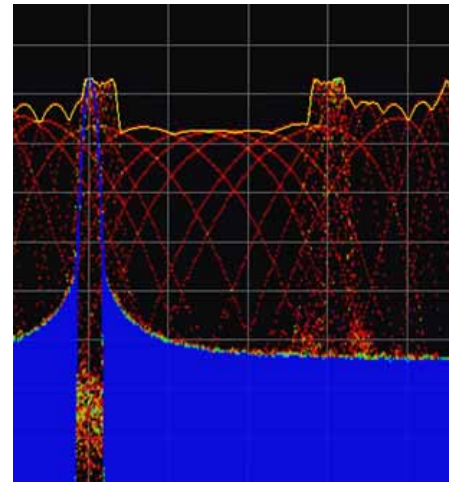
Summary:

H600/SA2600 Unique Value for Field Measurements

- Discover signals with DPX™ technology – 100% Probability of Intercept
- Benchtop performance in a handheld Spectrum Analyzer
- Integrated mapping allows for faster interference detection
- Integrated signal classification (H600)
- Rugged platform and long battery life in a handheld



Thank You!



RTSA – Discover...Trigger...Capture...Analyze