Developing the DFS Standard – A Laboratory Perspective

Mark Briggs

Elliott Labs – An NTS Company

mark.briggs@ntscorp.com

Key Elements

- Test methodology had to be repeatable
- Test procedure had to be commercially viable
- Test procedure had to be able to handle non “standard” equipment

Repeatability

- Tests performed by one lab must be repeatable by another
- FCC performing pre-grant testing on ALL master devices
  - All master devices are tested twice – by the lab and by the FCC
  - We want confidence that products passing the test in our lab also pass at the FCC lab

Repeatability

- Conducted method versus radiated method
  - FCC use the radiated method for all master devices
  - Conducted method is easier to set up
    - More repeatable
    - Assumptions about antenna gain
  - Radiated method
    - More “realistic”
    - Have to align receive antenna to radar antenna
    - Less repeatable/higher measurement uncertainty

Repeatability

- Build in margins into testing to account for
  - Measurement uncertainty associated with radar level calibration
  - Uncertainties associated with the EUT
    - Large, high gain antennas may be tested in Rayleigh near field for the radiated test, gain not fully realized
    - Measured antenna gain outside of the system may over-estimate actual gain when antenna is installed into a system

Repeatability

- FCC Method tests at threshold +1dB
  - FCC lab does radiated test at threshold +1dB
- Conducted measurements we recommend testing at threshold -3dB
- Radiated method we test at threshold and seem to have good correlation with the FCC

Repeatability

- Un-written aspects of the test
- The procedure allows for testing across the detection bandwidth
  - FCC lab varies frequency of applied radar across the system's signal bandwidth
  - Important to do the same – can show deficiencies in channel-bonded systems

Commercially Viable

- Main costs
  - Test equipment
    - Signal generator
    - Traffic monitoring system
  - Actual Test Time
    - Automation of testing
      - Looking into ways to poll master devices rather than rely on the master device to send console messages for detection probability tests
      - Go/No Go overnight testing
    - Automation of report generation
      - Need to log 100's of trials and summarize data

Commercially Viable

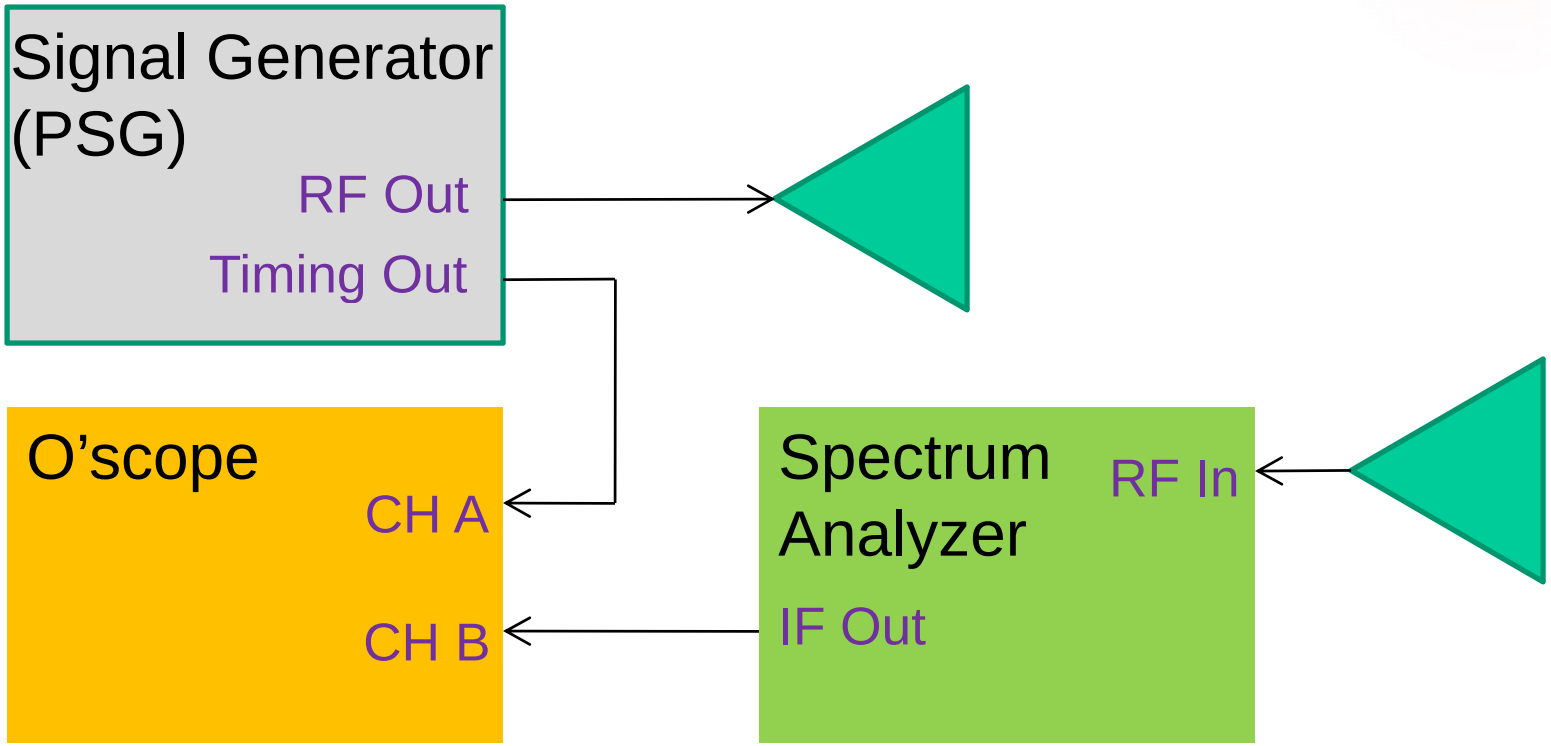
- Test equipment, Signal generator
  - Long sequence waveform (12 seconds long) plus modulated pulses with different parameters
    - Agilent PSG + Pulse Building Software Suite
  - Frequency agility
    - Initial procedure required frequency agile signal generator with hop rate of 3kHz (later reduced to 1kHz)
    - Not commercially available in a single box
    - Developed alternate method to the frequency hopping test
      - Allowed use of a “standard” signal generator
      - Created the detection bandwidth test

Commercially Viable

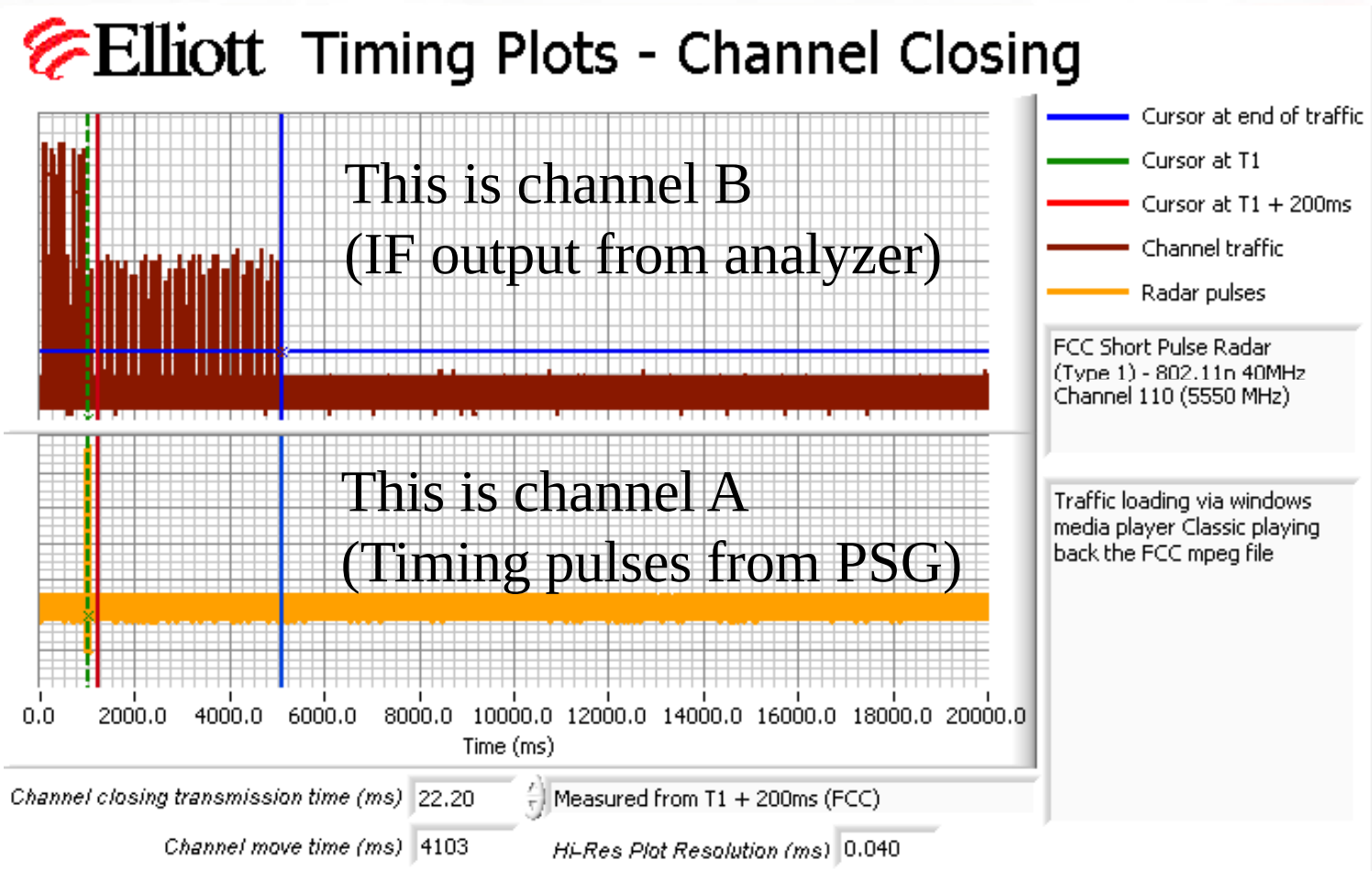
- Test equipment, Traffic Monitoring System
  - Long record lengths with high resolution
    - Channel closing – 20 second plot with resolution of (ideally) 40us (500k samples)
    - Frequency selective - only looking at channel being vacated
    - Synchronized to Radar burst
    - Non occupancy – 30 minute sweep time

Commercially Viable

- Test equipment, Traffic Monitoring System
  - Scope has resolution and record length but no frequency selectivity
  - Analyzer has frequency selectivity but not record length
  - Use narrowband IF output of analyzer into ‘scope
  - Signal generator provides triggering



Traffic Monitoring System



Traffic Monitoring System Output

Commercially Viable

- Time (= Test Automation)
  - No bundled “DFS” package
  - Developed in-house control software
    - Avoided building IQ waveforms by using Agilent Pulse Building API to interface with PSG
    - Integrated data capture and report generation using LabView
  - DFS packages subsequently developed and are commercially available
    - National Instruments , Aeroflex and Tektronix
    - DFS test system must be approved by the FCC with NTIA review

Commercially Viable

- Time (= Test Automation)
  - Still reliant on console messages to determine if master device detected radar during probability tests
  - Working with Veriwave to develop integrated system
    - Poll the air for protocol-defined information elements to automate the test
    - Generate the required traffic through master device
    - Pass/fail production line testing

Non-Standard EUTs

- Specification and method for packet based systems based on 802.11an
  - Assumes client devices can stream a video file through the master
  - OK for most master devices
  - 802.11 client devices are not all laptops running MS Windows
    - Medical monitoring system
    - Hand-held device with limited data buffering

Non-Standard EUTs

- Non-standard devices need a test plan approved by NTIA/FCC
  - Causes delays in testing and approval process
  - Becoming formulaic as we see more non-standard devices
    - Easier to create the test plan based on similar devices already approved