Staggered PRT Status

(Informational Briefing)

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NEXRAD Technical Advisory Committee
Outline

- Why SPRT?
- Overview of SPRT
- Three Phased Approach
- Status
- Future Plans
Why SPRT?
Why SPRT?

• Recovers higher velocities from longer PRTs
  – Long PRT reduces range folding
  – Staggered PRT provides method to recover aliased velocities

• Replaces Batch and Contiguous Doppler without range unfolding (CDBatch) tilts
  – Less range folding than Batch
  – Can recover higher velocities than CDBatch
SPRT Overview

• Dealiasing Technique
  – Transmits alternating Pulse Repetition Time intervals, $T_1$ and $T_2$
  – Employs Pulse Pair Processing equations
  – Calculates a velocity from each time interval
  – Finds the difference between velocities
  – Uses that difference to dealias one of the original velocities

• Utilizes a DC removal clutter filter
  – Only achieves 30 dB suppression
Example: Scale reflects $\kappa = 2/3 = T_1/T_2$ and $T_1 < T_2$
Velocity Difference Transfer Function

$$v_1 - v_2$$

$$v_1$$

$$v_2$$

Aliased $v$

True $v$

add $2v_{a1}$ to $\hat{v}_1$

closest level

$\hat{v}_1 - \hat{v}_2$

Diagram provided by S. Torres, CIMMS/NSSL
SPRT and Clutter Filtering

• SPRT originally used a DC removal clutter filter
  – Only achieves 30 dB suppression
  – Does not meet requirements
• Why not use GMAP with SPRT?
  – GMAP works in the frequency domain, not time domain
  – Fourier Transform changes from the time domain to the frequency domain
  – The DFT is the commonly implemented Fourier Transform method
  – The DFT assumes uniformly spaced time samples
  – SPRT has non-uniformly spaced time samples
• NSSL developed a solution
  – Spectral Algorithm for Clutter Harmonics Identification and removal (SACHI Filter)
The SACHI Filter

- **Zero filling** reconstructs uniform PRT sequence ($T_u$)
- Spectrum is modulated: 5 replicas
- Central portion of spectrum is given to GMAP to determine notch width
- **Projections** are used to remove clutter from other 4 replicas
- **Velocity** is estimated from resulting spectrum
  - Higher errors due to replicas
- **Deconvolution** undoes modulation
- **Velocity** is estimated from resulting spectrum
  - Extended Nyquist: $v_a = \lambda/4 T_u$

Diagram provided by S. Torres, CIMMS/NSSL
Three Phased Implementation Approach - Overview

• Phase I – CCR: NA07-10703 NA06-33301
  – Enabled Sigmet’s Dual PRT (DPT2) Major Mode
  – Collected Staggered PRT level 1 data
  – Compared Sigmet’s DPT2 with NSSL’s Staggered PRT (SPRT)
  – Selected NSSL’s SPRT

• Phase II – CCR: NA07-10802 NA07-35104
  – Implemented RVP8 Major Mode for NSSL’s SPRT
    • Engineering test functionality
    • Utilizing a DC removal clutter filter
  – Continuing data collection and analysis
  – Analyzing SACHI’s complex spectral clutter filter (NSSL)

• Phase III – CCR: NA08-21662
  – Add implementation of the SACHI clutter filter
  – Provide operational functionality
Three Phased Implementation Approach – Phase I

• Phase I – Complete
  – Enabled Sigmet’s Dual PRT (DPT2) Major Mode
  – Collected Staggered PRT level 1 data
  – Compared Sigmet’s DPT2 with NSSL’s Staggered PRT (SPRT)
  – Selected NSSL’s SPRT
Three Phased Implementation Approach – Phase II

• Phase II – **Complete**
  – Implemented RVP8 Major Mode for NSSL’s SPRT
    • Engineering test functionality
    • Utilizing a DC removal clutter filter
  – Continuing data collection and analysis
  – Analyzing SACHI’s complex spectral clutter filter (NSSL)

• **Verified SPRT implementation**
  – Bin by bin comparison with NSSL

• **Applications Branch adjusted the VDA**

• **RDA Build 11.2 (non-operational)**
  – Deployed to the field 23 November 2009
Three Phased Implementation Approach – Phase III

- Phase III – In Progress
  - Implement the SACHI clutter filter
  - Provide operational functionality
- NSSL provided the AEL for the SACHI filter
  - Included recovery of range overlaid signal
- Need for data became apparent
  - For use in unit testing the implementation of the SACHI filter
  - For engineering analysis once implementation is complete
  - SPRT changes transmission of pulses
    - Required collection of data in operational mode
  - Required determining an operational VCP
- Knew that KCRI resource was limited
  - Increased the priority of data collection
Engineering SPRT VCP

- Create an engineering VCP
  - NSSL provided analysis for optimal PRFs
    - SPRT
    - SACHI filter
    - 2/3 PRT ratio
  - Merged SPRT and VCP 221
    - Proposed operational SPRT VCP, VCP 222
  - Modified VCP 222 to add information for engineering
    - Additional SPRT scan at 1.5° elevation
      - Provides data with clutter contamination
    - Additional Batch scan at 1.5° elevation
    - Multiple sweeps at the same elevation angle
      - 2.4°, 3.4°, and 9.9°
      - Different processing
        » Batch
        » SPRT
        » CD
    - Provides a comparison between processing methods
Engineering SPRT VCP

Range vs. Height from WSR-88D Beam Height Equation VCP 223

<table>
<thead>
<tr>
<th>Height Above Radar Level (kft)</th>
<th>Distance from Radar (nm)</th>
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<tr>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>10</td>
<td>50</td>
</tr>
<tr>
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<tr>
<td>60</td>
<td>300</td>
</tr>
<tr>
<td>70</td>
<td>350</td>
</tr>
</tbody>
</table>

- Blue – SZ-2
- Red – Batch
- Black – SPRT
- Green – CD
Future Plans

- Continue to implement the SACHI filter
- Risks
  - Dual pol first priority for resources
    - People
    - Testbed
- Build 13 first build after Dual Pol deployment
  - Focus on implementing CMD
  - Fine tuning Dual Pol
- Operational SPRT targeted for Build 14
  - Implemented in Build 13
Questions?
SPRT Spectrum Width