DIFI Plugfest Update

October 30, 2023
Agenda

- Overview
- Interop Setup
- Test Methodology
- Test Matrix
- Test Results
- Challenges / Issues
- Lessons Learned / Recommendations
- Summary
Overview

- 7 participating companies (~18 people)
  - Calian
  - Evertz
  - Keysight
  - Kratos
  - ST Engineering iDirect
  - Wavestream
  - Welkin Sciences

- **Purpose:**
  - Interop/Plugfest (not a certification event) to test V1.1 interoperability
  - DIFI implementations were in various states from prototype to pre/production product

- **Goals:**
  - Verify implementations & interoperability of V1.1 across scope of the standard
  - Not testing performance of RF/devices/system
Overview

- Equipment being tested
  - BUC
  - Combiner/Divider
  - DIFI Stream Generators/Testers
  - IFCs (ADC/DAC)
  - Modems
  - Modulator (DIFI out)
Interop Setup
Test Methodology

- Survey of participants to determine level of V1.1 supported in equipment being tested (Frequency Range, Bit Depth, Sample Rates, PHY, Reference)

- Selected profiles to accomplish 3 objectives
  - Span the range of bit depth and BW/SR in V1.1
  - Accommodate the widest participation
  - Could be tested in the timeframe

- Test Profiles:
  - Low BW/Sample Rate: 10 MHz BW, 12.5 MSps @ 16 bits
  - Mid BW/Sample Rates: 120 MHz BW, 150 MSps @ 16 bits, 200 MHz, 250 MSps @ 6 bits
  - High BW/Sample Rates: 400 MHz, 500 MSps @ 8 bits, 600 MHz, 750 MSps @ 6 & 8 Bits

- Sources: NB RF 1–120MHz, WB RF to 600MHz, 1500MHz center, QPSK, ¾

- Criteria for successful interop:
  - DIFI RX able to lock to TX and happy with signal
  - Analog spectrum from input to output was recreated
## Test Matrix

<table>
<thead>
<tr>
<th>12.5 MS/s @ 16 bit</th>
<th>Calian, Adv. Tech</th>
<th>Evertz</th>
<th>Keysight</th>
<th>Kratos</th>
<th>ST iDirect</th>
<th>Wavestream</th>
<th>Welkin Sciences</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Company</strong></td>
<td><strong>Product</strong></td>
<td>RX</td>
<td>RX</td>
<td>RX</td>
<td>RX</td>
<td>RX</td>
<td>RX</td>
</tr>
<tr>
<td>Calian, Adv. Tech</td>
<td>XYZ TX</td>
<td>NA</td>
<td>Y/N/NA</td>
<td>Y/N/NA</td>
<td>Y/N/NA</td>
<td>Y/N/NA</td>
<td>Y/N/NA</td>
</tr>
<tr>
<td>Evertz</td>
<td>XYZ TX</td>
<td>Y/N/NA</td>
<td>NA</td>
<td>Y/N/NA</td>
<td>Y/N/NA</td>
<td>Y/N/NA</td>
<td>Y/N/NA</td>
</tr>
<tr>
<td>Keysight</td>
<td>XYZ TX</td>
<td>Y/N/NA</td>
<td>Y/N/NA</td>
<td>NA</td>
<td>Y/N/NA</td>
<td>Y/N/NA</td>
<td>Y/N/NA</td>
</tr>
<tr>
<td>Kratos</td>
<td>XYZ TX</td>
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<td>Y/N/NA</td>
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<td>Y/N/NA</td>
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</tr>
<tr>
<td>ST iDirect</td>
<td>XYZ TX</td>
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<td>NA</td>
<td>Y/N/NA</td>
<td>Y/N/NA</td>
</tr>
<tr>
<td>Wavestream</td>
<td>XYZ TX</td>
<td>Y/N/NA</td>
<td>Y/N/NA</td>
<td>Y/N/NA</td>
<td>Y/N/NA</td>
<td>NA</td>
<td>Y/N/NA</td>
</tr>
<tr>
<td>Welkin Sciences</td>
<td>XYZ TX</td>
<td>Y/N/NA</td>
<td>Y/N/NA</td>
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<td>Y/N/NA</td>
<td>Y/N/NA</td>
<td>NA</td>
</tr>
</tbody>
</table>

**Notes**
## Test Results

<table>
<thead>
<tr>
<th>Profile</th>
<th>Products Tested</th>
<th>Interop Success</th>
<th>Notes</th>
<th>Success Excl. Stream Gen</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOW</td>
<td>12.5 MSps @ 16b</td>
<td>7</td>
<td>85.7% Issue with one DIFI TX no RX could receive</td>
<td>100%</td>
</tr>
<tr>
<td>MED</td>
<td>150 MSps @ 16b</td>
<td>7</td>
<td>95.8% One RX unable to receive a specific source</td>
<td></td>
</tr>
<tr>
<td></td>
<td>250 MSps @ 6b</td>
<td>8</td>
<td>83.7% Issue with one DIFI TX no RX could receive</td>
<td>98.0%</td>
</tr>
<tr>
<td>HIGH</td>
<td>500 MSps @ 8b</td>
<td>7</td>
<td>100%</td>
<td></td>
</tr>
<tr>
<td>750 MSps @ 6b</td>
<td>5</td>
<td>50%</td>
<td>Two RXs unable to receive any sources</td>
<td></td>
</tr>
<tr>
<td>750 MSps @ 8b</td>
<td>2</td>
<td>100%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: Total of 12 products tested over the various profiles
Challenges / Issues

- Underestimated of wiring, setup and config time (est. 1 - 1.5 days)
  - Infrastructure wiring, network config and equip setup took 2.5 days, testing 1 day, teardown 0.5 – 1 day.
  - Misunderstanding of IP schema provided - required reconfig
  - Late arrival of participants

- Device related vs DIFI related issues slowed testing
  - Many participants running development code - many issues encountered were not DIFI but device related
  - Signal sources with excessive output power levels
  - Hard coded parameter that required other participants to do workarounds to accommodate

- Bursty Senders
  - Some receivers unable to receive bursty senders (>500 packets of burst/void).

- Insufficient signal capture resources
  - Limited test equipment slowed down interop confirmation during profile testing

- Did not get a chance to do some augmented testing
  - Adding network impairments (packet jitter, dropped packets, etc.)
Lessons learned / Recommendations

- Interop setup
  - Need 2 days (min) for wiring and setup
  - Clearer communication on things like IP schema and setup times
- Default profiles that all participants support
  - Reference P-Caps or an algorithm to generate them – Test before hand
  - Include occupied BW definitions with the sample rates
- Recommended Practice or Appendix around packet playout and buffer profiles
- Vague information in VITA-49
  - Clarify IQ order in DIFI spec
- Test Cases
  - V1.1 is relatively simple so simple TX >> RX was sufficient
  - Specific test cases may be required for V1.2, 1.3 etc. as complexity increases
Summary

- DIFI Plugfest/Interop was a resounding success!!!
- Issues seen that could be quickly resolved in Plugfest environment
- Confirmed interoperability across a range of profiles in the V1.1 standard
- Identified potential enhancements to the V1.1 standard that can improve implementations and interoperability
Thank You

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