Wideband HF Spectral Sensing Results

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HFIA / BLOS Comms – Sept, 2012

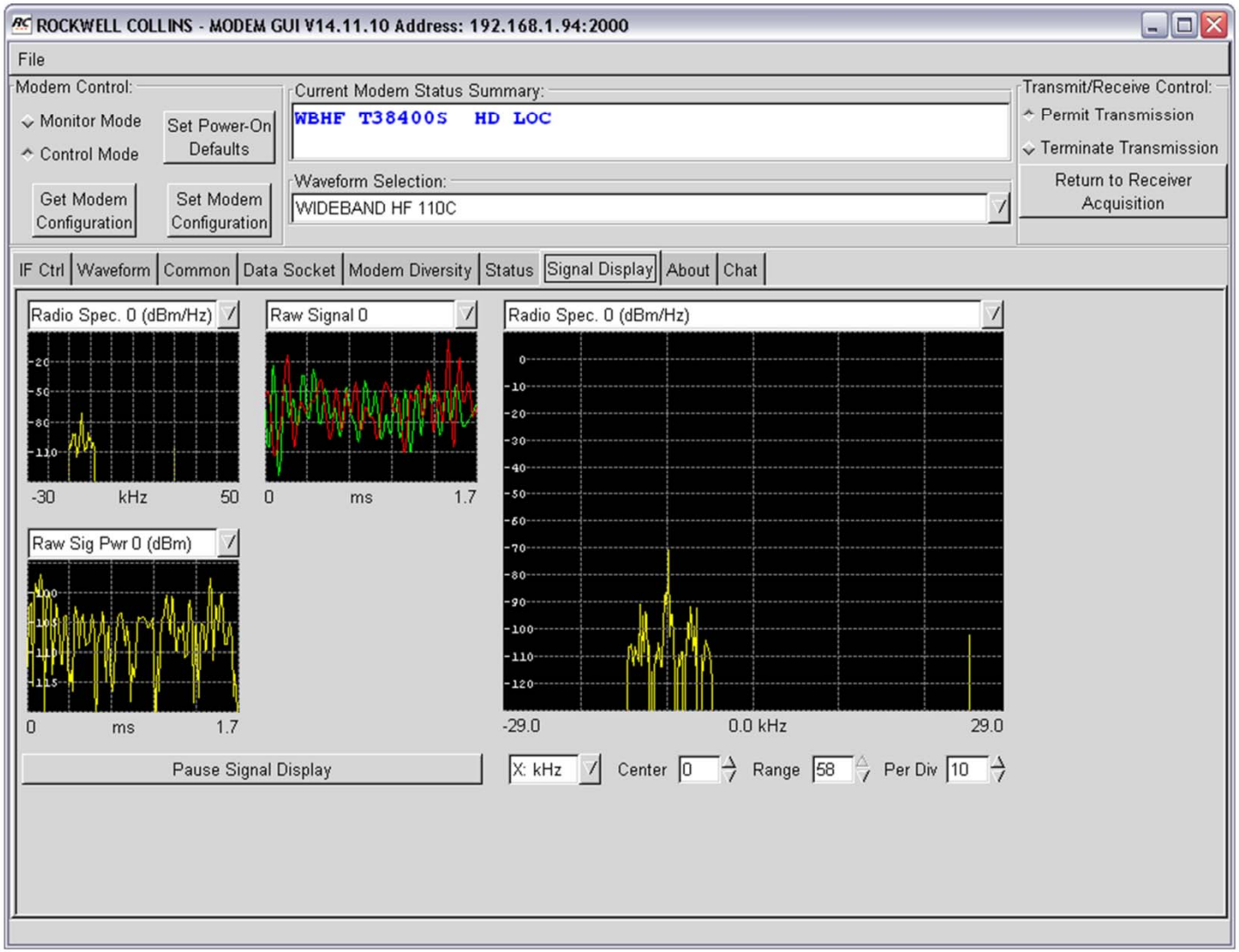
Rockwell Collins

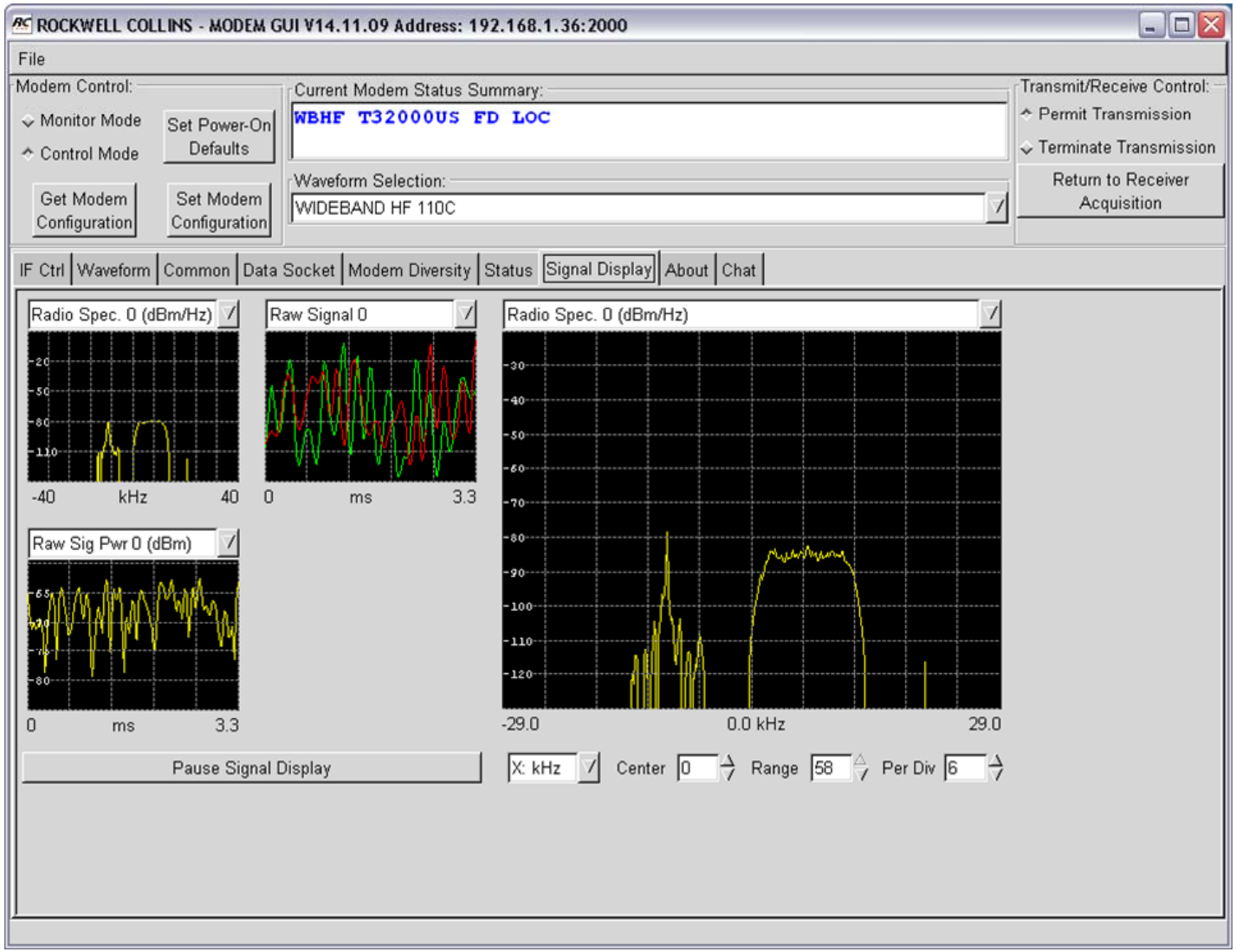
Motivation

- Mil-Std 188-110C Appendix D provides the basis for a number of high capacity services over HF links – if the bandwidth is available
  - Eight data waveforms for eight HF bandwidths, 3 kHz through 24 kHz in 3 kHz increments
  - All eight waveforms fully autobaud, within a particular bandwidth selection
  - Bandwidth selection is an external function
- Harris and CRC have both shown spectrum sensing results indicating that channels up to 24 kHz may be commonly available, based on channel occupancy
- Spectral sensing capability is necessary for the development of a Wideband HF compatible ALE system
  - Playing nicely with others
  - Or not …

ALE Considerations

- Current ALEs choose
  - Frequency
  - Data rate
  - Link maintenance - adapt data rate or look for a new channel
- WB ALE will have to choose
  - Frequency
  - Bandwidth (and offset)
  - Data rate
  - Adaptation involves data rate, bandwidth, offset or new channel
- May be more desirable for WB ALE to play nicely
  - Attempt to avoid channels with signals on them, even if they would provide good links
  - May not always be possible …


ROCKWELL COLLINS - MODEM GUI V14.11.10 Address: 192.168.1.94:2000
File
Modem Control:
Monitor Mode
Control Mode
Set Power-On Defaults
Get Modem Configuration
Set Modem Configuration
Current Modem Status Summary:
WBHF T38400S HD LOC
Waveform Selection:
WIDEBAND HF 110C
Transmit/Receive Control:
Permit Transmission
Terminate Transmission
Return to Receiver Acquisition
IF Ctrl
Waveform
Common
Data Socket
Modem Diversity
Status
Signal Display
About
Chat
Radio Spec. 0 (dBm/Hz)
-30
kHz
50
Raw Signal 0
0
ms
1.7
Raw Sig Pwr 0 (dBm)
0
ms
1.7
Radio Spec. 0 (dBm/Hz)
-29.0
0.0 kHz
29.0
Pause Signal Display
X: kHz
Center
0
Range
58
Per Div
10


ROCKWELL COLLINS - MODEM GUI V14.11.09 Address: 192.168.1.36:2000
File
Modem Control:
Monitor Mode
Control Mode
Set Power-On Defaults
Get Modem Configuration
Set Modem Configuration
Current Modem Status Summary:
WBHF T32000US FD LOC
Waveform Selection:
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Waveform
Common
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Status
Signal Display
About
Chat
Radio Spec. 0 (dBm/Hz)
-40
kHz
40
Raw Signal 0
0
ms
3.3
Raw Sig Pwr 0 (dBm)
0
ms
3.3
Radio Spec. 0 (dBm/Hz)
-29.0
0.0 kHz
29.0
Pause Signal Display
X: kHz
Center
0
Range
58
Per Div
6

Measurement campaign

- Spectral measurements included in the data
  - July 27
  - July 30 to Aug 1
  - Aug 6 to Aug 13
  - Aug 14 to Aug 20
  - Aug 21 to Aug 24
- Scan list of 246 frequencies across the HF band
  - 48 kHz receiver bandwidth
- Approximately 1.5 s per channel

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Receiver Location – Cedar Rapids, Iowa

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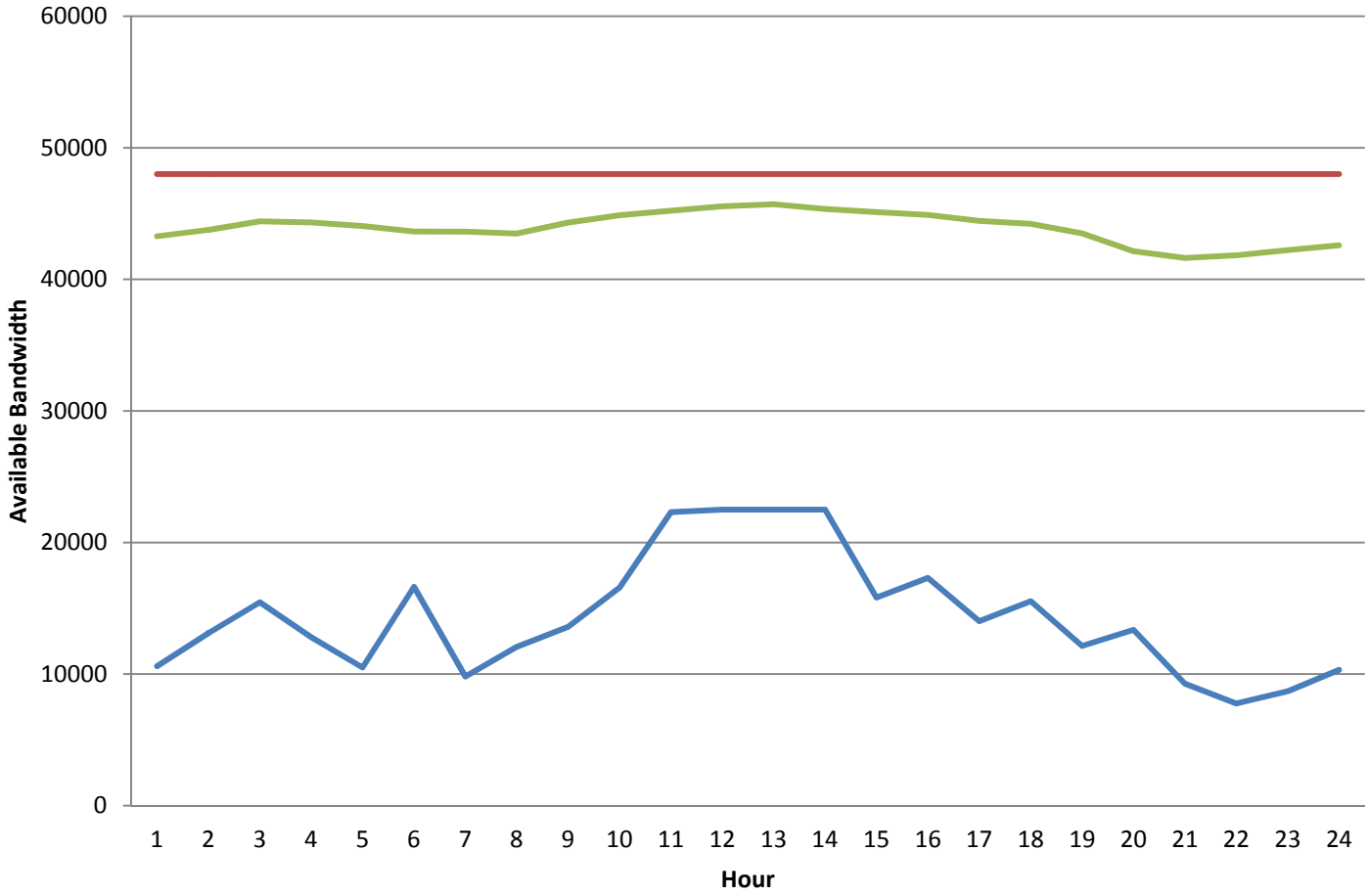
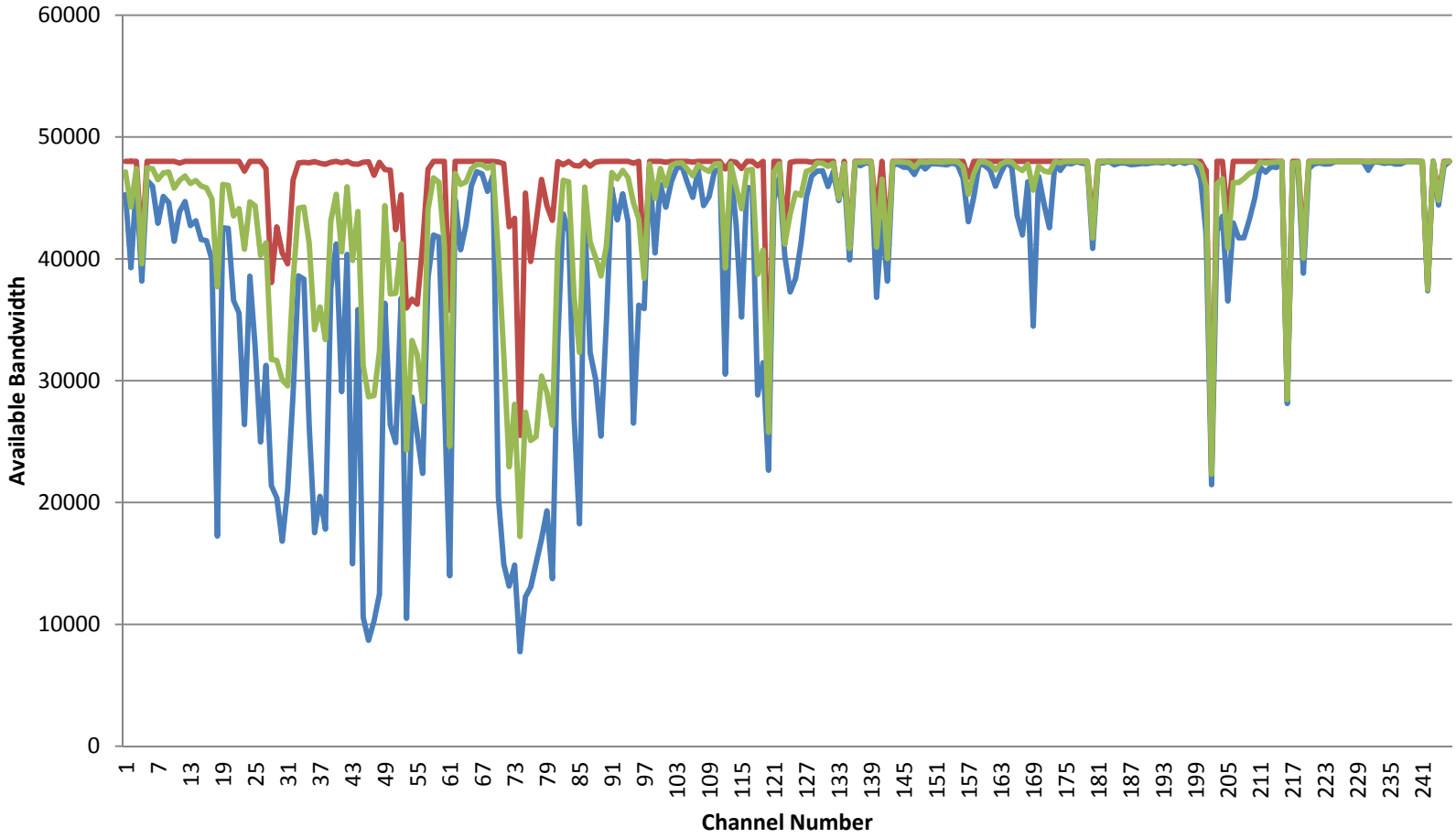
Cedar Rapids, IA Lab 13 HF Station

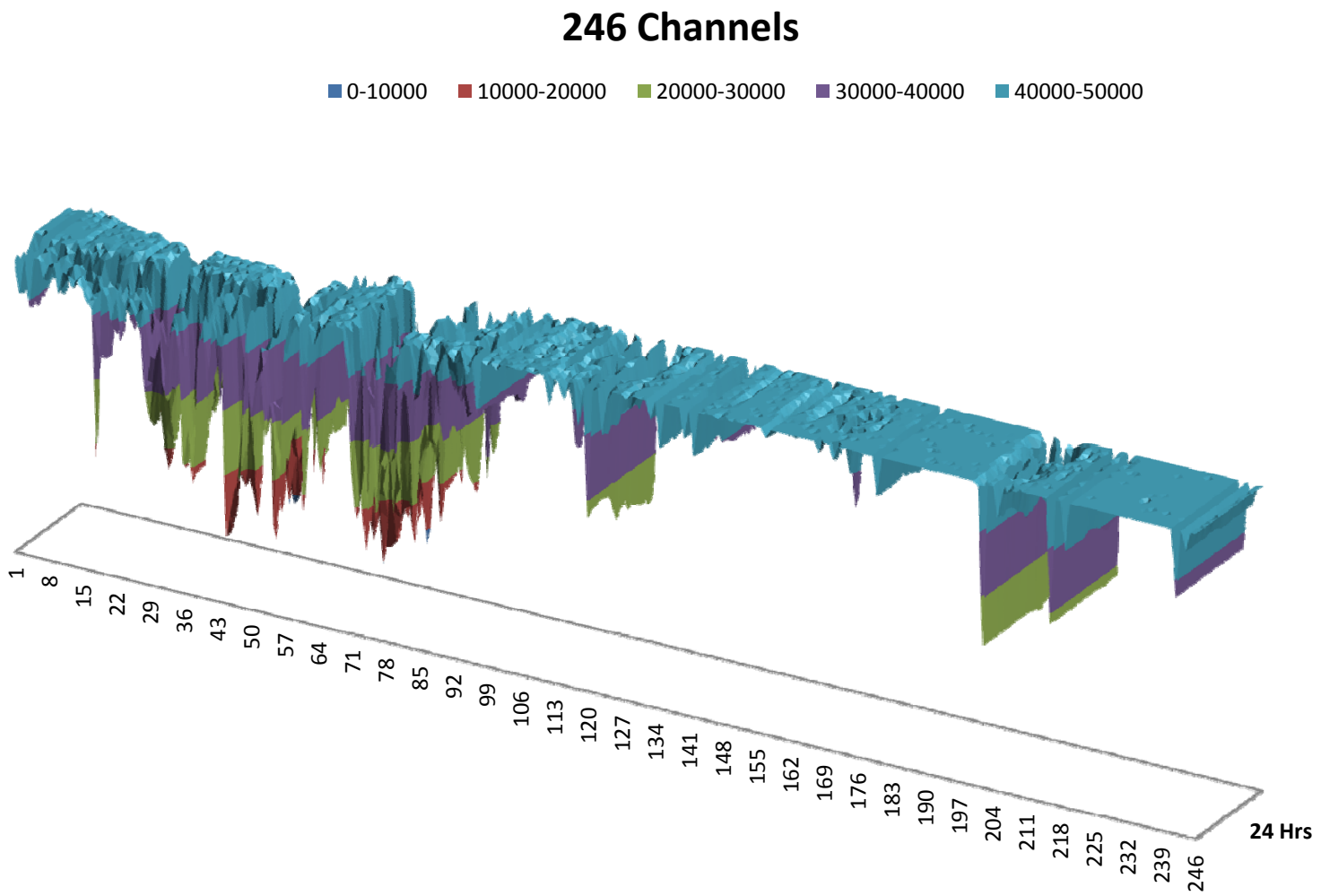
Min, Max and Average Available BW by Time



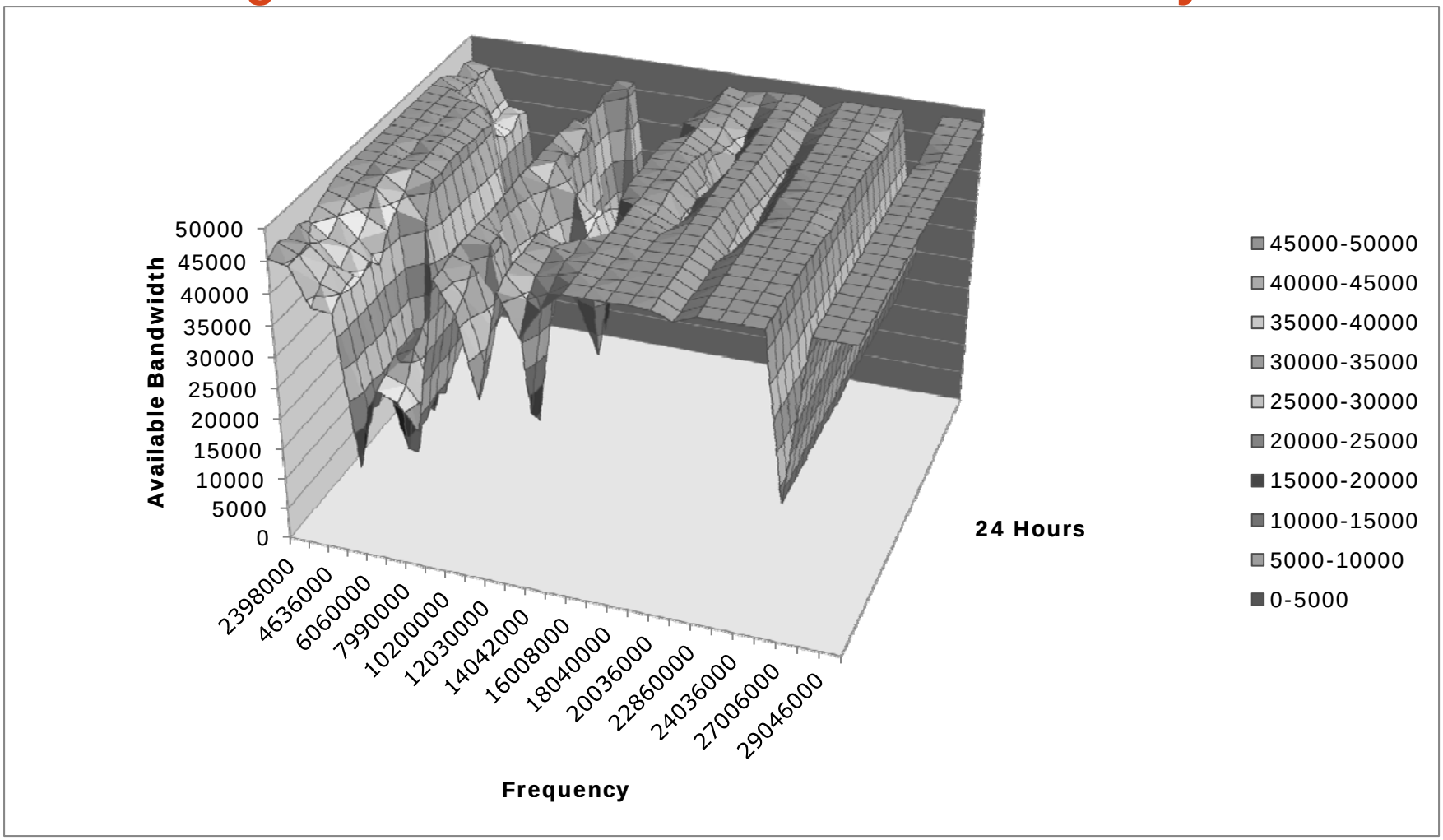
Min, Max and Average Available BW by Channel



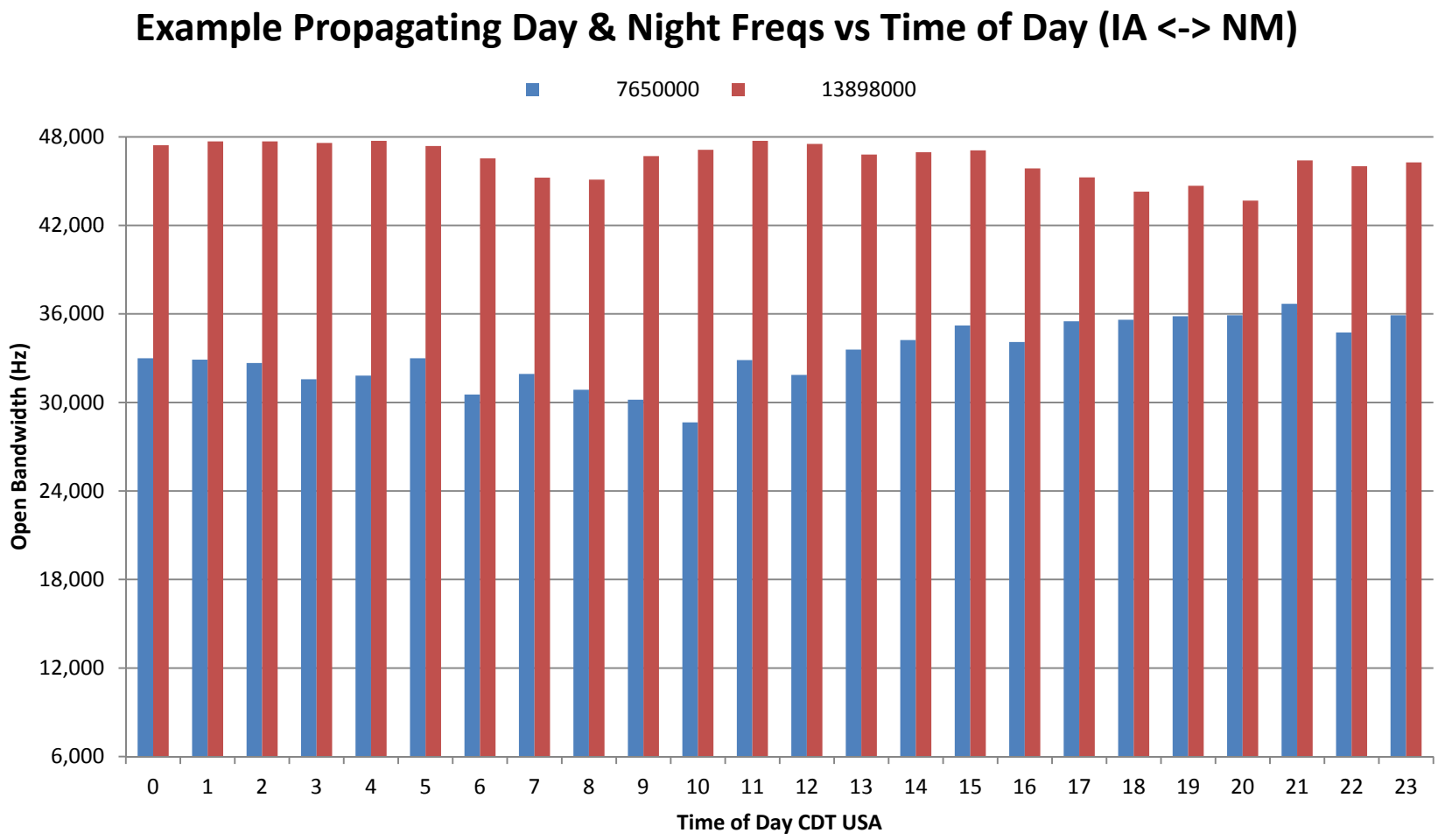
Average Available Bandwidth Over 24 Hours



Average Available BW for 30 Channels by Hour



Available Bandwidth: Las Cruces – Cedar Rapids



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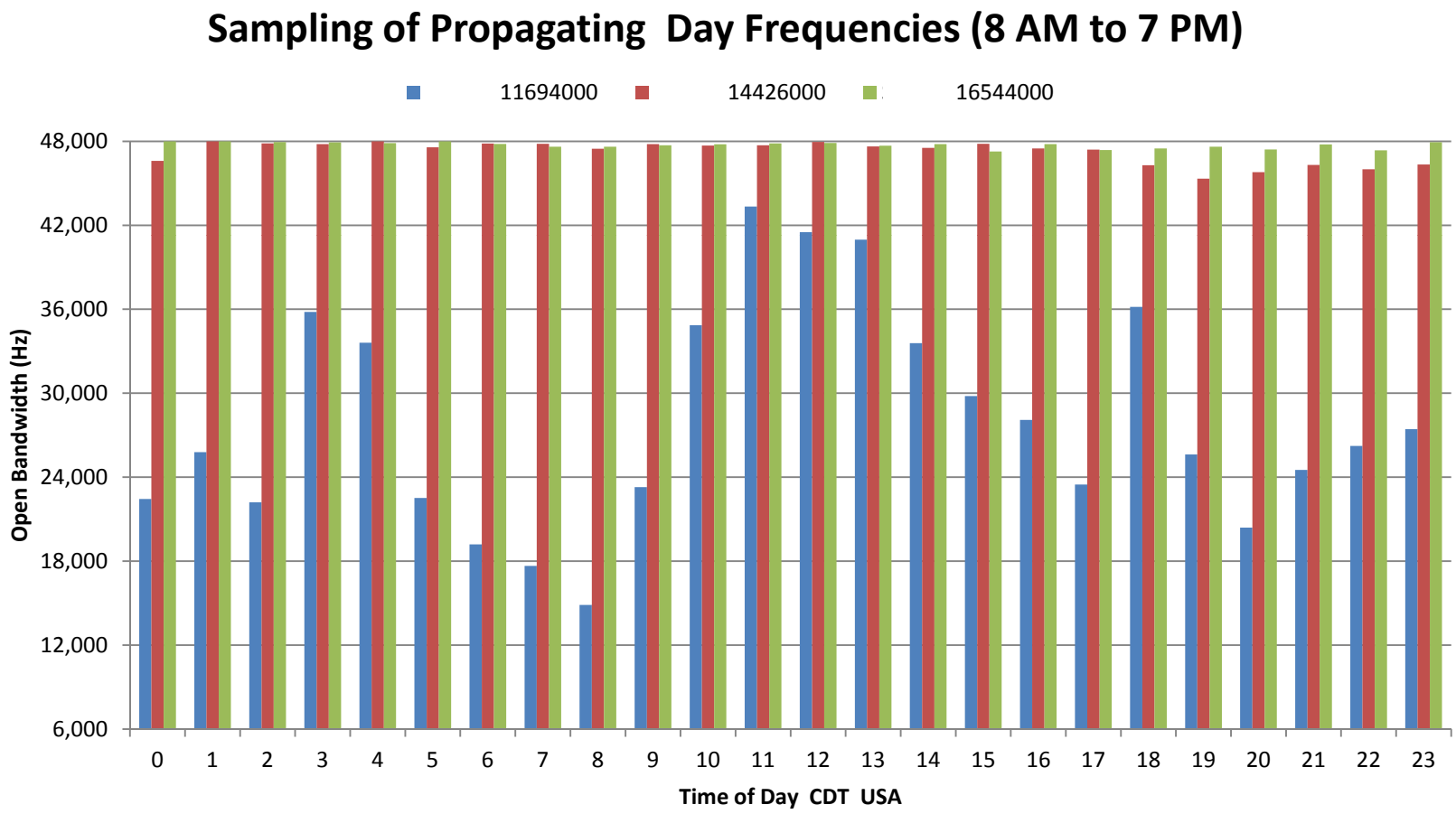
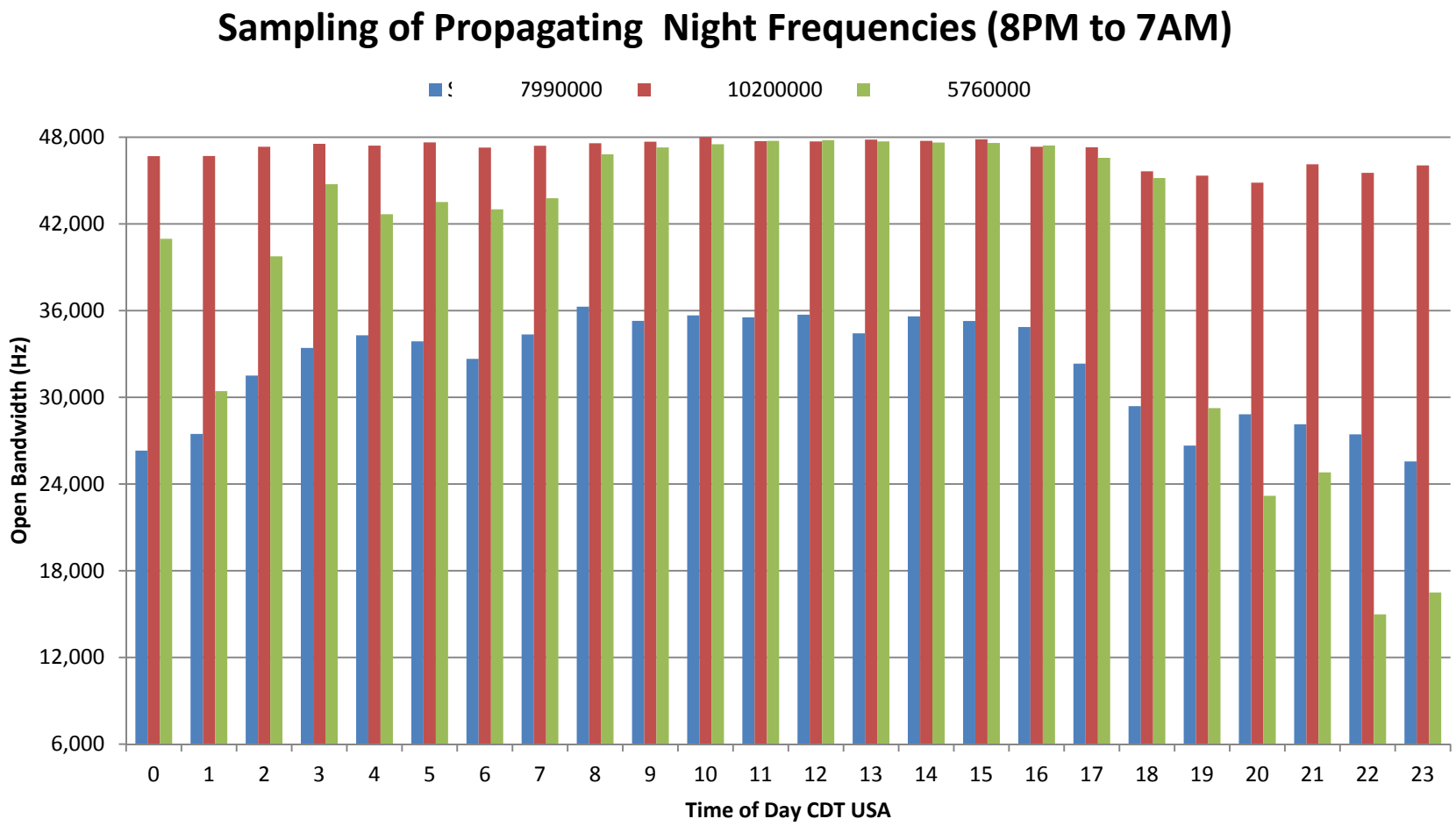


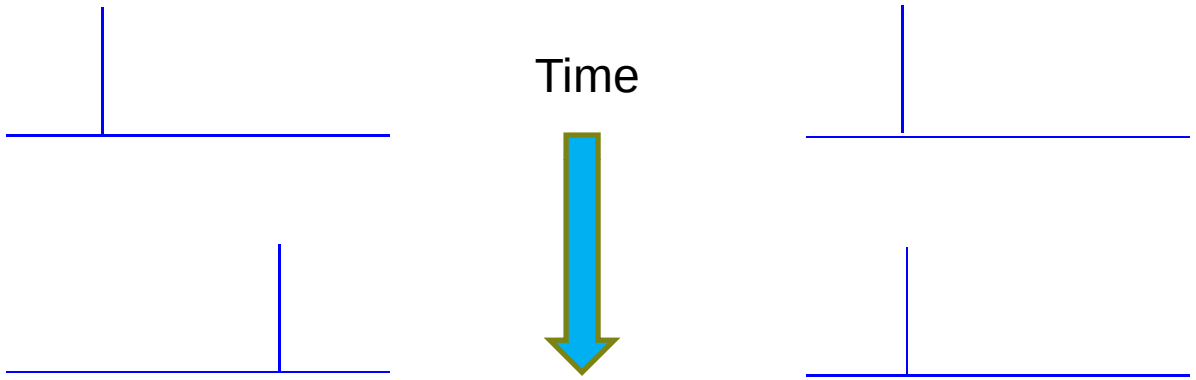
Available Bandwidth: Las Cruces – Cedar Rapids



Other Considerations

- Only looking at whether there is a detectable signal, not whether the channel could be used to pass data
- This data comes from an ALE perspective
  - Distinct scan list, not general frequency monitoring
- Determining occupancy may be require more sophisticated analysis than we've used thus far
  - Channels that show an exchange on an intermittent basis should probably be counted as fully occupied
  - Today we would only say they were occupied when we see a signal
  - Need to go beyond looking at independent snapshots to looking at a time history

- Just capturing available bandwidth by time is not enough



- All independent snapshots of the 24 kHz channels above show about 15 kHz of available bandwidth
- If the snapshots are close in time,
  - The channel on the left likely only has about 6 kHz of usable bandwidth
  - The channel on the right really does have 15 kHz available

What's Next

- Spectrum Analysis
  - More careful analysis of the data
  - Combining with propagation prediction to get estimates of predicted throughput, and then validating with over the air tests
  - European receiver site (Toulouse)
- Wideband HF
  - Continue to experimenting and refining ALE techniques for wideband HF
  - More testing with MARLIN (Subnet Relay) over Wideband HF
    - May be good reasons to look at dynamic TDMA rather than token passing with higher available data rates
    - Testing an IP network based on Subnet Relay/WBHF supporting video, file transfer, white boarding, etc. between Cedar Rapids and Las Cruces

Questions, Comments, Suggestions?

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