

# Approaching HF Radio With Your Eyes Wide Open

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## ABOUT ME

# Tamir Ostfeld Deputy CEO & COO, Raft Technologies

- 25 years of experience leading development in Networking and Connectivity groups
- With Raft since 2017 early HF trials
- Overseeing network development R&D and Ops





# HF-BASED ULTRA LOW LATENCY WIRELESS NETWORK

# Let's talk about HF performance:

- What powers it?
- What performance can you expect?
- How far can we get (latency, distance, bitrate, uptime)?





## SKYWAVES (HF / SHORTWAVE RADIO) TRAVEL LONG DISTANCES AT THE SPEED OF LIGHT

Skywaves propagate back from the atmosphere, acting as a mirror

HF Radio Transmitter

Ionosphere 50-200Km

Receiver



# HF ADOPTION HAS STARTED

Deutsche Börse cross-correlation analysis

Showing trades in Frankfurt / following trade events in Chicago



Stefan Schlamp • 1st Head of Content Development & Management 2mo • 🕲

Having **#cmegroup** and **#eurex #marketdata** on Deutsche Börse's A7 Analytics Platform helps reveal the footprints of shortwave trading in the **#histogram** of reaction times between trades on **#cme** and **#eurex**.

...

The lowest "classical" (#microwave + dedicated trans-Atlantic #fiber) latency is approximately 37 ms. The data, however, shows the shift towards shortwave radio (high-frequency, "HF") of #hft trading participants. This technology (at very low bandwidths) provides a 9 ms #latency advantage.

Read more...



XCME/XEUR Cross-Venue Reactions

### REFRACTIVE EFFECTS OF THE IONOSPHERE (LAYER CAKE)





### REFRACTIVE EFFECTS OF THE IONOSPHERE

#### Signals take different paths



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Plasma Frequency (MHz)

# CYCLES DEFINING HF SERVICE AVAILABILITY



# DAY-NIGHT CYCLE IONOSPHERE LAYERS CHANGE



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1D

# DAY-NIGHT CYCLE IONOSPHERE LAYERS CHANGE

#### Date: June 15, 2022



Just before dawn, "battery drains out"



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1D



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# SEASONAL CYCLE DAYLIGHT HOURS CHANGE

The Earth Axial tilt ≈23 Degrees





# SEASONAL CYCLE DAYLIGHT HOURS CHANGE

SUN Č

#### December

June





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SEASONAL CYCLE DAYLIGHT HOURS CHANGE





day

Summer

day

**Not STAC Benchmarks** 



# SOLAR CYCLE THE SUN'S MAGNETIC FIELD

Sunspots – the more the better







# SOLAR CYCLE THE SUN'S MAGNETIC FIELD

#### There's a good tailwind for HF



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# HF NETWORK KEY PERFORMANCE INDICATORS

Latency	•	HF delivers the shortest latency ever	24h
Capacity		0.5-1.2 Kbps	20
Goodput	•	75-95%	12
Uptime	•	Near 24h, summertime cross-Atlantic	8
Error Rate	•	In the 10EXP-5 zone	





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# WEATHER FORECASTS – IN SPACE, NOT ON EARTH

#### Positive

- Active Regions
- Sunspots

#### Negative

- Solar-Flux
- X-Rays
- A master indicator: K-Index





# HF CHALLENGES RECEIVING A SIGNAL

#### Man-made noise

- Crowded spectrum
- Narrow-band noise
- Chirp-type noise

#### Your own "noise"

- Multipath
- Long path / 2<sup>nd</sup> time around



# EXAMPLE: CHICAGO TO TOKYO LINK



0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%



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# EXAMPLE: CHICAGO TO TOKYO LINK

- Distance: 10,125 Km
- No repeater (!)
- End-to-end latency (colo to colo): below 50ms...



# CONTINUOUS INCREASED PERFORMANCE



Developed procedures for link mgmt.



AI-powered link monitoring and control





# HF NETWORK KEY PERFORMANCE INDICATORS

#### Current focus

Latency	•	Pushing toward the physical limit
Capacity	•	x10
Goodput	•	75-95%
Uptime	•	Near 24h year-round
Error Rate	•	In the 10EXP-5 zone



# Q&A





# Thank you!

"Any sufficiently advanced technology is indistinguishable from magic"

Arthur C. Clarke



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# a bit faster