



**AES NY 2023**  
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New York City  
October 25 - 27

#AESSHOW

# UWB – A New Wireless Tech in the Future of Pro Audio





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# Panel

**Chair / Opening** - Jonny McClintock

**Sonical** - CosmOS / Operating System for the Ear (Gary Spittle)

**Qorvo** - UWB / wireless (Alexis Bizalion)

**Nexonic** – Clock Matching (Jackie Green)

**Antennaware** - Bodywave / addressing RF issues (Jonny McClintock)

**Lenbrook** - End device for the consumer (Torben Sonderskov)





# Summary

- CosmOS (OS for the Ear) offers headset configurability. Agnostic to transport i.e. wired or wireless.
- UWB delivers “almost nirvana” for wireless applications i.e. data and latency.
- However, UWB has two “Achilles heel” eg body blocking and Clock Matching. Body Blocking is solved by Antennaware’s UWB Bodywave antenna.
- Clock Matching is solved with Nexonic’s prior knowledge with UWB Digital Wireless Microphone’s
- Aside from audio, TWS’s buds recessed in the ear canal can also be used for EEG (acquiring data around brain activity) and Hearing “Protect and Detect” with Segotia.



# SONICAL

Everything sounds better

Dr Gary Spittle - CEO

SONICAL

# Problem

Audio products stuck with price sensitive  
feature driven products

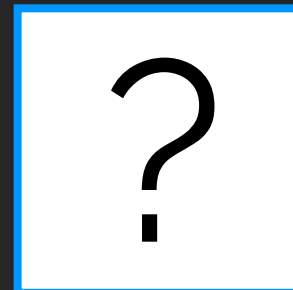
Features



- Buy new product for new features
- Basic functions
- One size fits all



Apps



- User selects features using apps
- Multi-functional innovative products
- Personalised computing platform

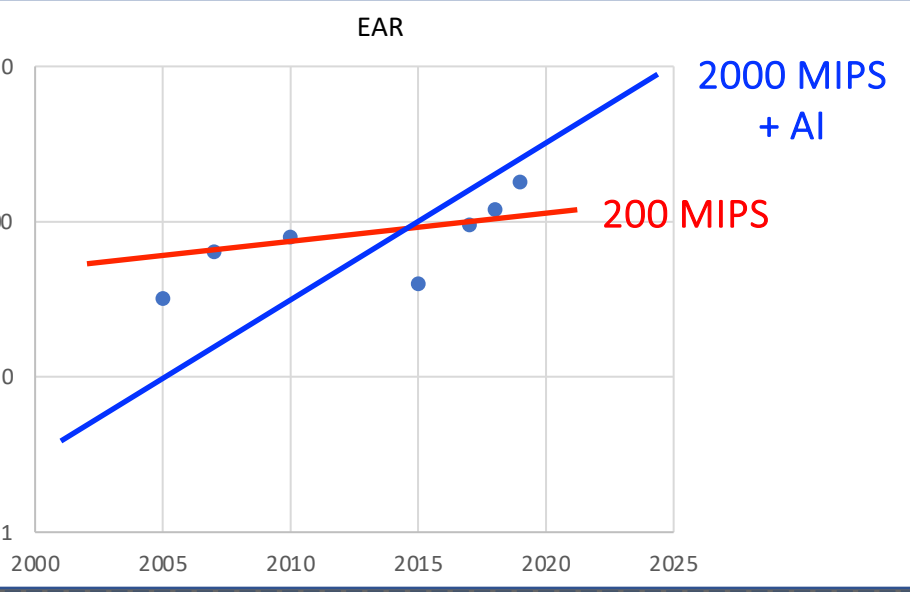
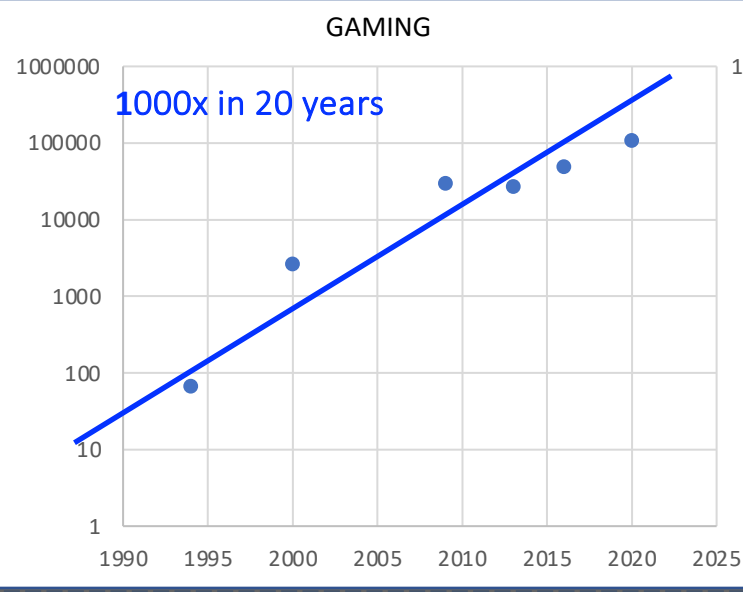
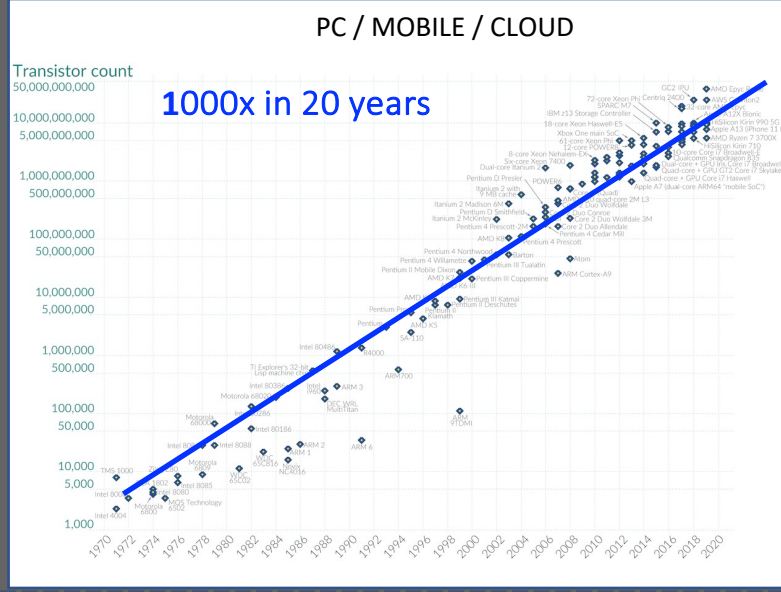
HOST PROCESSOR + OS

**SONICAL**

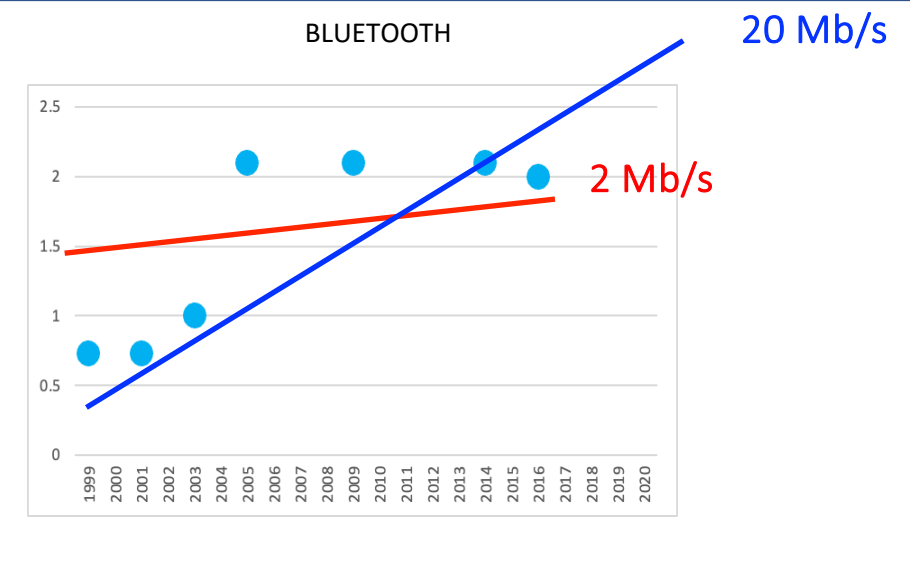
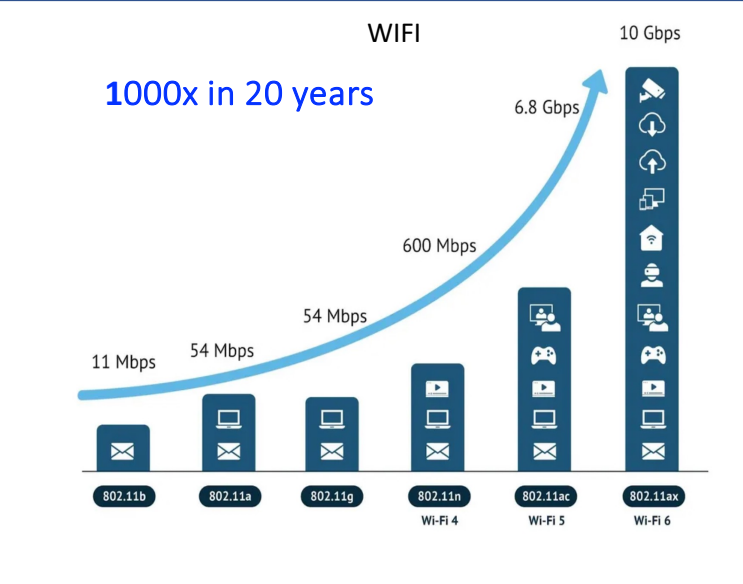
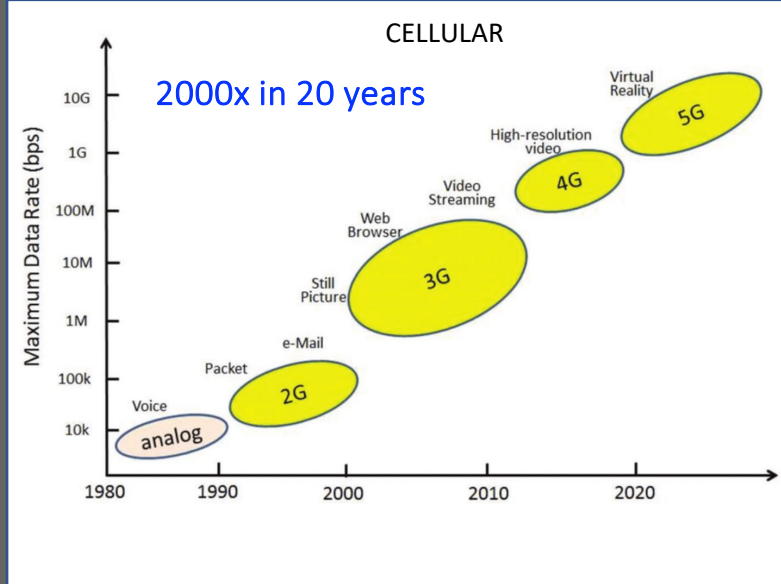


# Endpoint products thrive on advanced processing and connectivity

PROCESSING



CONNECTIVITY



# Market transitions to Headphone 3.0 using ear computers

CONNECTIVITY

COST DRIVEN CONSUMER COMMODITY

HEADPHONE 1.0

**Fixed**  
Single function



BLUETOOTH LIMITS

HEADPHONE 2.0

**Bluetooth**  
Closed system



USER DRIVEN INNOVATION

**HEADPHONE 3.0**

**User defined**  
Ear computer



**SONICAL**

COMPUTE

# Market transitions to Headphone 3.0 using ear computers

CONNECTIVITY

COST DRIVEN CONSUMER COMMODITY

HEADPHONE 1.0

**Fixed**  
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BLUETOOTH LIMITS

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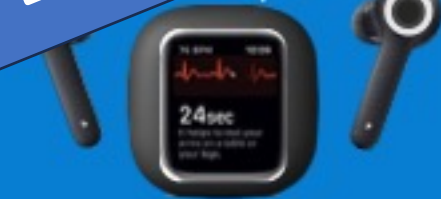


USER DRIVEN INNOVATION

HEADPHONE 3.0

**PLUGINS**

Ear Computer



**SONICAL**

COMPUTE



# Headphone 3.0

A new computing platform for  
endpoint AI

Apps downloaded whenever  
you need them



# CosmOS – the operating system that enables AI for audio

## Apps

Downloaded by the user

AUDIO HEARING HEALTH

## Ear computer



## Integration

Complete solutions



## Sensors

Health & wellness



## Connectivity

High bandwidth / low latency



# App developers – no one is as smart as everyone

## Audio



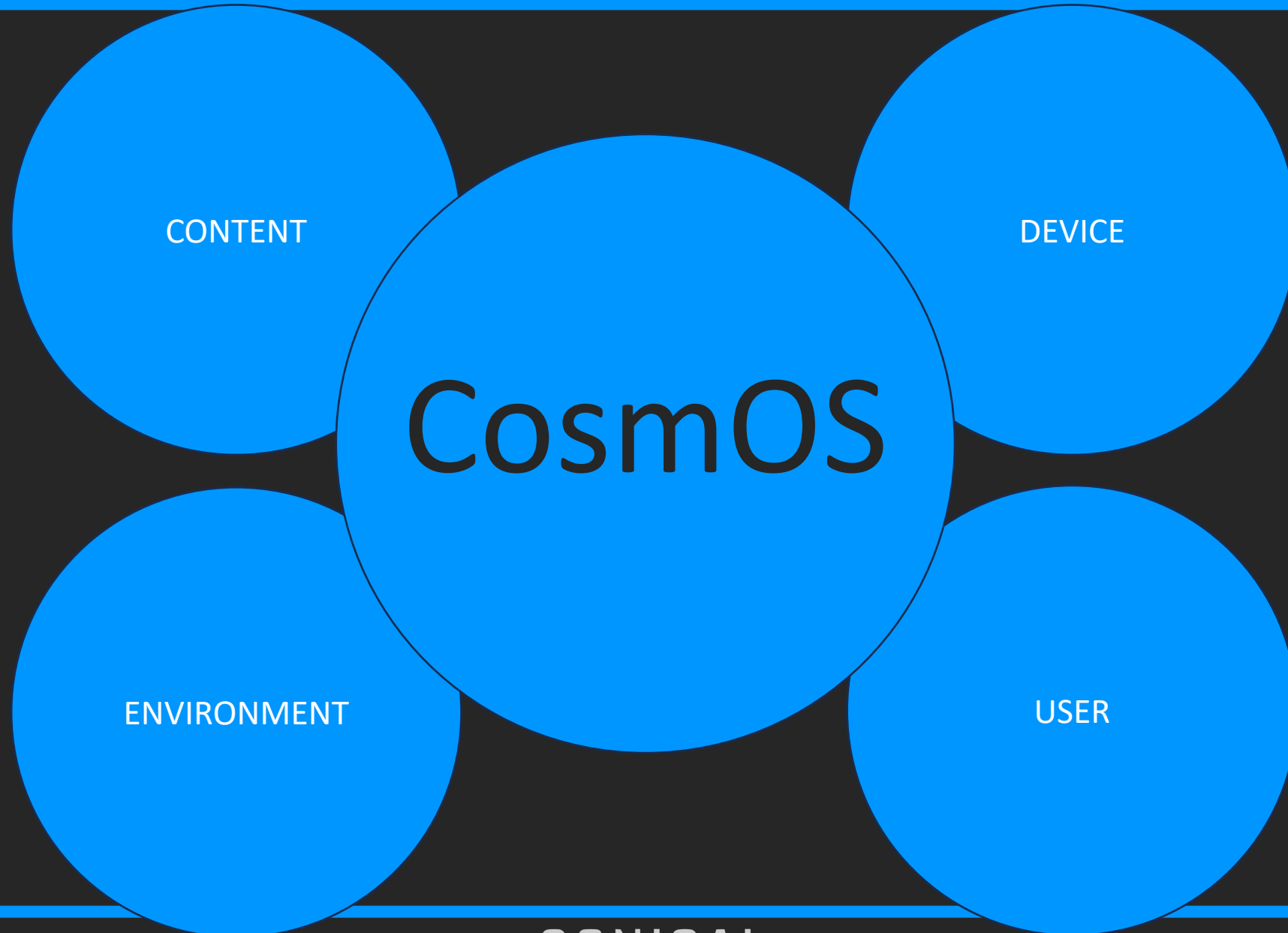
## Hearing



## Health



# CosmOS combines plugins for user driven experiences



# Plugins extend performance of endpoint products



Product EQ  
Pro dynamics

Personalised sound profiles  
Sound exposure monitoring



Product EQ  
Pro dynamics

User profiles  
Wind / Pop / Noise reduction



Product EQ  
Pro dynamics

Room calibration  
Multichannel placement

Thank you



SONICAL




**The best sounding**

**The best hearing**

**The best listening**

 [www.sonical.ai](http://www.sonical.ai)

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 +1-650-302-9582

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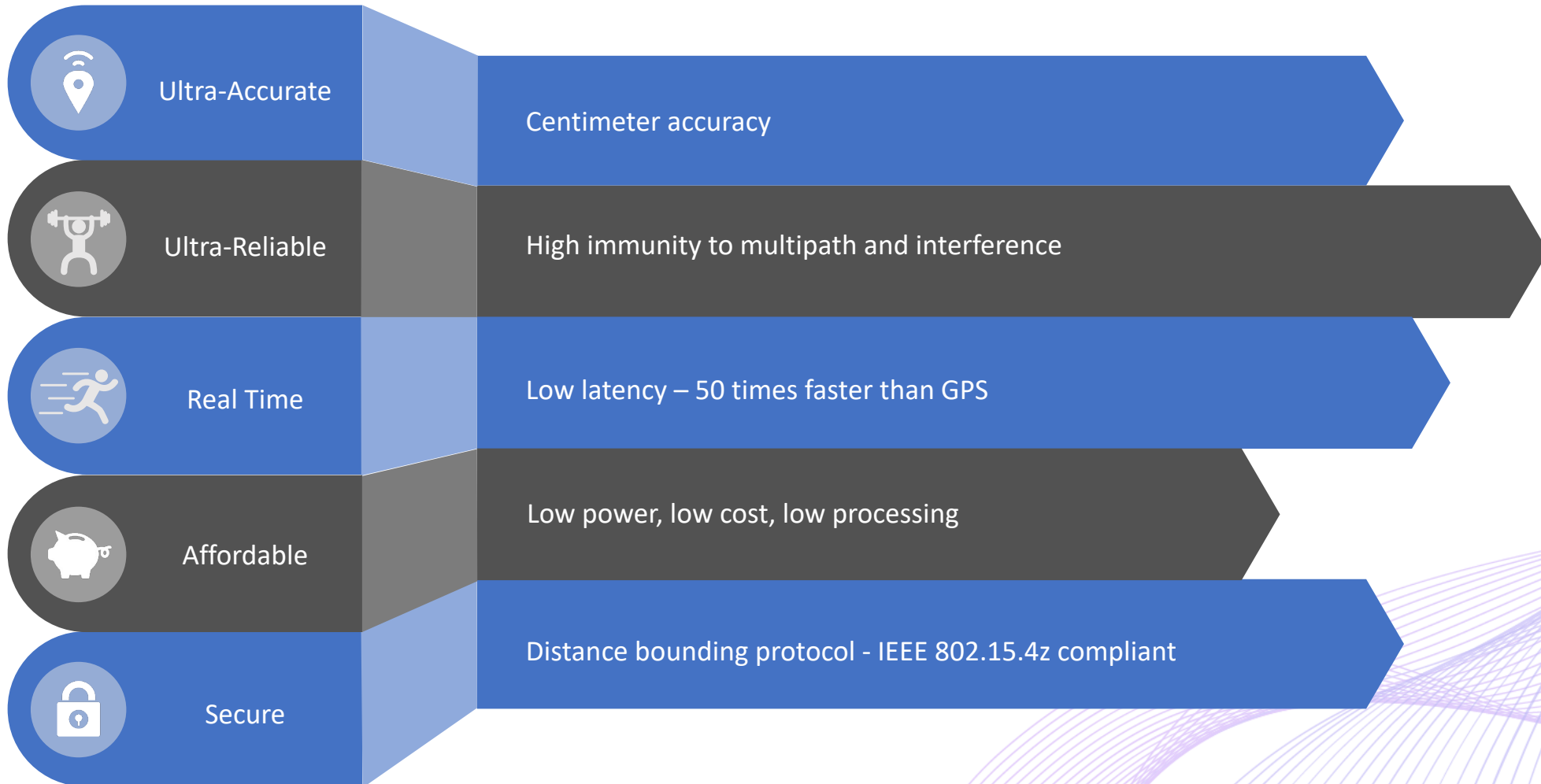
# Qorvo UWB for Audio Applications

AES NY 2023 – October 27<sup>th</sup>





## UWB : designed to deliver micro-location and secure communication







# 100's of New User Experiences Enabled By Qorvo UWB

## Precision Spatial Awareness



Personalization  
 (Follow-me  
 Audio & Lighting)



Micro Localization  
 (Indoor RTLS)

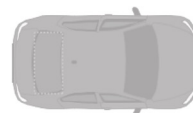


Indoor  
 Navigation

Standards Driven



## Secure Access and Transactions



Car Access



Office/Home  
 Access



Contactless  
 Payments &  
 Public transport

## Low Latency & High Speed Wireless Data Comms



Ultra Low Latency  
 Gaming



Low Latency High  
 Quality Audio  
 Streaming

Extended  
 Functionalities

Under Development

## Sensing



Motion



Presence



Gesture

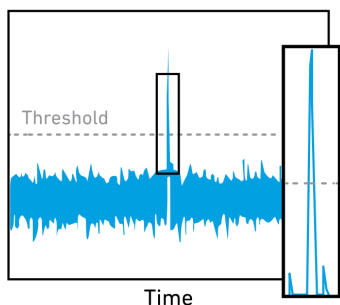


Vitals



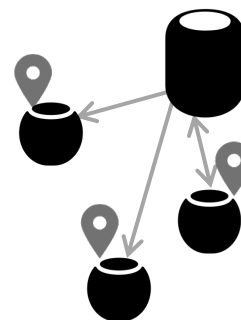
## High Speed, Low Latency & Reliability

### Ultra Low Latency



- Short frames containing large amount of data
- Sub-5ms latency for audio
- Precise time synchronization

### Versatility



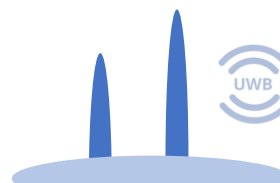
- Supports one-to-many & bidirectional protocols
- Ability to perform accurate ranging in real-time

### High Speed Data



- 27Mbps PHY
- 10Mbps data throughput
- Short airtime benefits power consumption & co-existence

### Reliability



- Operates at 8GHz, far away from crowded 2.4GHz band
- Robustness to interference and multipath
- Up to 50m line-of-sight range



## UWB enabling a superior Audio Streaming UX : Comparison

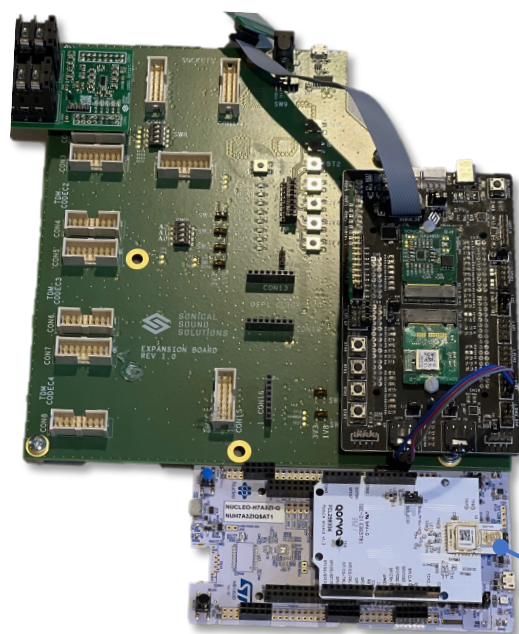
KPI	((UWB))	2.4 GHz Proprietary audio protocol (Example)
Max PHY datarate	27Mbps	6Mbps
Lossless audio streaming	Up to 192kHz/24bit/stereo uncompressed (current demonstrator)	16bit/44.1kHz/stereo uncompressed
Audio Streaming Latency	Sub-5ms (current demonstrator)	16ms
Device time synchronization	ns	ms
Location accuracy	< 10cm / +/-6° in real-time	NA
Energy efficiency	High (~10mW/Mbps)	Low (~75mW/Mbps)
Co-existence w/other wireless technologies	Operates at 8GHz Roadmap to 8.5GHz (CH10) and 9GHz (CH12)	Operates in crowded 2.4GHz spectrum



# Sonical Headphone 3.0 platform, powered by Qorvo UWB Solution

**Headphone 3.0**  
 development platform

**Headphone 3.0**  
 form-factor demonstrator



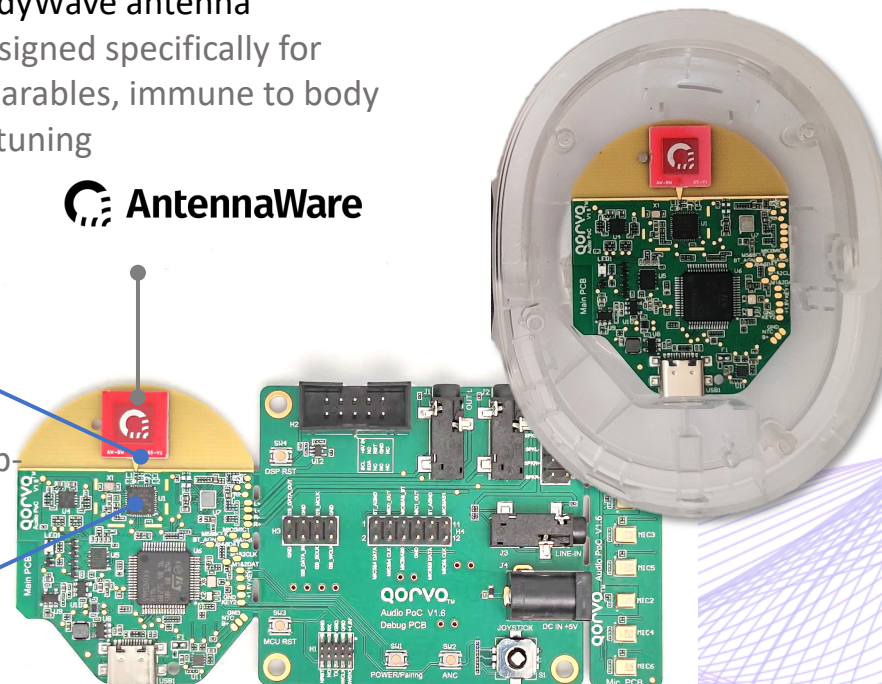
UWB Low Noise Amplifier  
 Extended range  
 CH5 & CH9 support



UWB Transceiver  
 Stream audio over 27Mbps PHY with sub  
 5ms latency  
 CH5 & CH9 support



BodyWave antenna  
 Designed specifically for  
 wearables, immune to body  
 detuning



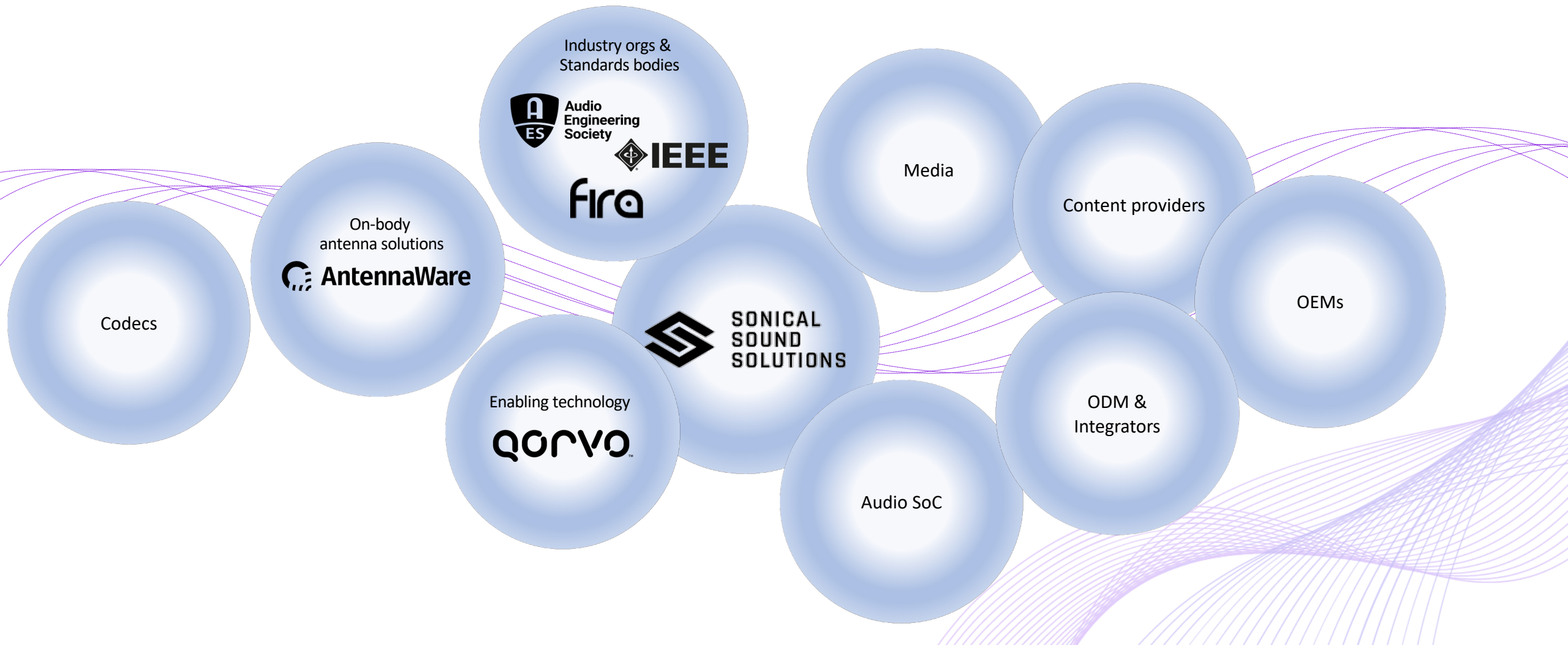


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# Successful adoption requires a complete eco-system



## Where we see opportunities for UWB?

Applications requiring exceptional audio quality, multi-channel, low latency

Home Cinema



Smart Speaker & wireless speaker system



Headset (Hi-Fi & Gaming)



Pro Audio



UWB  
 Enables

- Higher resolution
- Multiple channels
- Lower latency
- In-band location





Thank You



## The evolution of wireless mic and speaker/headphone audio:

### ✓ **FM – carrier based real-time and continuous**

- ❖ High quality audio if good compander design
  - ❖ No latency issues
  - ❖ Compander does limit full frequency and transient response
- ❖ Difficult to manage the many harmonics and intermods as modulated bandwidth changes continuously
  - ❖ Complicated frequency coordination needed
  - ❖ Limited device density in area of reception (which can be building-wide or even building-to-building)

### ✓ **Digital – carrier based timing based on processing = latency, continuous**

- ❖ Wi-Fi, BT, Zigbee etc.
  - ❖ specifications (bandwidth and communication requirements) limit audio quality and have high latency
- ❖ BT LE Audio holds promise of good audio with lower latency
  - ❖ multipath and device density still an issue





## ✓ Digital – carrier based

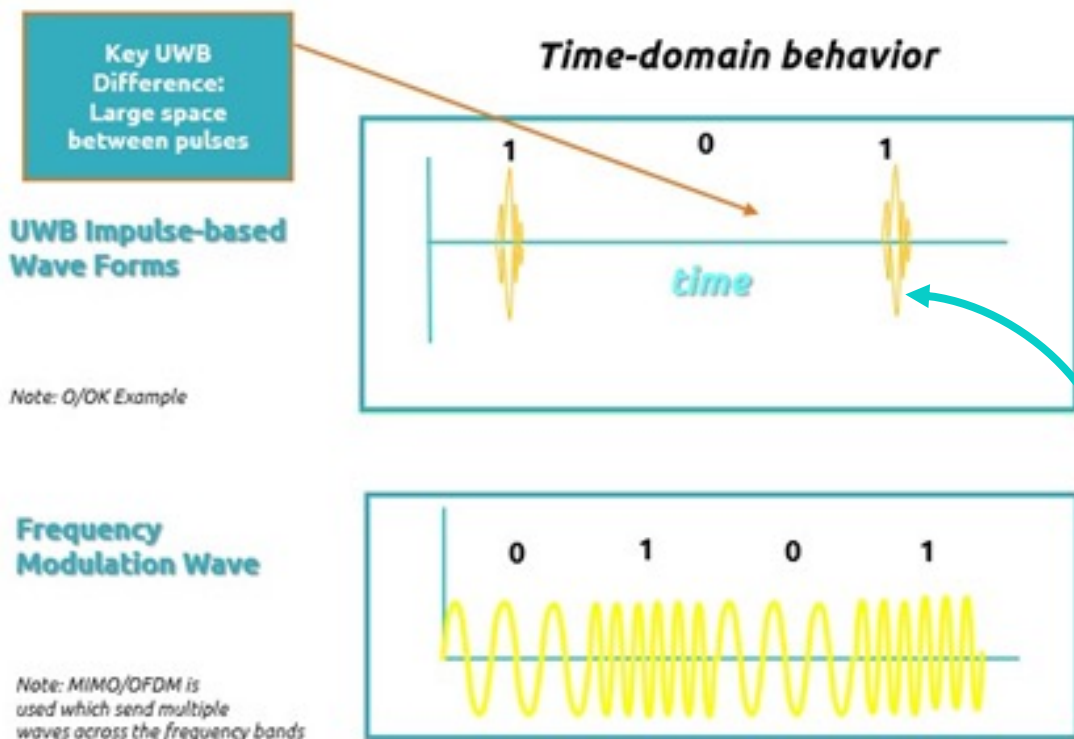
- ❖ Bandwidth remains constant so much easier to compensate for intermod interference however:
  - ❖ “Well-designed digital wireless microphone systems may exhibit a wider frequency response and increased dynamic range compared to analog FM systems. However, it is not possible to directly transmit data representing a full fidelity audio signal with 120dB dynamic range within a single channel’s allowable bandwidth” (Shure website)
- ❖ Multipath complicates performance
- ❖ True Pro digital audio is expensive to implement

## ✓ UWB – is a **NON carrier-based wireless!** **Not continuous and can be tracked real-time**

- ❖ 500 MHz bandwidth for superior audio performance – already proven in highly demanding broadcast and production environments!
- ❖ Sound quality is comparable to “wired”
- ❖ Sub 3mS latency – is mainly due to processor
- ❖ No frequency coordination required – but **TIME** coordination must be considered
- ❖ High device density possible
- ❖ Co-exists with other forms of wireless without interfering



## Why the focus on carrier-based vs. non carrier-based?



### The answer is “physics”

- ✓ UWB sends short 2nS bursts of signal – like a direct to digital audio stream
- ✓ There is no “wave” to add/subtract/or distort
- ✓ Frequencies do not intermodulate – there is no “frequency” – just bursts in time that contain data
- ✓ So , the sound quality is comparable to any other professional electronic gear operating in the digital domain

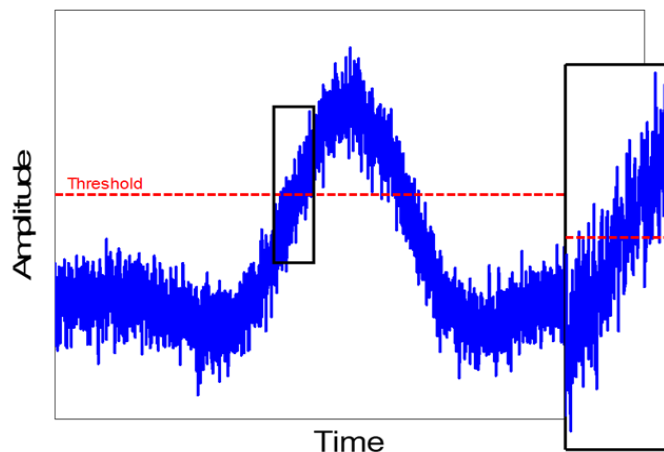
As long as a receiver “sees” a pulse during this 2nS point in time, the entire signal is delivered. So – **RX and TX must be VERY tightly sync’ed**



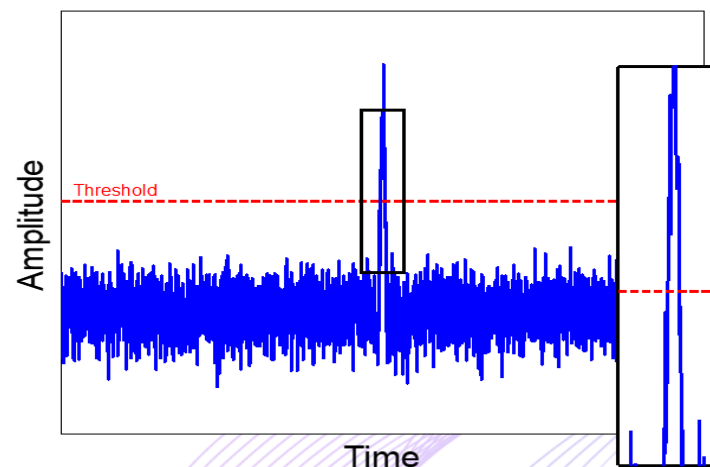
## MANY ADVANTAGES – but meeting the timing challenge is essential

- ✓ UWB pulses do not carry “noise” as in other wireless methods – **clearly an advantage**
- ✓ The pulses are obvious to detect when the rising edge crosses the receiver threshold **but**, they are VERY brief (2nS)
- ✓ UWB design for pro audio requires extreme timing precision – **timing is everything**
  - ❖ **Requires 1ppm with max of 3ppm**
  - ❖ Luckily, we can benefit from experience with truly excellent digital audio gear such as consoles
  - ❖ Devices to meet the timing and capacity (4-8mb/s) requirements are now readily available
  - ❖ Pro gear may take into consideration sync to house, Blackburst, WordClock, Dante, etc.

Narrowband with Noise



Ultra Wideband with Noise

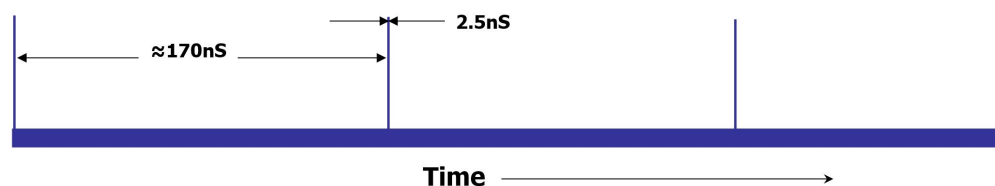




UWB Pulses contain the transmitted data – and millions of them can be managed and sent in only 1 second

## UWB PULSE TIMING

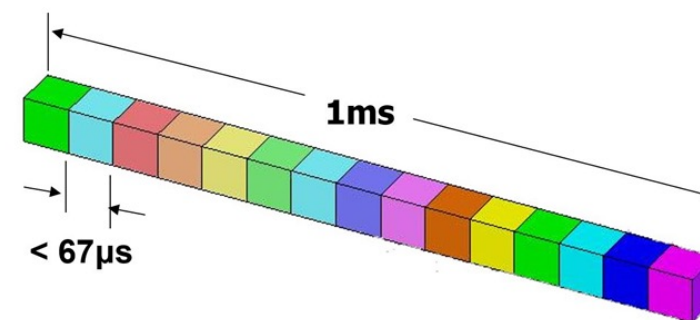
- Pulse duration < 2.5 nS
- Signal present < 1.5% of time
- Each pulse = 1 bit of information
- 384 pulses / channel / millisecond ( $\pm 5$  million/second)



With 2nS pulses, a very large amount of audio data can be sent over many channels in 1mS

- ✓ Low latency
- ✓ Full frequency response and dynamic range

- TDMA implementation
  - Critical for multiple channels
  - Based on 1mS “time slice” (packet)
  - Minimal latency (< 1.12 ms)





✓ Professional audio is a **REAL-TIME** activity. The re-transmission and error correction methods of other digital RF methods are difficult to maintain in real-time

❖ Pro UWB audio utilizes techniques such as:

- Digital windowing (filters)
- MRC
- CRC
- FEC
- Frequency, time, receiver, and phase diversity
- Multiple receiver gain stages
- Multiple transmit configurations
- Buffered/offset transmit configurations
- Pulse positioning and stretching techniques
- Over-the-air system synchronization – remember **timing is everything**



## What's next?

- ✓ Premium high-end audio UWB systems exist, but are built with discreet components
  - ❖ Large and expensive
  - ❖ Powerful new chipset solutions allow UWB pricing and size to reach consumer device levels without sacrificing the desired performance – but -
  
- ✓ We need a **standard** for interfacing UWB audio devices
  - ❖ The best technology is useless unless designers, manufacturers, and end users can depend on successful and effective interoperability
  
- ✓ Create products that maximize the “right” wireless for the “right” job
  - ❖ Wi-Fi, BT, UWB, NFC should all operate easily together
    - Even in a pro audio application these other wireless methods can provide useful supporting information and functionality
  
- ✓ AES STANDARDS: SC-02-02-B
  - ❖ Task group on Ultra Wide Band Audio Interface
  - ❖ In conjunction with the UWB Alliance and multiple UWB companies
  - ❖ <https://www.aes.org/standards/participation-507.cfm>





# BodyWave UWB Antenna

Presented By: Jonny McClintock

The first dedicated antenna for Wearable devices

Enabling the next generation of wireless wearable technologies for audio, medical and sports applications



## The Problem – Difficult Platforms



### Limited Wireless Coverage

- Limits quality of performance
- Limits Deployability
- Higher Infrastructure costs
- Reduces ability to Scale
- Can't serve larger consumer markets



### Complete Coverage





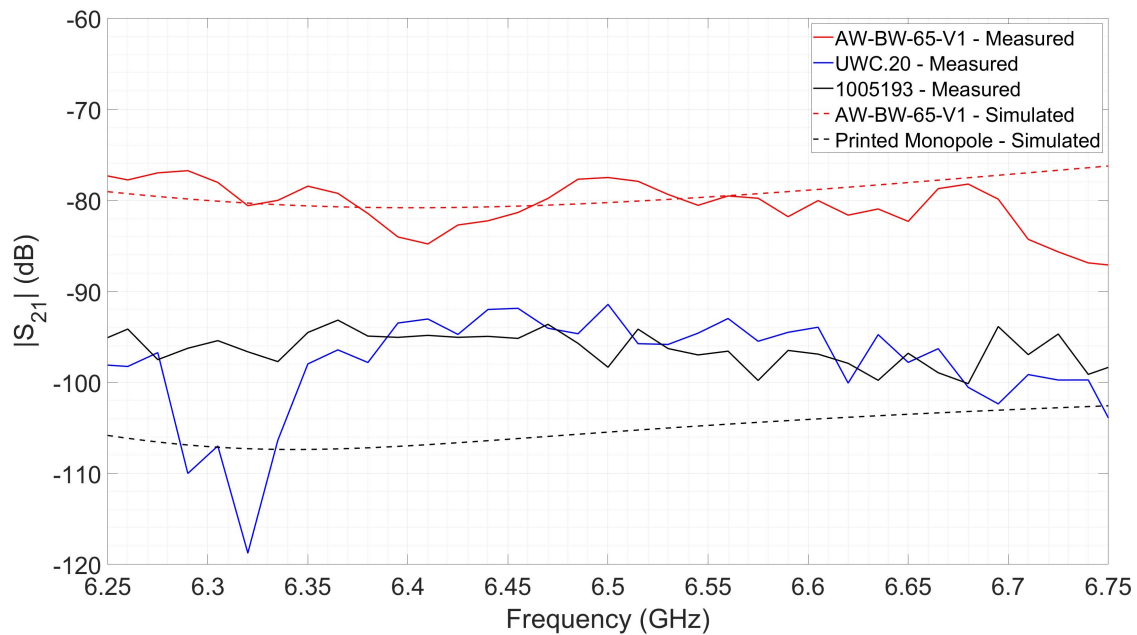
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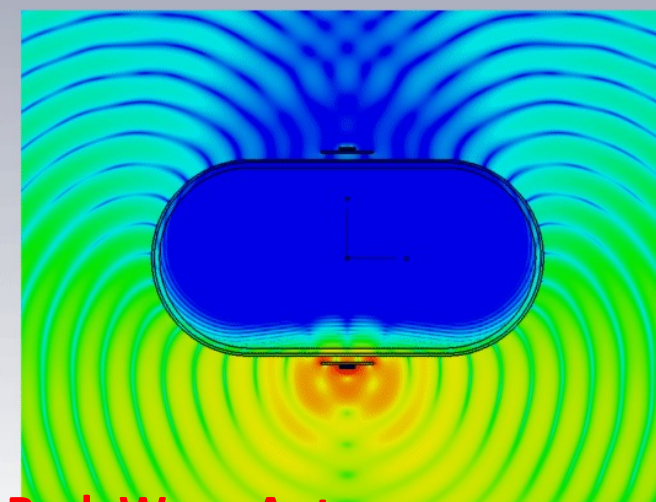
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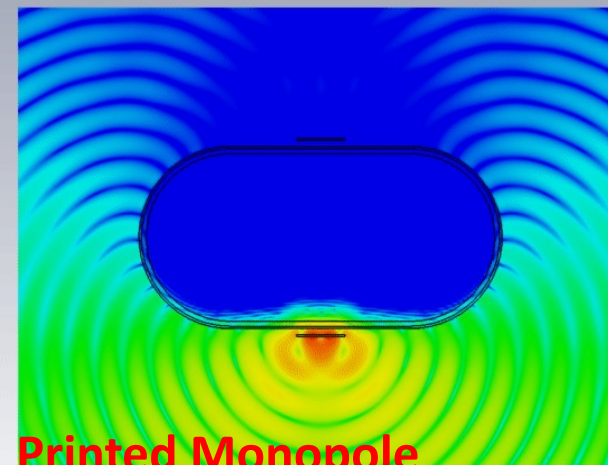
in



AUT	Measured Band Average $S_{21}$ (dB)
AW-BW-65-V1	-80.6
UWC.20	-98
1005193	-96.4



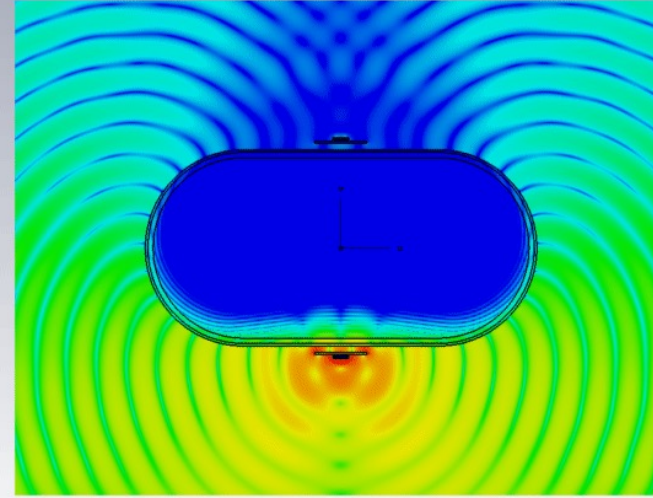
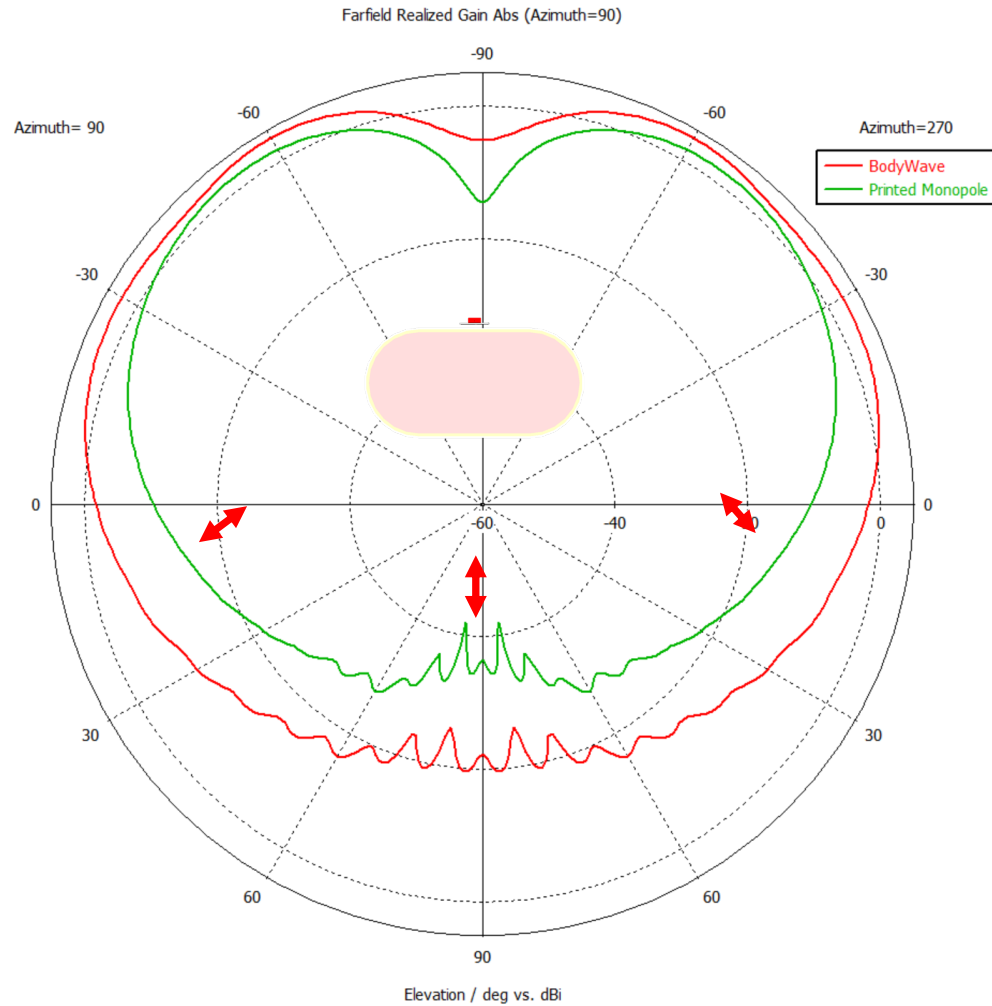
BodyWave Antenna



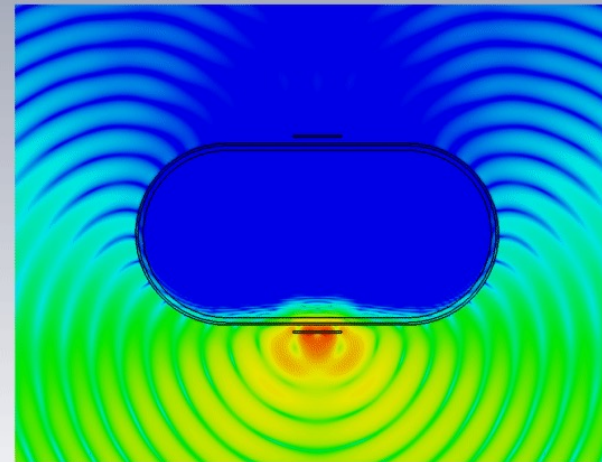
Printed Monopole



B0



**BodyWave Antenna**



**Printed Monopole**

# HiRes Wireless Headphones

Torben Sonderskov

Research & Systems Architecture

Lenbrook Industries

# Who is Lenbrook?



- 50+ Year History, Privately Held
  - Global development & distribution of specialty HiFi, video... and wireless telecom
  - Design center in Pickering Canada (HQ); Hong Kong & Singapore offices
  - Manufacturing partnerships throughout Asia (S. Korea, Vietnam, China)
- Audio / Video Brand Development & Design – Over a Century
  - NAD Electronics (1973)
    - Audio/Video Receivers, HiFi Amplifiers (model 3020, launched 1978)
  - Bluesound (2013)
    - First HiRes wireless whole-home audio system - 20+ music services
  - PSB Speakers (1972)
    - Loudspeakers & Headphones



# Wireless Headphones

- What's wrong with Bluetooth?
  - Enjoys 25 year history, ubiquitous, battery life good but approaching limits
  - Standard BLE / A2DP 'profiles' but...
  - Needs more bandwidth for HiRes Audio!
    - CD Audio (44.1/16) – max w/ near-lossless compression over BT
    - 96/24 – max 4:1 lossy under **ideal** RF conditions
    - 192/24? - forget about it!
- WiFi?
  - Plenty of bandwidth for HiRes
  - Battery Life?
  - No user-friendly standard fast-pair wireless connection to headphones

# Why UWB?

- Ultrawide Band wireless – nothing new
  - 2006: Intel pushes UWB as ‘Wireless USB’ standard
  - Missed market timing – no UWB commodity chips for next 10+ years
- 2018: New Challenges – Security, Micro-location
  - WiFi, BT: commodity chips, no micro-location
  - UWB well-suited to mass opportunity in wireless key devices and micro-location
  - Commodity-priced UWB chips, now inside latest Android/iOS
- UWB’s - unique radio modulation
  - Excellent battery life
  - Emerging standards allows more audio bandwidth allocation than BT

# UWB: Challenges for Personal-Area HiRes

- Wireless signal path near human body
  - Antennaware!
- Lenbrook reviewing silicon industry's latest UWB radio chips
  - Growing selection of large silicon vendors offering low-cost UWB radios
- Audio protocol development
  - Variable rate HiRes codec (MQA), adjusts bitrate to current RF conditions
- UWB Regulatory certification (EU, NA)
- Mass Production
  - Acoustic testing, RF performance validation on MP line

# HiRes Headphones: Consumer Demand

- Lenbrook's audiophile community very familiar with Bluetooth Audio
  - Among first consumer BT devices with HiFi audio codecs (10+ years)
- Updated BT HiFi codecs as lossy codecs as BT technology evolved
  - Consumer demand for better HiFi wireless was relentless!

• Nov. 2020:

**No, Bluetooth cannot deliver hi-res audio**



by John

November 5, 2020, 13:24

- John Darko: Audiophile influencer (250k+ Followers, YT)
- Today: Lenbrook's customers could not agree more!