YAMAHA
Make Waves

Virtual Immersive Sound
(Virtual Immersive Sound for XR)

What is virtual immersive sound,

and its future bridging with real immersive sound.

Introducing an overview of the virtual immersive sound solution, and concept, mechanism of HRTF processing which is utilized as its core technology. Furthermore, we present enhanced spatial sound technologies for virtual environment, and raise how these technologies can be effectively applied in real world sound, like “Digital Twin”.

Yamaha
Corporation

Oct 28, 2025

Agenda

- Part 1 : Binauralization for Immersive Sound (by Daichi Iseri)
  - Background
  - Basics of Binauralization
  - Features of Yamaha's method

- Part 2 : Immersive Sound for XR (by Ted Morikawa)
  - Background
  - How to create immersive (spatial) sound in XR
  - Features of Yamaha's method
  - Case studies

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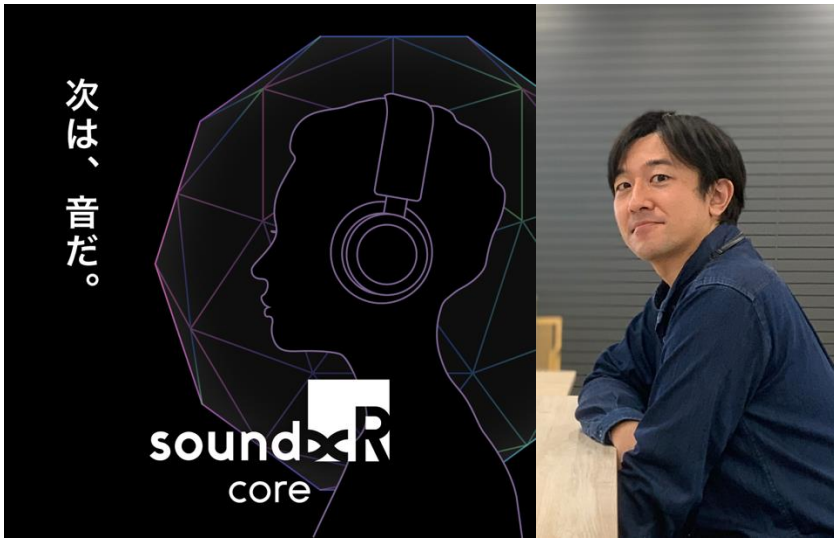
- Case studies

Daichi Iseri

Project Manager, Sound xR Project, Speaker & Amplifier Development Department, Yamaha Corporation

- 2005 : Join the company
  - Worked as a software engineer, engaged in software development for applications, networking, and cloud technologies.
- 2018 – 2024 : Contributed to the development of Sound xR Core, a spatial audio solution.
  - Responsible for developing plugins for Unity and Unreal Engine (UE).
  - Promoted integration into games and XR content
- 2025 - : Leading the Sound xR project
  - Driving the expansion of immersive audio solutions in both real-world and virtual-world.



Why Virtual Immersive Sound Matters ?

- **Increase in audio experiences via headphones and earphones.**
  - The popularity of FPS (First Person Shooter) and online multiplayer games, along with the rise of smartphones as a primary gaming platform, has led to an increase in audio experiences through earphones and headphones.

- **Interactive audio enhances immersive experiences.**
  - In interactive environments like games and the metaverse, players naturally move freely through space.
  - Real-time audio responsiveness — such as the voices of people in a city can be heard from the right side — greatly enhances immersion and realism.

Sound localization and movement enhance spatial realism and directly impact user experience.
Spatial audio is essential for HP/EP applications.

Yamaha's Spatial Audio History

Research and Development

- From hearing sound inside the head to experiencing it in space.
- Dynamic HRTF (Head-Related Transfer Functions)

Implementation

- Implemented binauralization features in a game title (2017).

Commercialization

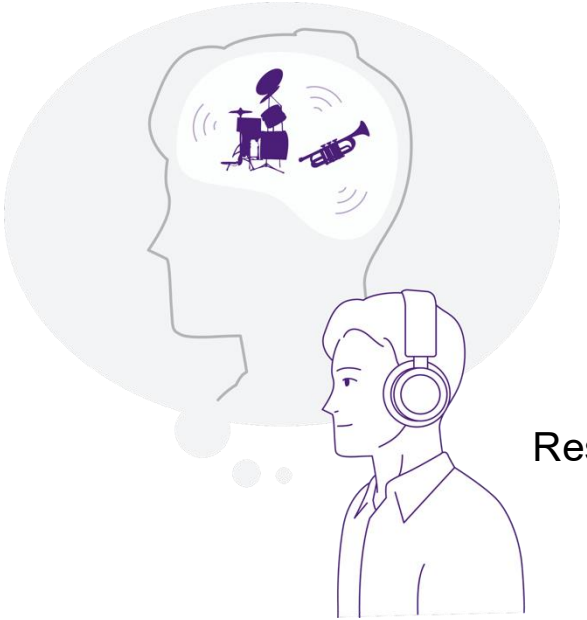
- Launched "Sound xR", immersive experience solution applicable to both digital and real-world environments. (2025, ISE)
- Offer binauralization features as Sound xR Core, delivered as a multi-platform compatible plugin and library.

<Virtual World>
Sound xR Core

<Real World>
AFC (Active Field Control)

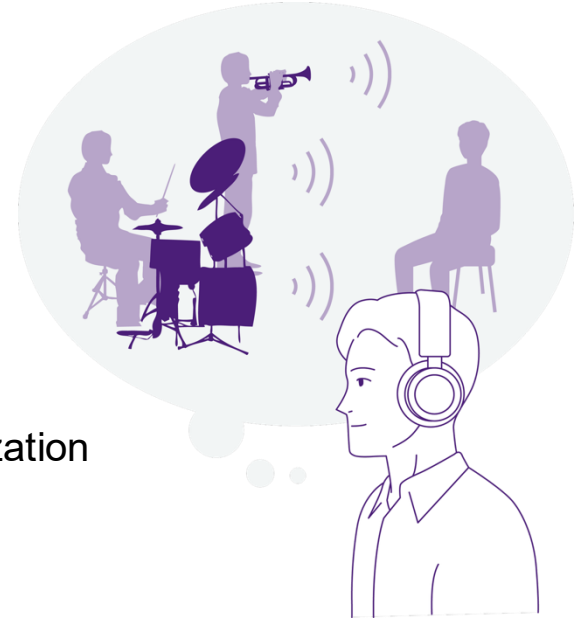
From hearing sound inside the head to experiencing it in space.

Sound inside the head



Resolve in-head localization

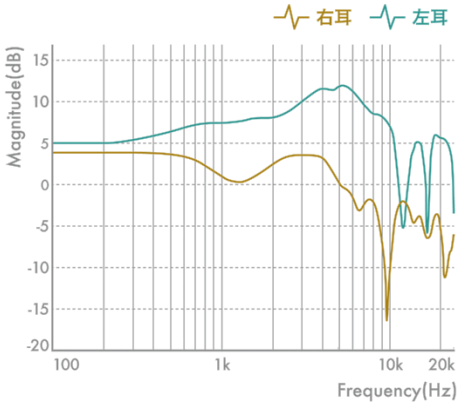
Bring sound outside the head !

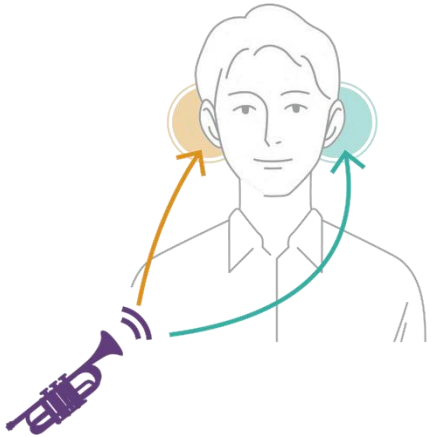


Naturally, there are situations where in-head localization is effective — for example, when the sound is meant to speak directly to the listener's inner thoughts.

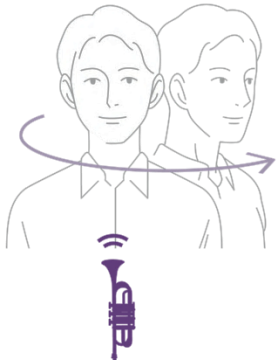
What Binauralization is ?

- Binauralization replicates how the human ear shapes sound to enable 3D spatial perception.
- It uses **HRTFs (Head-Related Transfer Functions)** to model direction-dependent acoustic filtering.
- Applying HRTFs to monaural sources simulates how sound reaches each ear, creating spatial audio images.

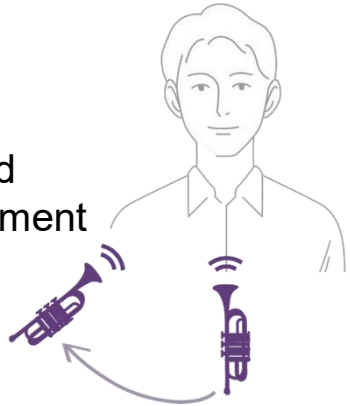




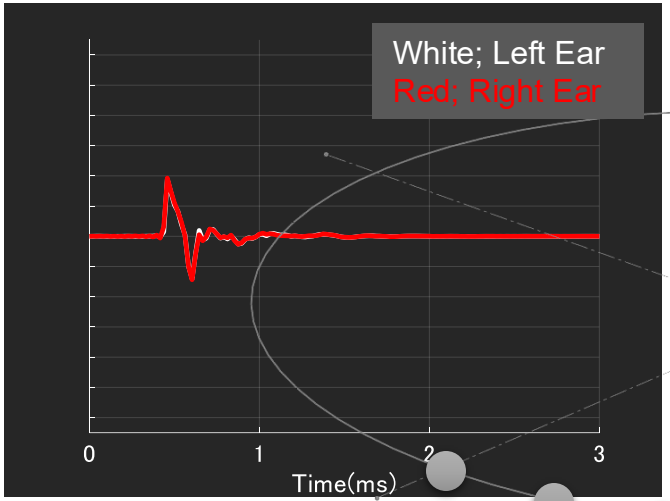
Real-time Binauralization

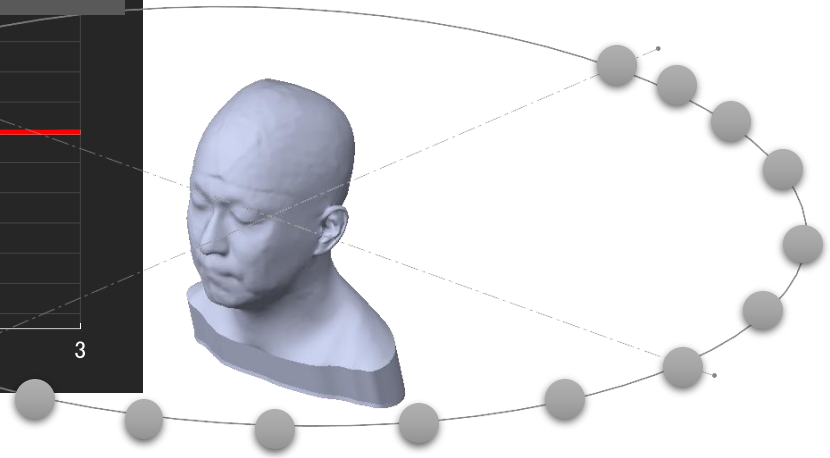


Head movement



Sound movement





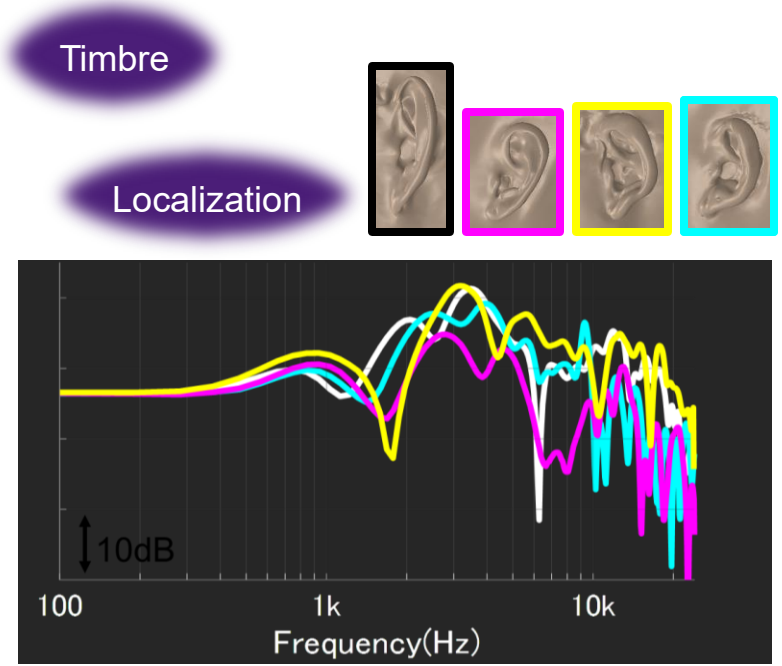
Depending on the location of the sound source, the waveform that reaches the left and right ears varies, contributing to spatial perception.

We adopted our original generalized HRTF models

rather than pursuing individual optimization.

Why ?

- ✓ Accurate HRTF measurement is difficult due to individual anatomical differences.
- ✓ Generalized HRTFs are more practical and scalable for a wide user base.

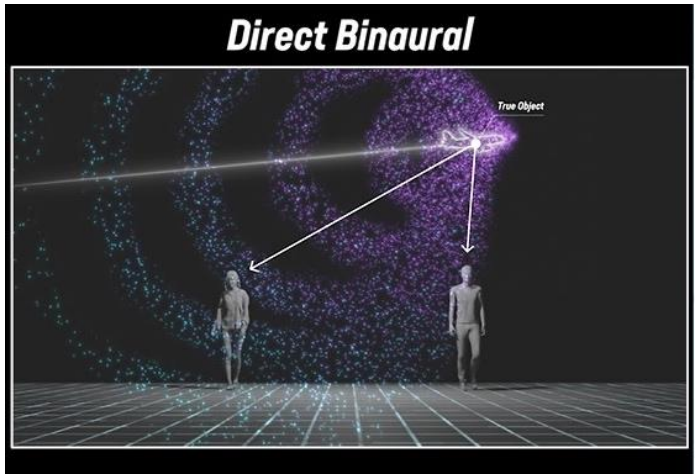


Key Factor

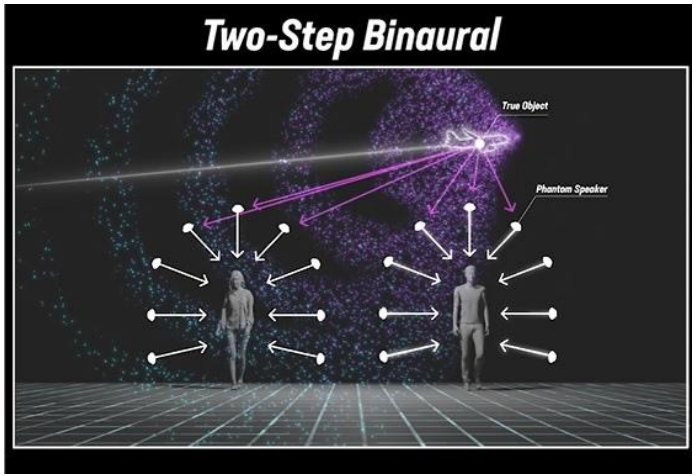
- ✓ 3D human body shape database
- ✓ Statistical feature extraction model
- ✓ Acoustic simulation
- ✓ Over 2,000 HRTF measurement points
- ✓ Computational optimization

- Binaural processing suitable for a wide range of people
- Smooth sound source movement

2 methods of binauralization



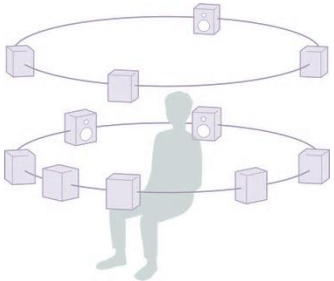
- ✓ Per-object binauralization
- ✓ Ideal for intentional and expressive sound design
- ✓ High localization accuracy, with increased processing cost for more sources



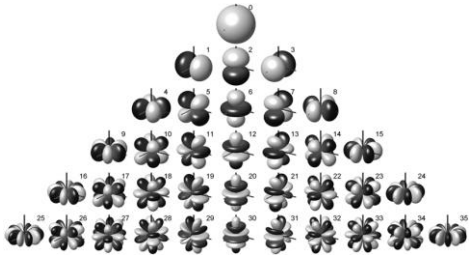
- ✓ Binauralization via virtual speakers (e.g., 7.1.4ch, Ambisonics)
- ✓ Suitable for ambient and atmospheric background sound
- ✓ Lower localization accuracy, but stable processing cost regardless of source count

Unifies various playback formats into one binaural experience

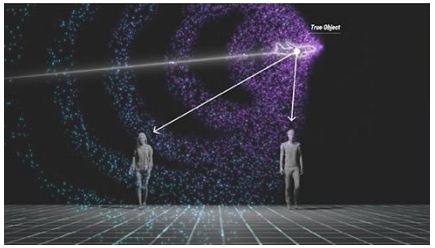
Channel-based



Scene-based



Object-based



Our Concept

“Empowering creators to express their intended sound !”

Enabling creators to choose the optimal HRTF according to the artistic intent of their content.

Yamaha's Virtual Immersive Sound Solution

Game Engine

Unity

UNREAL ENGINE

Audio Middleware

Wwise

CRIWARE®

Built-in implementation & Plugins

Compatible with major platforms, including PC, Mobile, PlayStation, and Switch … etc

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- Case studies

Self Introduction

Tadashi “Ted” MORIKAWA

Group Manager, MIRAI Technology Development Grp., Core Technology Development Div.

- Acoustic Design Bachelor & Master Program (Architectural Acoustics)

- Panasonic (Professional Audio)
  - PA System and Architectural Acoustic Design (Olympic Game Venue System etc)
  - PA System & Acoustic Design Simulation Software Development
  - Digital Mixing Console & Speaker System Development

- Yamaha Corp. (Professional Audio)
  - Product Planning, Speakers & Amplifiers Development
  - NEXO
  - Immersive System Planning & Development (Sound xR)

Why Virtual, XR ?

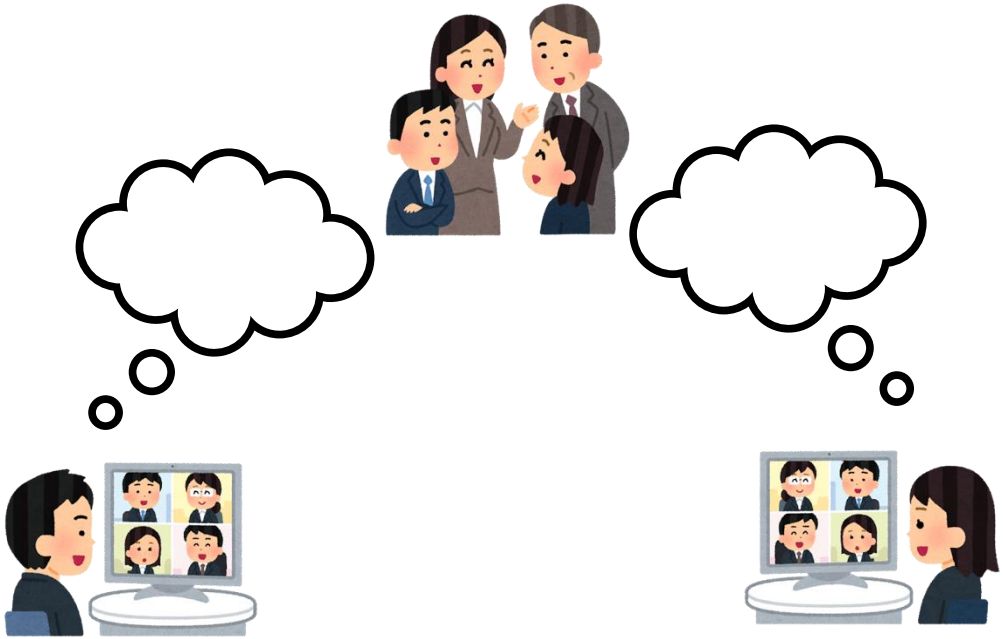
Why Virtual, XR?

Why Virtual, XR?



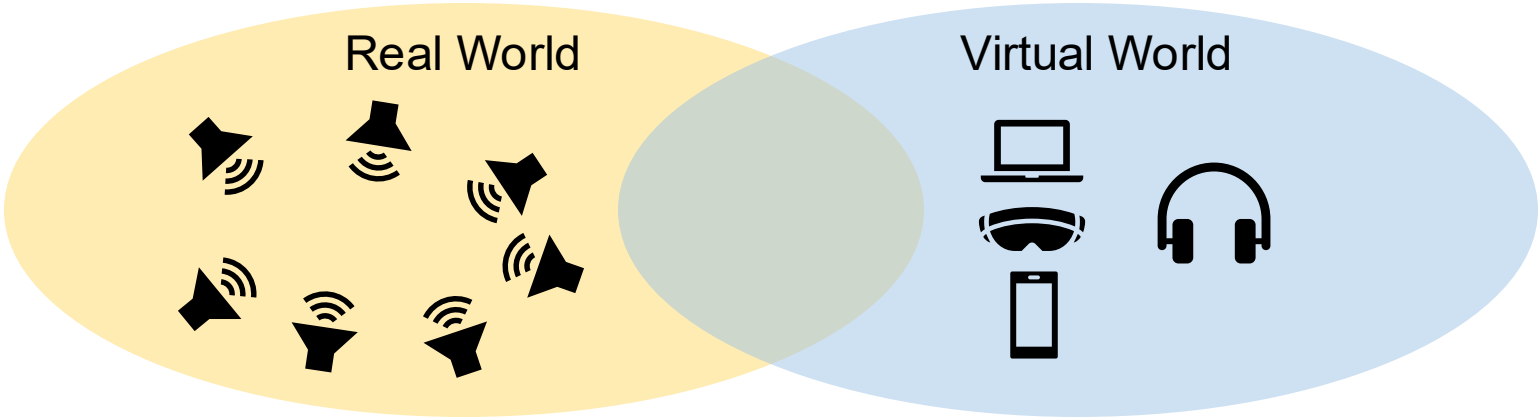



XR(VR, MR, AR) + Immersive Sound Technologies



Application of Immersive Sound for Real & Virtual World

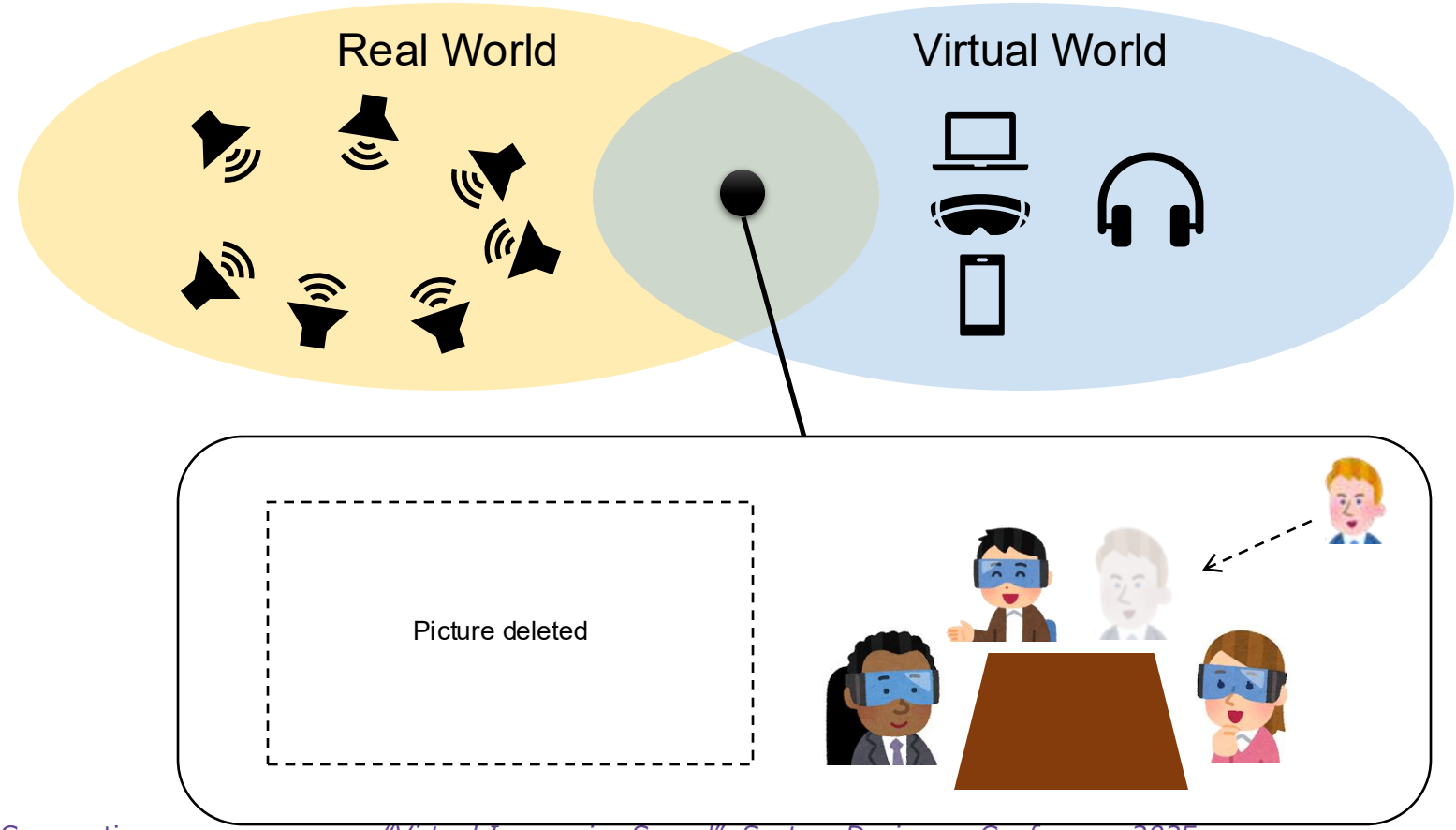
Real, Virtual, and...



Music, Theater act, Event
Attraction, Installation
…

Game
Music, Event, Travel
Technical Review, Co-work
Conference, Meeting, Exhibition
…

Real, Virtual, and Real + Virtual (AR, MR)



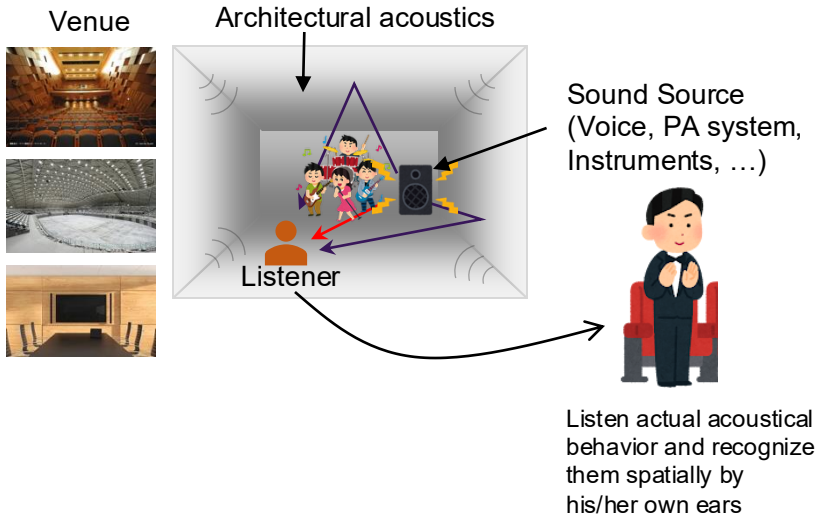
Immersive Sound for Virtual Space

What should We Do for Virtual World Acoustics?

Virtual World

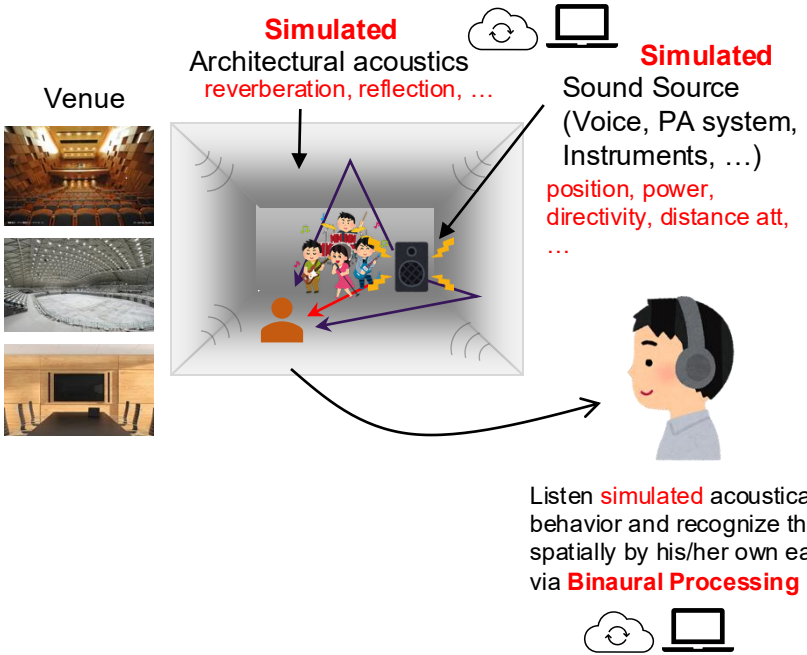
?

Real World

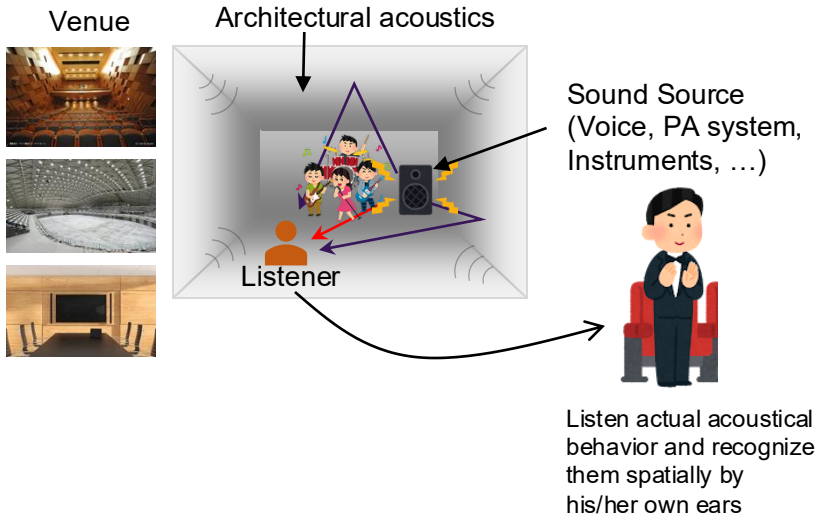


Modeling Acoustical Behavior

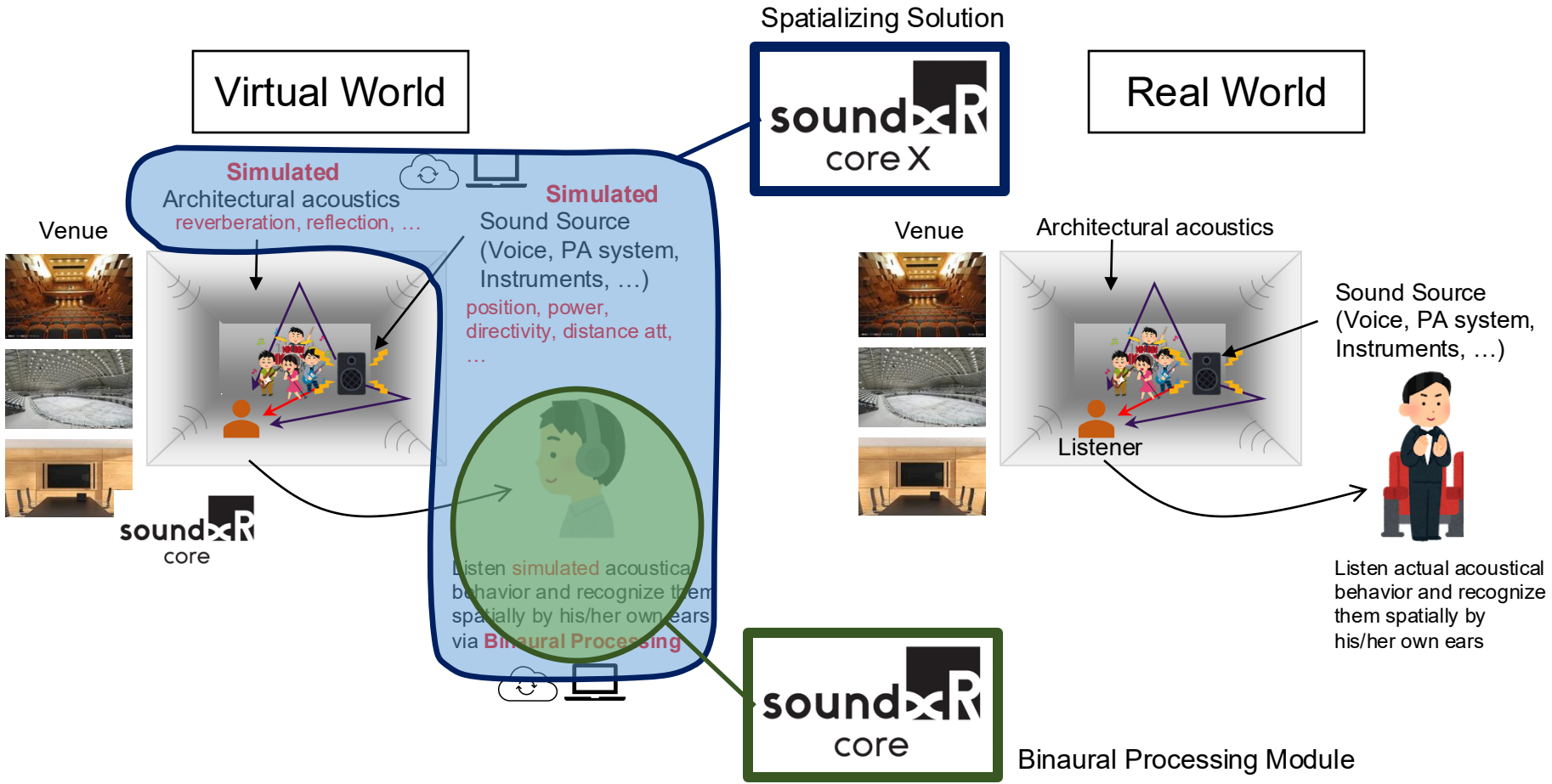
Virtual World



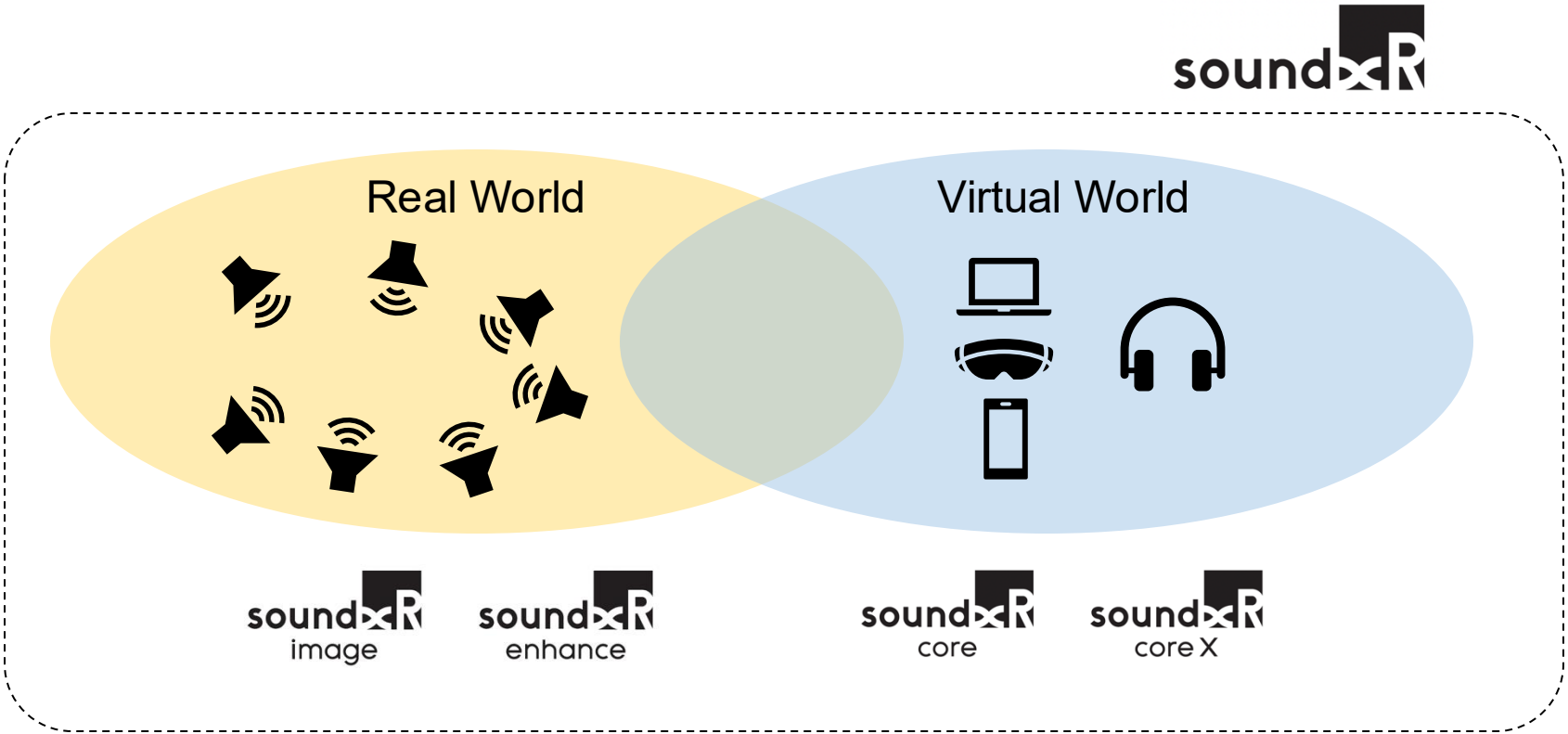
Real World



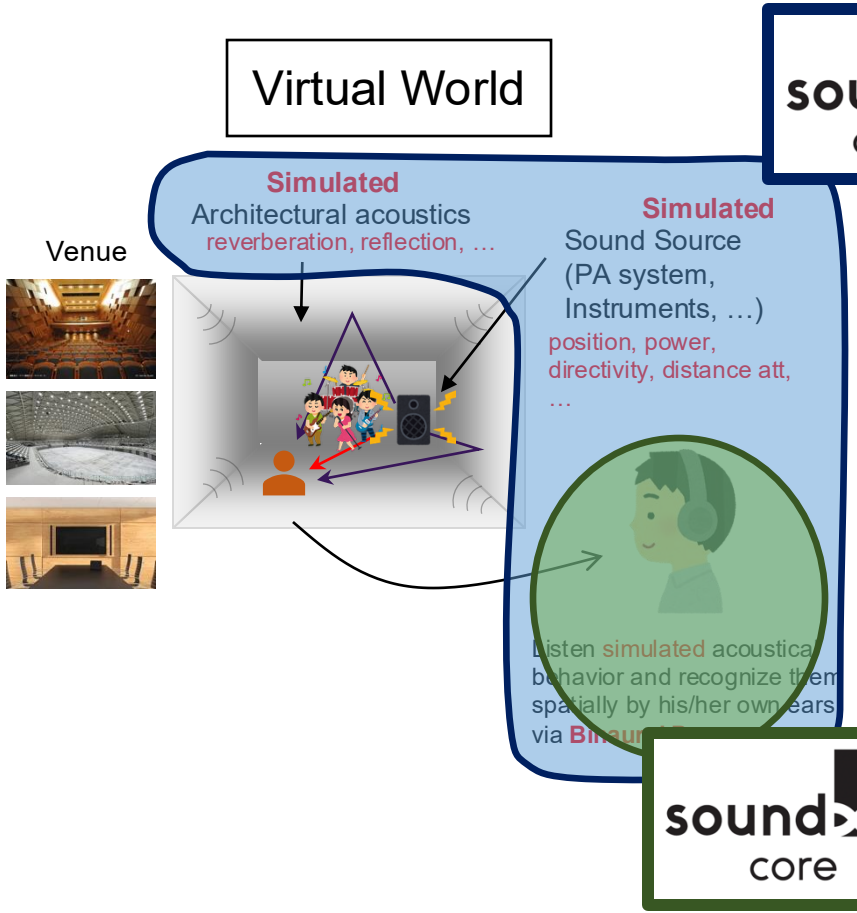
Yamaha's Case - Sound xR Core and Core X



Sound xR Overall Structure

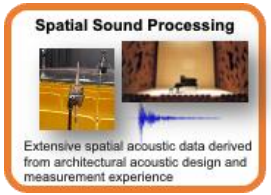


Sound xR Core, Core X Technologies



Create Object and Spatial Realistically

- 👍 Feeling of object distance (close ～ faraway)
- 👍 Impression of PA speaker
- 👍 Realistic reverberation and ambience

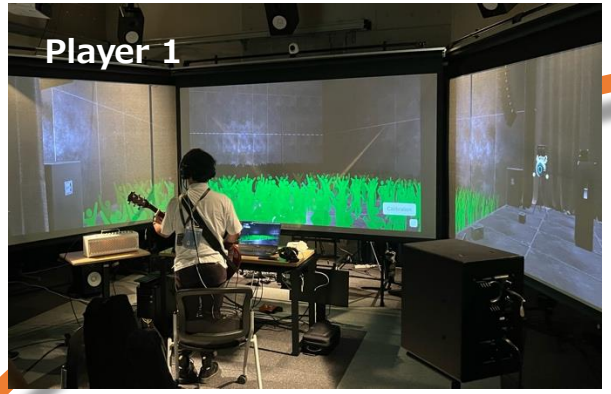


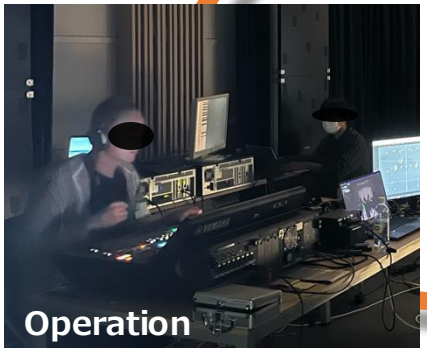
Binauralize Accurately

- 👍 Localization
- 👍 Movement of object

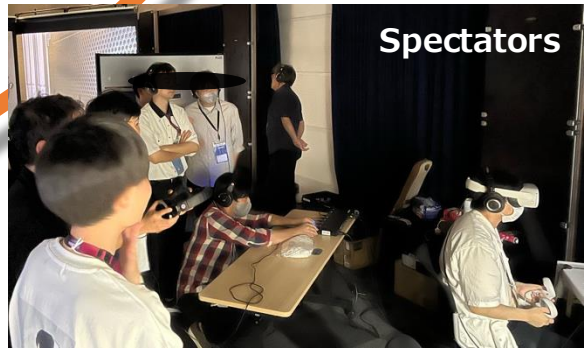
Case Study of Sound xR Core X

Yamaha internal test event, 2023





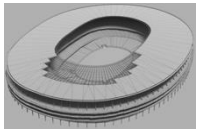
Create Empathy beyond Geographic



Future Scope – Digital Twin

OFF-SITE (VIRTUAL SPACE) PRODUCTION

VIRTUAL EVENT



MODELING
VIRTUAL VENUE,
Acoustics
PA System…

FACILITY DATA
PRODUCTION DATA

ON-SITE EXPERIENCE

LIVE PERFORMANCE

OFF-SITE EXPERIENCE

VIRTUAL REALITY

SMARTPHONE WITH
HEADPHONE

This Digital Asset could also utilize to…

System Tuning
Training and Performance Check
Archiving
…

Case Study of Sound xR Core X - Digital Twin

Actual Concert at Yamaha HQ Studio

Picture deleted

Reproduced Concert on VR System

Picture deleted

Demonstrate at NEXO booth, ISE 2025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