



# Simulation of urban soundscapes



## Overview

### **NOISE LEVEL PREDICTION AND AUDIO RENDERING OF OUTDOOR URBAN SOUNDSCAPES**

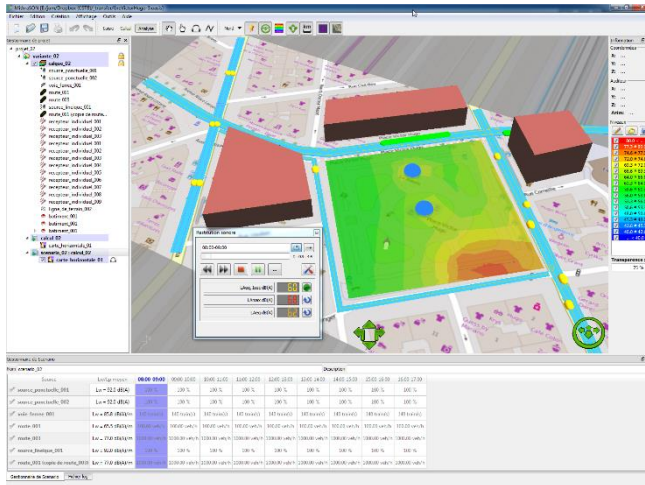
- > Direct perceptual evaluation of noise exposure for urban planning
- > Associate visualization of 3D scene and predicted noise levels with audio rendering
- > Analyze noise exposure at fixed points, along a predefined trajectory or within an extended area using interactive walkthrough

### **INCLUDE A WIDE VARIETY OF SOUND SOURCES**

- > Fixed and moving sound sources using recorded audio signatures
- > Motorized moving vehicles using real time audio synthesis and traffic flow modeling
- > Background noise sources using measured levels and signatures

### **APPLICATIONS**

- > To study project options at the design stage
- > To communicate project outcomes to stakeholders and the public



## Approach

### SOURCE/RECEIVER SOUND PROPAGATION MODELING

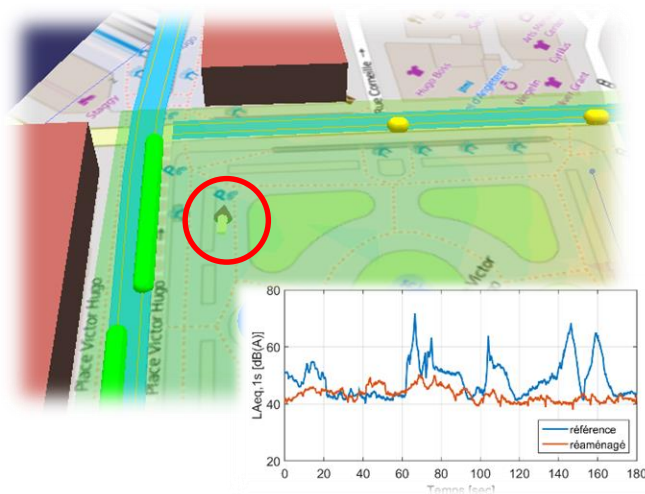
- > Source/received propagation paths obtained with MithraSIG/MithraSound shared calculation core
- > Standardized calculation methods implemented to calculate propagation effects: Crossoos-EU, NMPB-2008, Harmonoise, ISO 9613-2, ...

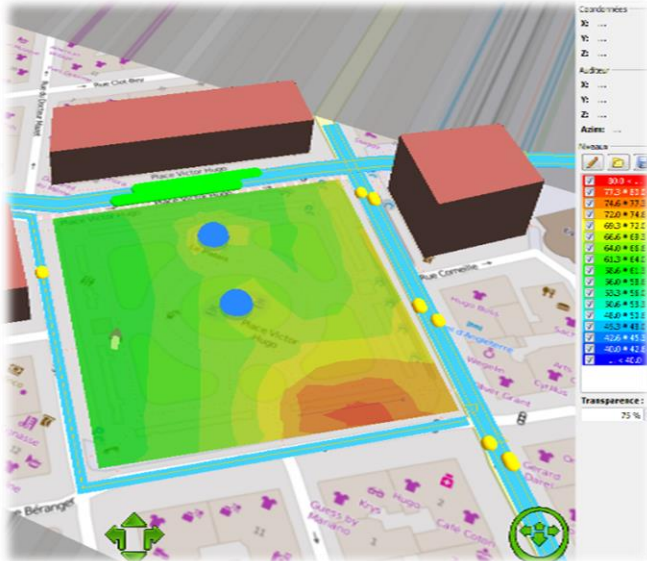
### ANALYSIS OF NOISE EXPOSURE LEVELS

- > Interactive calculation of averaged levels based on source emission properties

### AUDIO SIMULATION

- > Dynamic traffic flow simulation for rendering individual vehicles
- > Real time rendering of sources contributions allowing interactive listener motion
- > Spatialized audio rendering on headphones of multi-speaker systems
- > Short time level evolution and dynamic indicators based on auralized signals ( $LA_{max}$ , L10, L50, ...)





## Audio simulation of road traffic

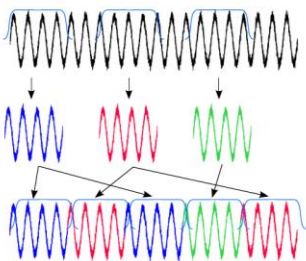
### TRAFFIC NETWORK SETTINGS

- > Integrated simple traffic network configuration
  - Simple traffic controls (stops, lights, speed limit, ...)
  - no out-of-lane motion
- > Advanced traffic modeling based on Symuvia traffic engine (Ifsttar)
  - Network configured within MithraSIG then exported to MithraSound

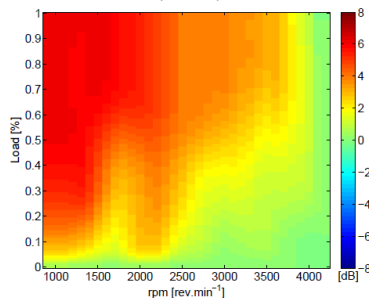
### ADVANCED AUDIO SYNTHESIS

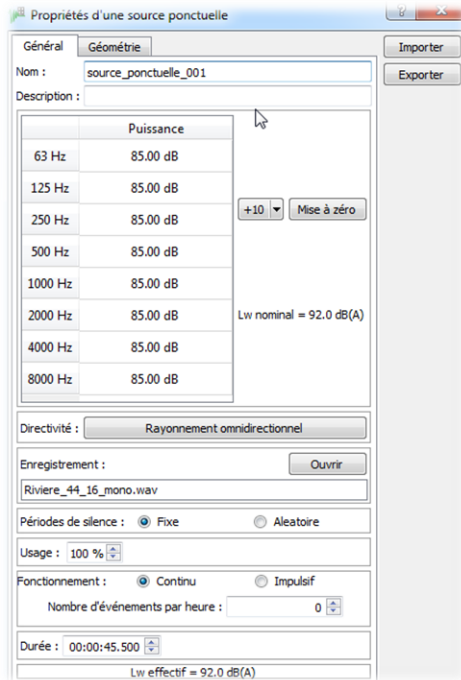
- > Real time synthesis of engine and rolling noise components
- > Engine noise implements granular synthesis techniques for extremely realistic emission signals
- > Audio synthesis is driven by vehicle and engine speed evolution

Engine noise  
synchronous granular synthesis



Interpolated diesel engine load gains  
(1 kHz)





## Additional sound sources

### SIMPLE SOURCES

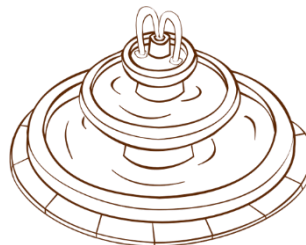
- > Fixed and moving point source, line source
- > Characterized by audio signature, emission power levels and directivity
- > Operating mode configuration

### BACKGROUND NOISE SOURCES

- > Add constant background noise to the listening area assuming constant exposure level
- > Characterized by audio signature and sound pressure levels

### URBAN SOURCE DATA BASE

- > Signature, emission levels and directivity
- > Include natural, human and industrial sound sources as well as background noise sources



## Results analysis

### QUANTITATIVE ANALYSIS

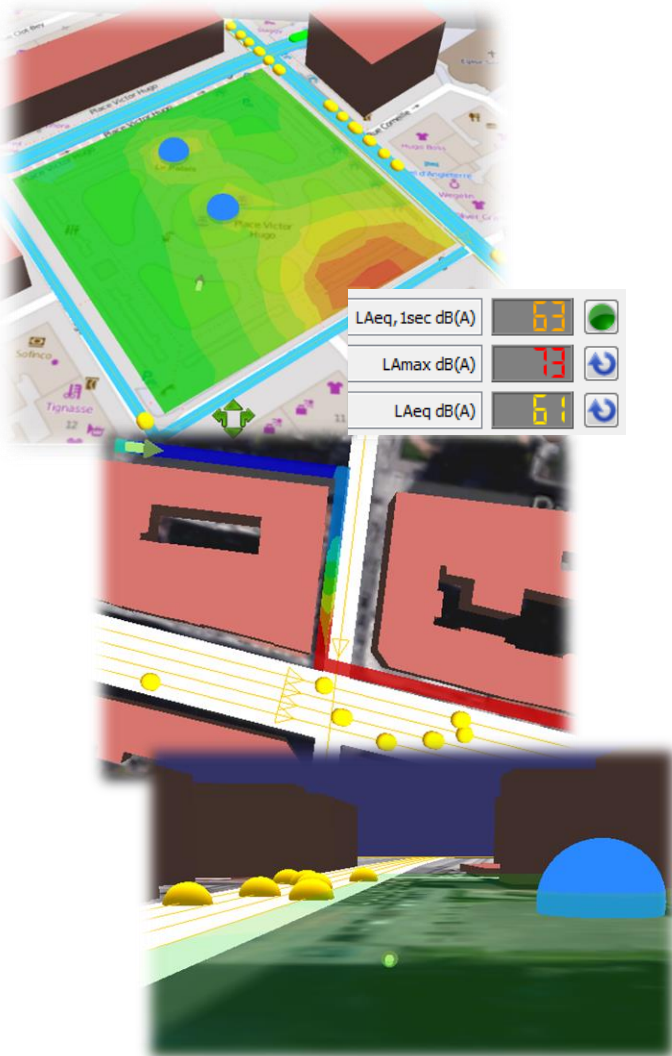
- > Visualization of exposure noise level through color maps and labels for individual receivers
- > Compare exposure levels between project variants (geometry) and scenarios (sources configurations)
- > Visualize time evolution of short-time equivalent sound levels and calculate derived dynamic indicators ( $LA_{eq,1s}$ ,  $LA_{max}$ , L90, L50, ...)

### SUBJECTIVE ANALYSIS

- > Spatialized audio rendering at listener position (fixed or moving)
- > Audio rendering system can be precisely calibrated
- > Dynamic visual rendering of moving vehicles
- > Audio samples may be saved for further analysis (listening tests, ...)

### SCENE 3D VISUALIZATION

- > Orthogonal top view
- > 3D view
- > 3D immersive view (camera controlled by listener position)





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