Sound and Audio extensions in X3D v4

Efforts to Improve X3D Audio

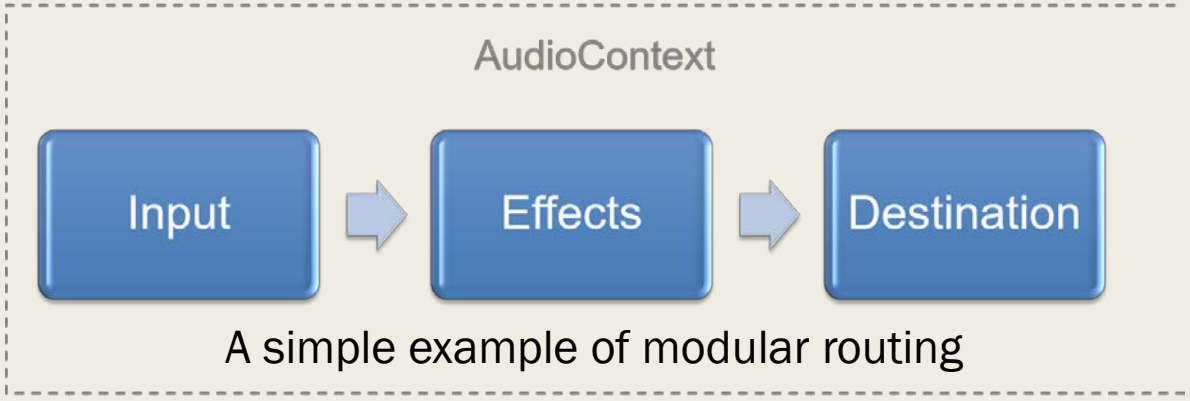
1st Approach Spatial Sound in X3D/X3DOM

- “Wrapping” X3DOM around Web Audio API
- Introduction of spatial sound components in the **X3DOM** framework, based on:
  - *X3D specification and*
  - ***Web Audio API***



Web Audio API - Structure

- Web Audio API involves handling audio operations inside an audio context (**AudioContext node**) and has been designed to allow modular routing.
- Particularly, the approach of Web Audio API is based on the concept of audio context, which presents the direction of audio stream flows, between sound nodes (**AudioNode**).
- A simple, typical workflow for web audio API. This flow includes the creation of audio context. Inside the context:
  - *create sources — such as <audio>, oscillator, stream*
  - *create effects nodes, such as reverb, biquad filter, panner, compressor*
  - *choose final destination of audio, for example your system speakers*
  - *connect the sources up to the effects, and the effects to the destination.*



A simple example of modular routing

Web Audio API – All Registered Nodes

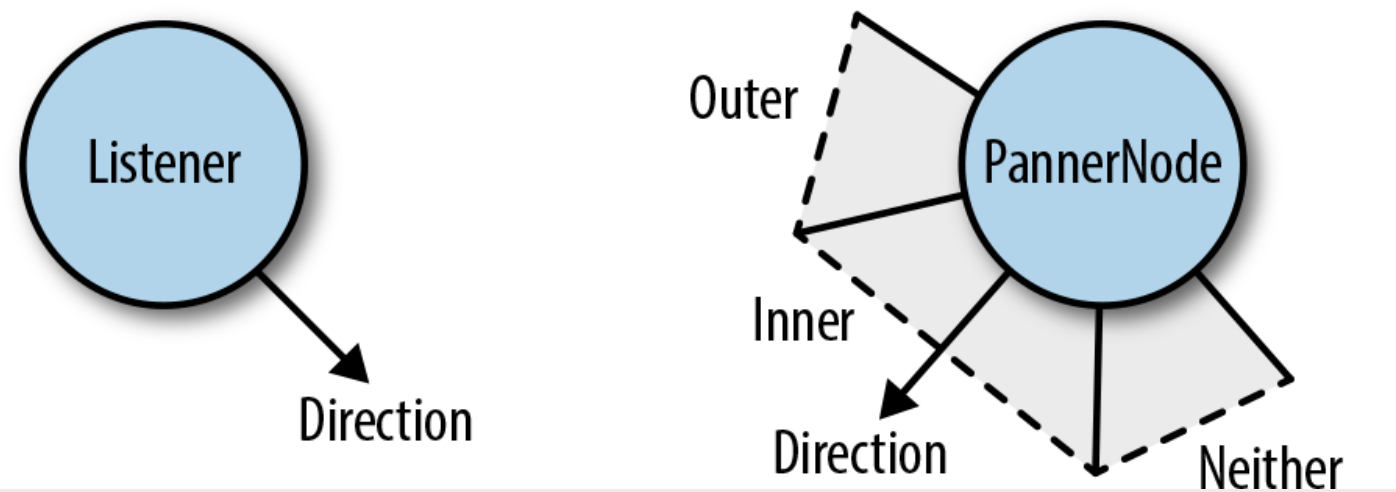
- WebAudioAPI Node
  - ***AudioSound*** *Node*
  - ***AudioSource*** *Node*
  - ***AudioContext*** *Node*
  - *AudioNode Node*
  - *AudioParam Node*
  - *OscillatorNode Node*
  - ***AudioBuffer*** *Node*
  - *AudioBufferSourceNode Node*
  - *MediaElementAudioSourceNode Node*
  - *MediaStreamAudioSourceNode Node*
  - ***BiquadFilterNode*** *Node*
  - *ConvolverNode Node*
- WebAudioAPI Node
  - ***Delay*** *Node*
  - *DynamicsCompressorNode Node*
  - ***GainNode*** *Node*
  - *WaveShaperNode Node*
  - *PeriodicWave Node*
  - *AudioDestinationNode Node*
  - *MediaStreamAudioDestinationNode Node*
  - *AnalyserNode Node*
  - *ChannelSplitterNode Node*
  - *ChannelMergerNode Node*
  - *AudioListener Node*
  - ***PannerNode*** *Node*

Main Interfaces - Role

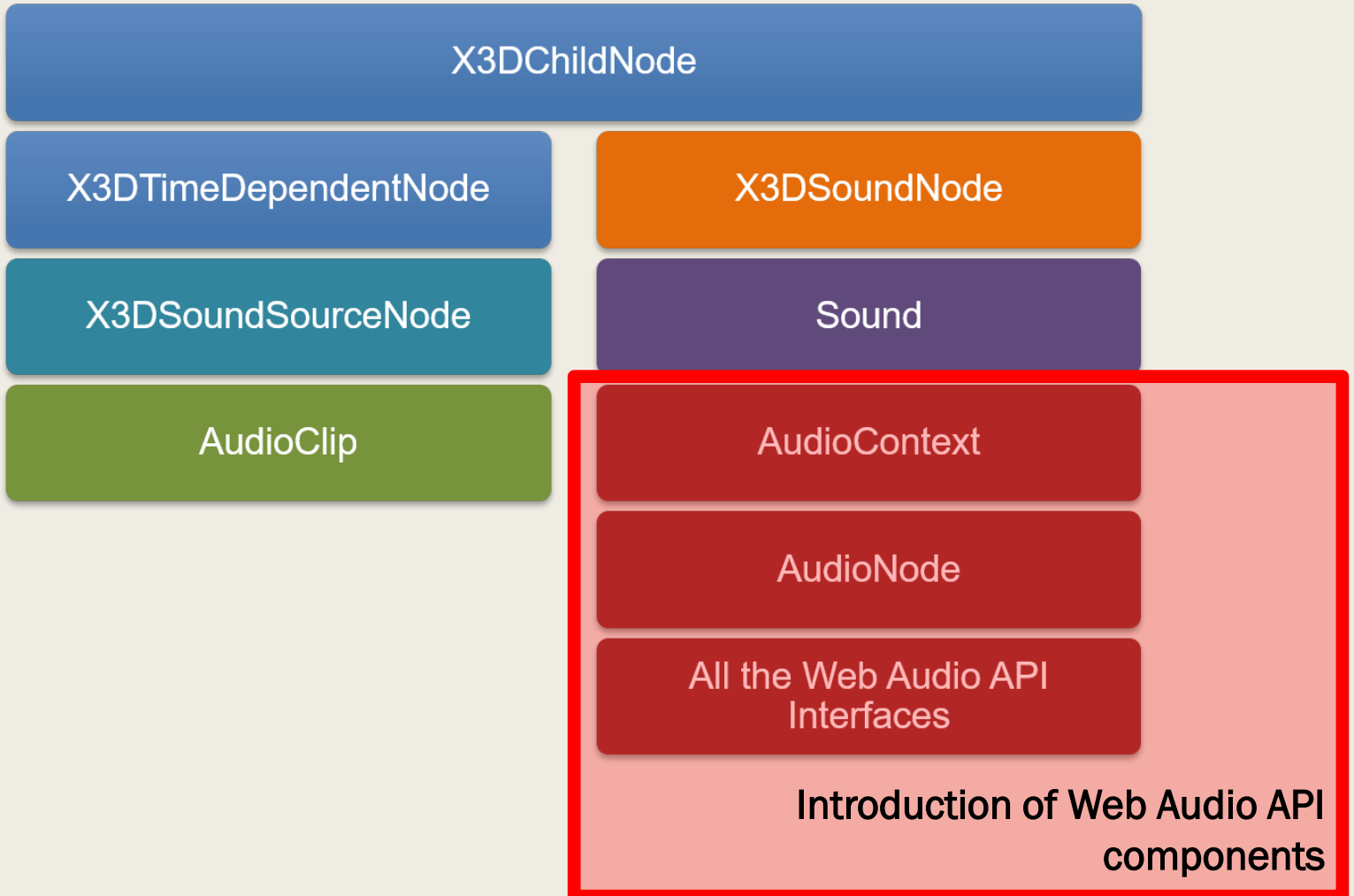
- The **AudioContext** interface, which contains an audio signal graph representing connections between AudioNodes
- The **AudioNode** interface, which represents audio sources, audio outputs, and intermediate processing modules. AudioNodes can be dynamically connected together in a modular fashion. AudioNodes exist in the context of an AudioContext.
- The **AudioBuffer** interface, for working with memory-resident audio assets. These can represent one-shot sounds, or longer audio clips.
- The **BiquadFilterNode** interface is an AudioNode for common low-order filters such as Low Pass, High Pass, Band Pass, Low Shelf, High Shelf, Peaking, Notch, Allpass.
- The **DelayNode** interface introduces a dynamically adjustable variable delay.
- The **GainNode** interface, an AudioNode for explicit gain control. Because inputs to AudioNodes support multiple connections (as a unity-gain summing junction), mixers can be easily built with GainNodes.

Main Interfaces - Role

- The **PannerNode** represents a processing node which positions / spatializes an incoming audio stream in three-dimensional space.
- There is a single listener (AudioListener) attached to the Web Audio API context that can be configured in space through position and orientation. Each source can be passed through a panner node (AudioPannerNode), which spatializes the input audio.
- Based on the relative position of the sources and the listener, the Web Audio API computes the correct gain modifications.



Proposal to Improve X3D Sound Component – Introduction of Web Audio API components



Sound Node

Sound Node (X3D)

```
x3dom.registerNodeType("Sound", "X3DSoundNode", defineClass(x3dom.nodeTypes.X3DSoundNode,
function(d) {
    x3dom.nodeTypes.X3DSoundNode.superClass.call(this, d),
    this.addField_SFNode("metadata", x3dom.nodeTypes.X3DMetadataObject),
    this.addField_SFVec3f(d, "direction", 0, 0, 1),
    this.addField_SFFloat(d, "intensity", 1),
    this.addField_SFVec3f(d, "location", 0, 0, 0),
    this.addField_SFFloat(d, "maxBack", 10),
    this.addField_SFFloat(d, "maxFront", 10),
    this.addField_SFFloat(d, "minBack", 1),
    this.addField_SFFloat(d, "minFront", 1),
    this.addField_SFFloat(d, "priority", 0),
    this.addField_SFNode("source", x3dom.nodeTypes.X3DSoundSourceNode),
    this.addField_SFBool(d, "spatialize", !0)

    //New attributes
    //In order to use it in html under the Sound node of X3D
    this.addField_SFNode("transform", x3dom.nodeTypes.Transform),
    this.addField_SFNode("panner", x3dom.nodeTypes.PannerNode),
    this.addField_SFNode("filter", x3dom.nodeTypes.BiquadFilterNode),
    this.addField_SFNode("delay", x3dom.nodeTypes.DelayNode)
}
```

X3DSoundSourceNode Node

X3DSoundSourceNode(X3D)

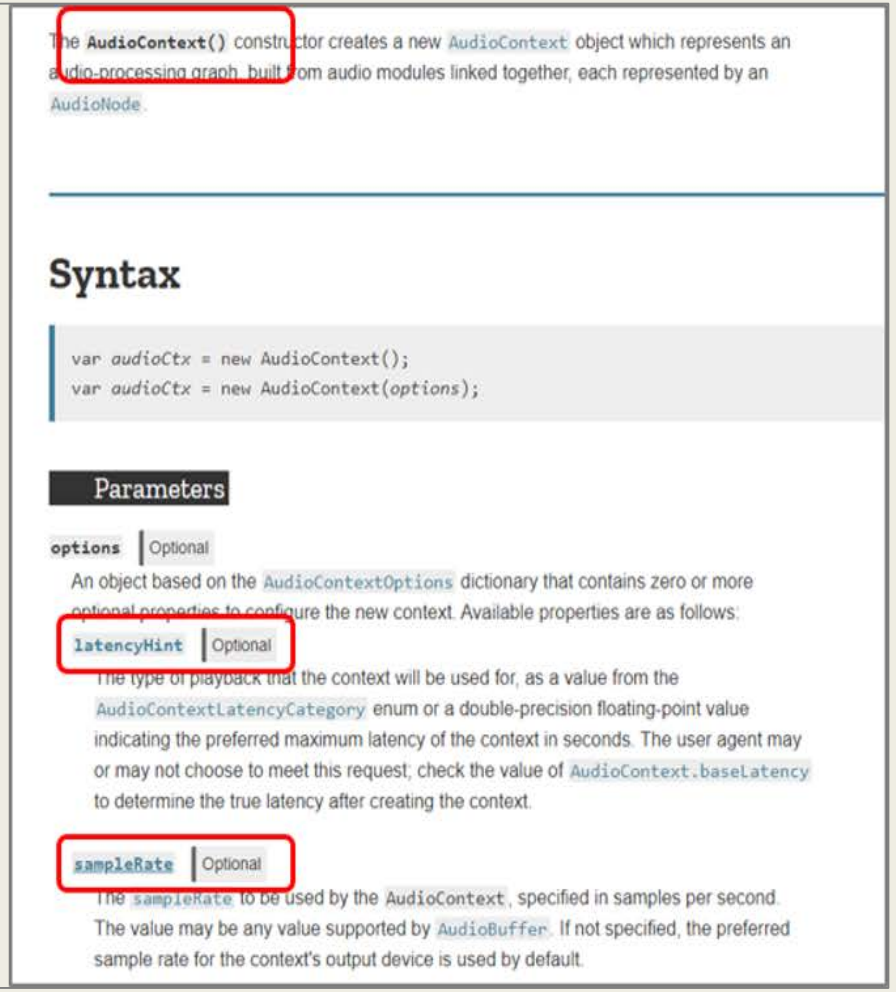
```
x3dom.registerNodeType("X3DSoundSourceNode", "X3DTimeDependentNode",
defineClass(x3dom.nodeTypes.X3DSoundNode, function(d) {
    x3dom.nodeTypes.X3DSoundSourceNode.superClass.call(this, d),
    this.addField_SFString(d, "description", ""),
    this.addField_SFBool(d, "loop", !1),
    this.addField_SFNode("metadata", x3dom.nodeTypes.X3DMetadataObject),
    this.addField_SFTime(d, "pauseTime", 0),
    this.addField_SFFloat(d, "pitch", 1),
    this.addField_SFTime(d, "resumeTime", 0),
    this.addField_SFTime(d, "startTime", 0),
    this.addField_SFTime(d, "stopTime", 0)

    //New attributes
    this.addField_MFString(d, "url", [])//From AudioClip X3D Node
    this._audio = document.createElement("audio"), "Microsoft Internet Explorer" != navigator.appName &&
document.body.appendChild(this._audio)
}
```

AudioContext Node

***AudioContext**: Sound {*
SFNode [in,out] metadata NULL [X3DMetadataObject]
SFDouble [in, out] latencyHint 0.0 (-∞, ∞) //optional or
SFString [in,out] latencyHint " "
SFFloat [in,out] sampleRate 0 (-∞, ∞) //optional

}



The `AudioContext()` constructor creates a new `AudioContext` object which represents an audio-processing graph, built from audio modules linked together, each represented by an `AudioNode`.

Syntax

```
var audioCtx = new AudioContext();
var audioCtx = new AudioContext(options);
```

Parameters

`options` | Optional

An object based on the `AudioContextOptions` dictionary that contains zero or more optional properties to configure the new context. Available properties are as follows:

`latencyHint` | Optional

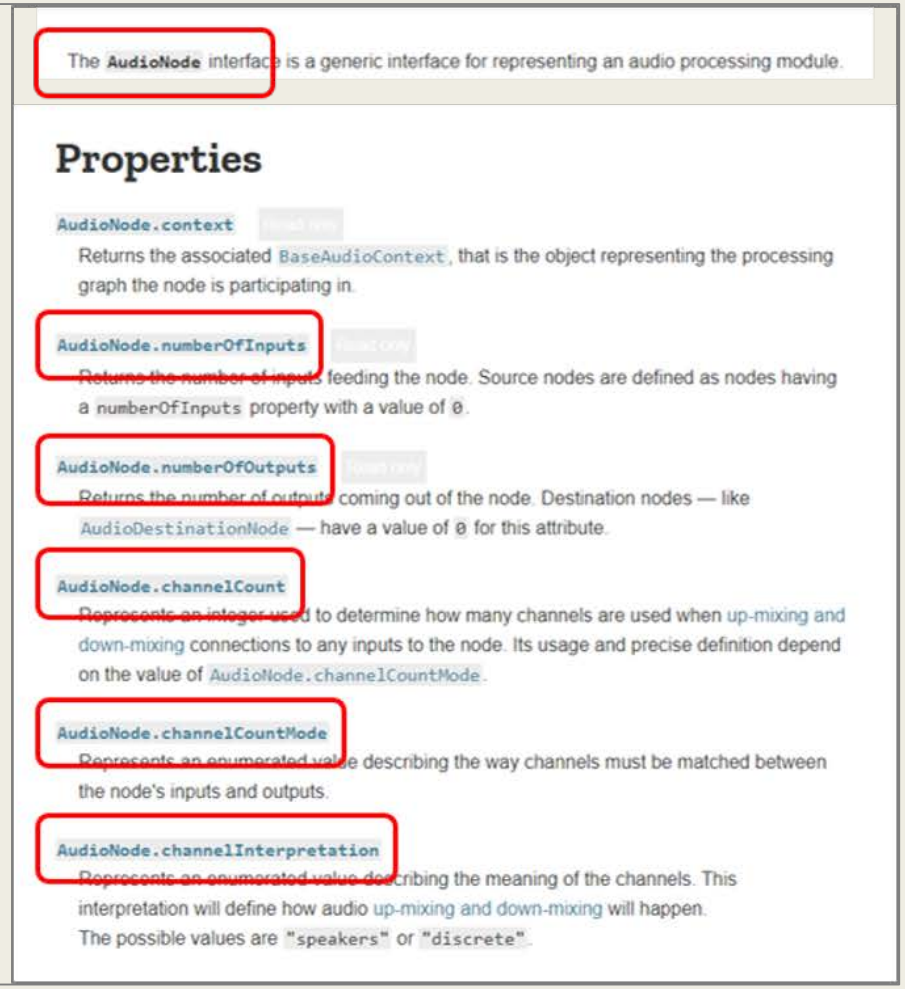
The type of playback that the context will be used for, as a value from the `AudioContextLatencyCategory` enum or a double-precision floating-point value indicating the preferred maximum latency of the context in seconds. The user agent may or may not choose to meet this request; check the value of `AudioContext.baseLatency` to determine the true latency after creating the context.

`sampleRate` | Optional

The `sampleRate` to be used by the `AudioContext`, specified in samples per second. The value may be any value supported by `AudioBuffer`. If not specified, the preferred sample rate for the context's output device is used by default.

AudioNode Node

***AudioNode**: AudioContext {*
SFNode [in,out] metadata NULL [X3DMetadataObject]
SFInt32 [in,out] numberOfInputs 0
SFInt32 [in,out] numberOfOutputs 0
SFString [in,out] channelCount 0
SFString [in,out] channelCountMode max
SFString [in,out] channelInterpretation speakers
}

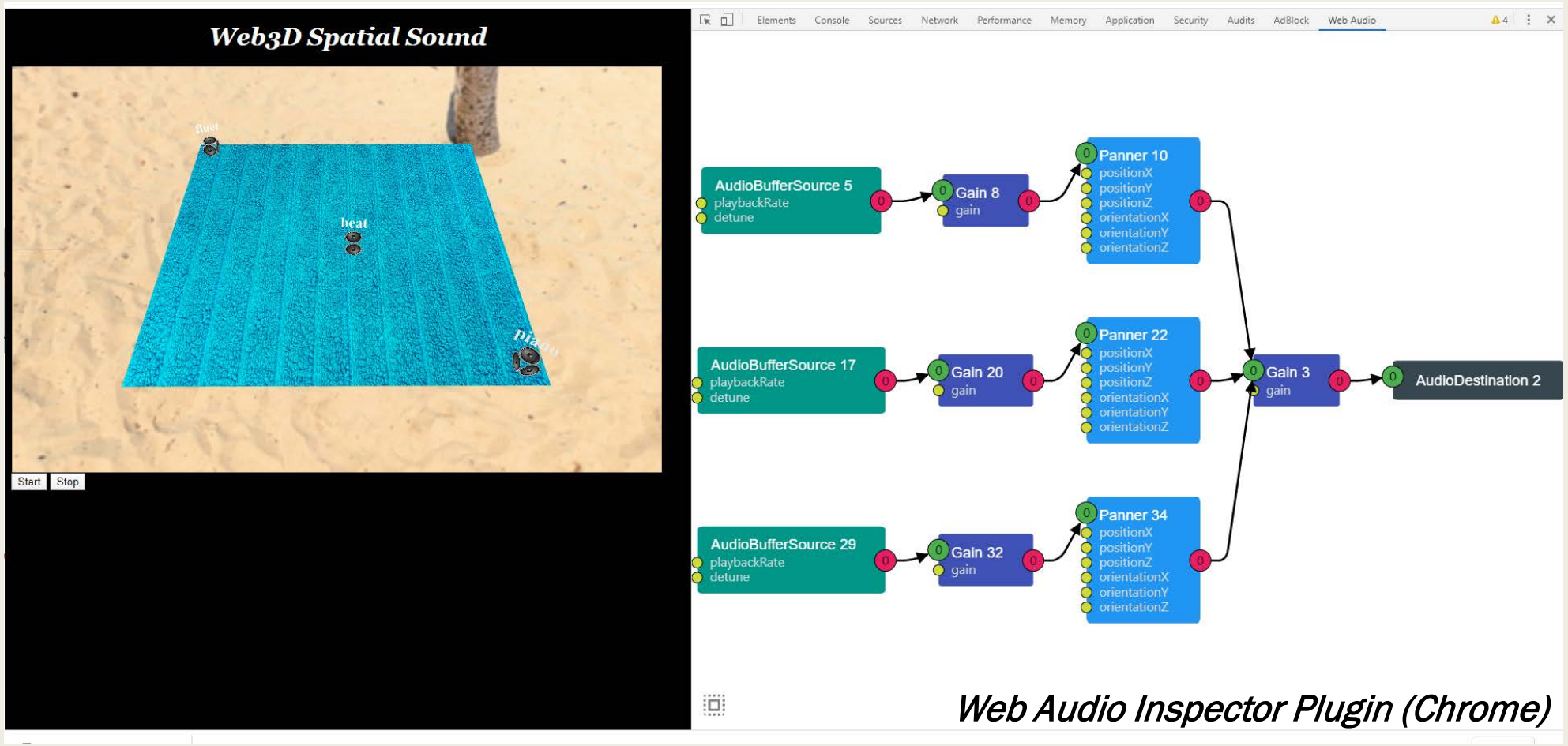


Current Status (1)

- we cloned the Web3D Project in my GitHub account, made the changes in the file sound.html
- we finished with a Pull Request

Current Status (2)

- GitHub code of a simple demo "x3domSpatialSoundDemo".
- This demo is a method for the introduction of spatial sound components in the X3DOM framework, based on the above proposed extra sound nodes in X3D for the ISO v4.



```
<Transform DEF='Audio1' translation='-900 0 -900’ >
        <Shape>
        <Appearance> <ImageTexture url="images/loudspeaker.png"> </ImageTexture>
        </Appearance>
        <box size="100 100 100"></box>\
        </Shape>…. </Shape>
        </Transform>
        </Billboard>
</Transform>
….
<Sound playbackRate='1.0'>
 <Transform USE='Audio1'/>
 <PannerNode position='0 0 0' orientation='1 0 0' velocity='0 0 0' coneInnerAngl
        e='360' coneOuterAngle='360' coneOuterGain='0' distanceModel='inverse' max
        Distance='1' panningModel='HRTF' refDistance='1' rolloffFactor='1'></Panne
        rNode>
  <X3DSoundSourceNode loop='true' url='"sound/africa/piano.mp3" "sound/africa/piano.
ogg"'/>
</Sound>
```

Next Steps

- Feedback for the Proposed Approach
- New Demos using more proposed extra sound nodes in X3D (e.g Filters)