W18. CS489/689 --Advanced Topics (Computational Sound)
Undergraduate "topics course". Check Quest, to get correct CS489!

Third offering, W18.
Previous offerings W16, W17 on Piazza.

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Audience
- 3B or later (CS370, 371, and/or Matlab/Octave experience)

- sound/ music/ math/ electronics interests

- students who want to do independent project and get course credit

- open to Math/ Physics/ Engineering with similar interests

- all necessary material will be developed in class, lectures + demo code

Grading

Lectures with term work, 50%

Term work: Experiments, homework exercises,
in the language of your choice
Matlab/Octave, Python, C, etc..

Student Project 50%

Alone or in groups

Option to present your work.

NO FINAL :)

Schedule/ Topics (preliminary)

W	Topic	Asst	Project
1	Introduction to acoustics		
2	Transducers (microphones, speakers) electronics and sound measurement	A0	
3	Analog to digital conversion (ADC)		
4	Time domain processing (mixing, reverb, compression)		
5	Fourier transform (FFT)		
6	Spectral processing (filtering, analysis, synthesis)		P0
7	Sampling and dithering		
8	Digital filtering (FIR, IIR filters)		
9	Synthesis: AM		P1
10	Synthesis: FM		
11	Other topics (students' choice)		
12	Student presentations ...		
			P2

Project topic determined/ negotiated during term,
P0 (one page proposal, week 6),
P1 (three pages, algorithm/ data ready, week 7),

Pfinal (ten to twenty pages, including figures, EOT)

Computing platforms

PC/Linux

USB interface
Mann/Vandkerkooy software
(Octave)

PC/Windows

USB interface

National Instruments "myDAQ"
- function generator
- oscilloscope
- frequency analyzer

Others:
- Raspberry Pi.
- Arduino. Teensy 3.6. ARM processor + ADC

Some past projects

Music synthesis (SW modeling of old school analog synths)
Automatic pitch detection (eg., guitar tuner, note transposer)
Analysis of bird calls ("bio acoustics")
Speech processing/ speech recognition
Music indexing (Shazam algorithm)
Recording and frequency analysis of (student's own) singing voice.
Building, testing and evaluating a new plug in for SW package X.
Time-frequency shifting of audio ("vocoder/ auto tune effects")
Realtime Audio effect programming on Arduino
Design/ measure your own loudspeakers

FAQ: Grading projects

Contributions students can make:
- collect your own data
- analyze others' data
- writing new algorithms/ code,
- evaluating others' code on multiple data sets
- building hardware

- contribute to open source software projects
- ...

FAQ: How much work is required?

Aiming for less than Realtime, Compilers, or Graphics.
But the choice is up to you ...

Case study, What is Computer Audio.

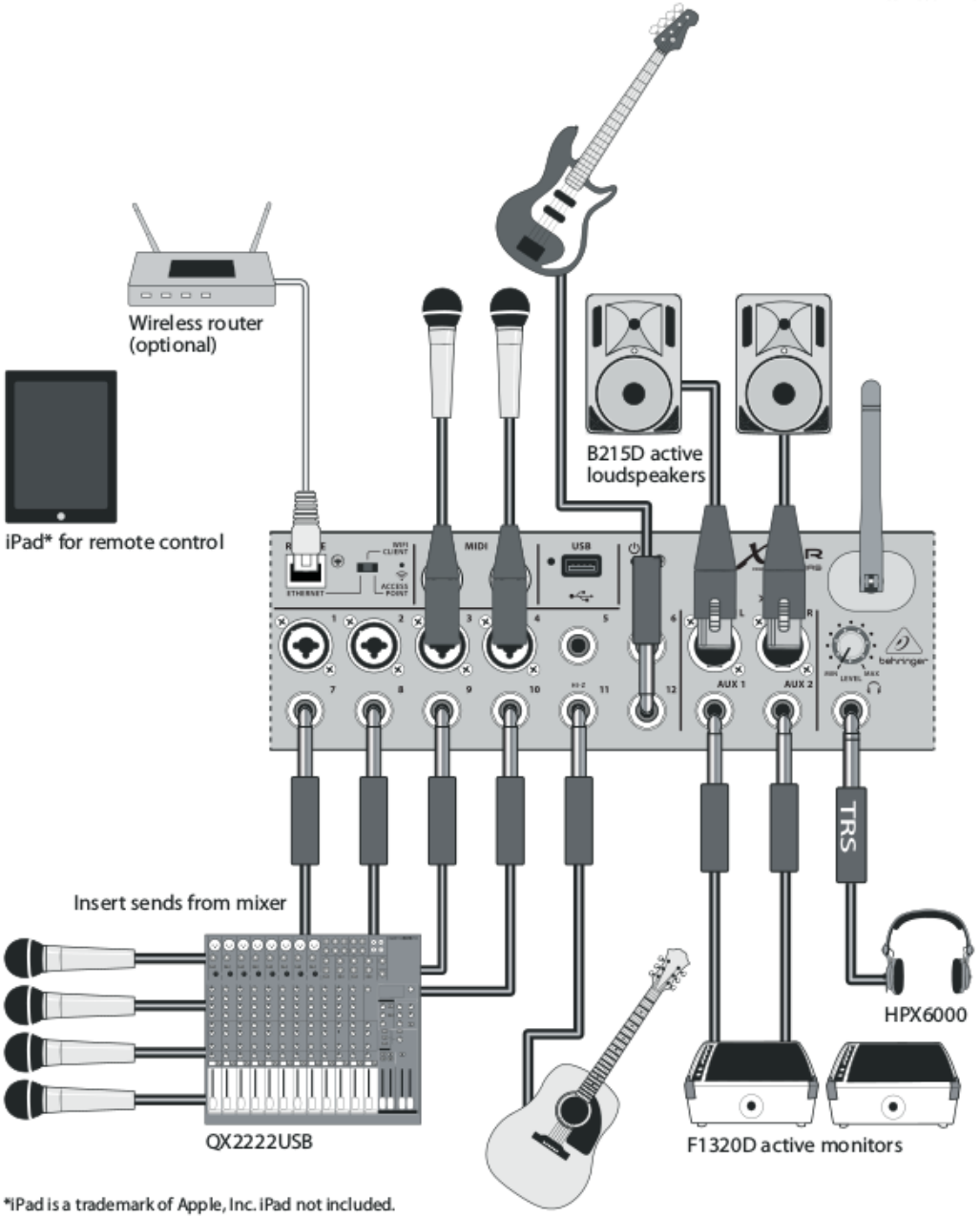
Behringer XR12 mixer, web and remote interface.


REMOTE
MIDI
USB
MAIN L
MAIN R
AUX 1
AUX 2
LEVEL

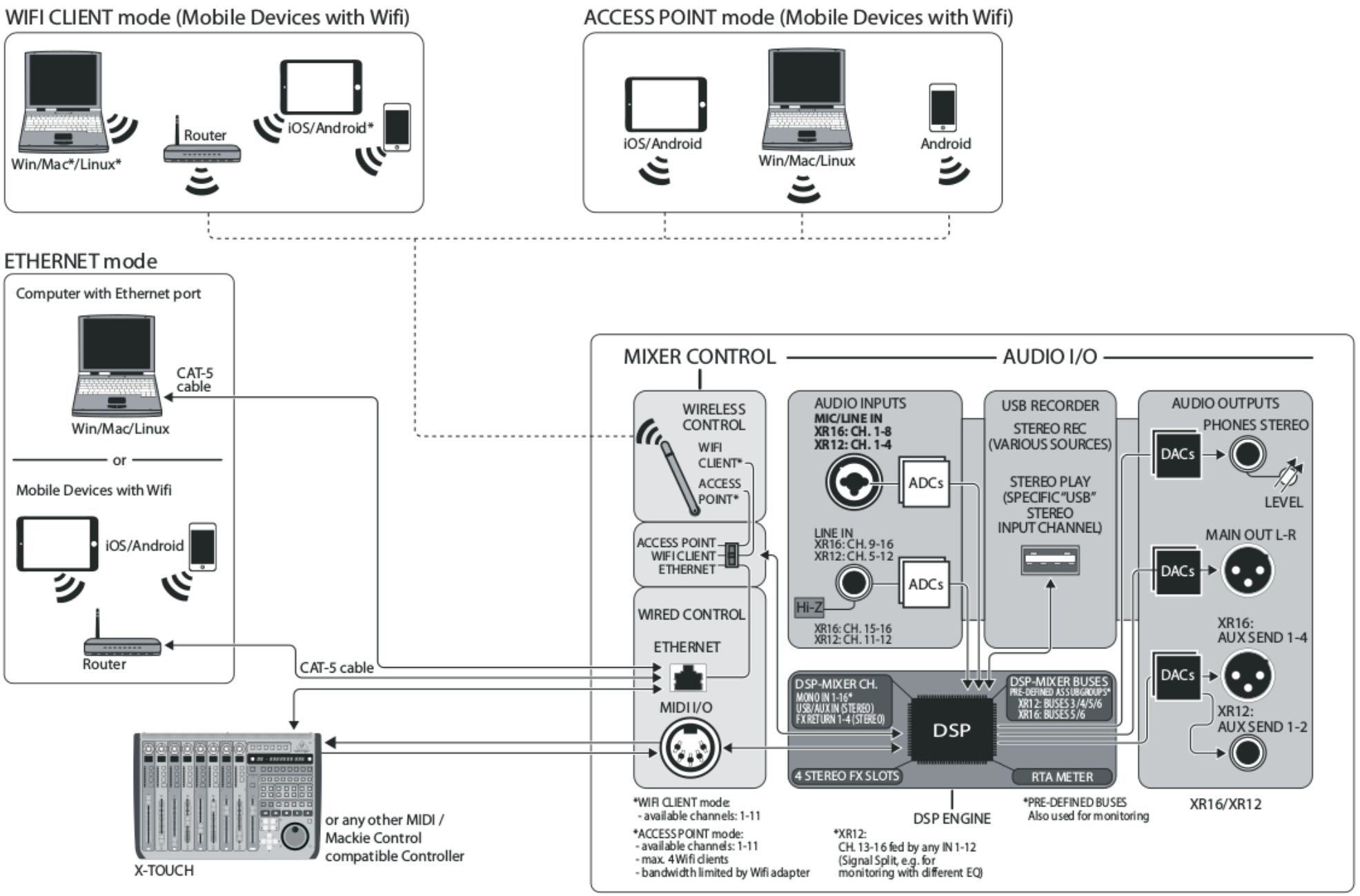
XAIR 12 avec sous-groupe de mixage

XAIR 12 mit Submischer

XAIR 12 com sub mixer



Interface



GUI interface

Block Diagram (Whiteboard)

Dynamic microphone -->

--> Preamp

--> ADC (analog to digital converter)

--> DSP (digital signal processing)

- Equalization,
- Compressor
- Reverb

---> DAC (digital to analog converter)

--> Audio amplifier

--> Speaker

Demos:
- RTAA, whistle vs. rain stick
- EQ
- All this has to happen in <1.8ms.

Audio measurement software

R. Mann and John Vanderkooy (Physics)

Open source

Implemented in Matlab & Octave

Linux, Windows, Mac

(Raspberry PI, not fast enough yet)

Stimulus: Pure tone, white noise, pink noise.

Block diagram (Whiteboard)