Overview

- **Science and Technology:**
  - Reverse Engineer the Human Auditory Pathway
- **Business:**
  - Cell-phones and Noise Reduction
- **Entrepreneur Experience:**
  - What’s it like to start a technology company?
Do we know enough about the brain to build one?

- \( \sim 10^{11} \) neurons, \( \sim 10^{14} \) synapses
- \( \sim 10^{16} \) Ops/s, \( \sim 10^{14} \) MByte
- \( \sim 20 \) W power consumption
- \( \sim 10^6 \) GOPs/W efficiency (compared with \( \sim 3 \) GOPs/W for current HW)
- \( V_{dd}\)(brain)=80mV accounts for nearly 3 orders of magnitude of power efficiency, trades power consumption against area/cost/yield \( P=CV^2f \)
- Vast variety of cell types
- Thousands of modules/regions being studied by

- \( \sim 30,000 \) neuroscientists
- **No individual knows everything.**
Dramatic increase in knowledge in last 20 years...

(van Essen and Anderson, 1990)
(Douglas and Martin, 1998), (Calvin, 1996)
Collectively, we know enough to begin…

(Kiang, Oertel, Covey, Rauschecker) (van Essen and Gallant, 1994) (Zigmond et al., 1999)
Brain-like Computing Capability by 2025

(Ray Kurzweil, *The Age of Spiritual Machines*, 1999)
Brain-like Computing Capability by 2025
Auditory Pathway

- Cortical functions: extensive pattern match, hypothesis generation and pruning, object tracking, HMM/Viterbi search, associative memory

- High-res feature detection, cross- and auto-correlation, and post-processing

- High-resolution sensory pre-processing

Real-time demos

- Lloydograph, presented live
Mobile is Noisy (Audio Demo)

- Hard to hear, hard to be heard
- Speakerphone is much worse
- Noise burns battery power & network capacity
Hear and Be Heard with Audience

Mobile Call with Audience

- Audience Voice Processor makes it easy to communicate
- Clear, comfortable voice communication anywhere
- Technology based on intelligence of the human hearing system
Reverse Engineering the Human Hearing System

Audience Voice Processor

Characterize
- Pitch
- Space
- Onset
- Time

Group
- Babble
- Taxi
- Voice
- Music
- Horn

Select
- Voice
- Inverse Fast Cochlea Transform

Echo Control

Multiple Noise Sources & Voice

Fast Cochlea Transform

Noise Suppression

Vivid Voice

Vivid Voice

Far End Voice & Noise
Audience A1010 Voice Processor

- Targeted at mid to high tier mobile phones
- “Drop-in” design for easy integration, fast Time To Market
- Supports both analog & digital audio interfaces
  - Clean signal mic output to baseband
- Flexible control interface (I²C & SPI) to all basebands
  - Works with CDMA, GSM, WCDMA, FOMA baseband platform architectures
  - API for control & configuration

Mobile Phone Block Diagram

CDMA
GSM
WCDMA
FOMA
A1010 Voice Processor
Tiny, Low Power, High Impact Chip

• Low Power, Mixed Signal IC
  - Optimized for Audience algorithms
  - Audience custom DSP & logic with on-board program and data memory
  - Digital & Analog Audio Interface
  - I²C & SPI Host (BB) Interface
  - 48-pin CSP, 0.4mm pitch
  - 15-25 mA Active
  - 30 uA Sleep

• Powerful Voice Quality Features
  - Noise suppression, AEC, Voice Equalizer

• Ease of Integration
  - Flexible microphone configuration
  - Supports all baseband chips and codecs
  - Extremely small size for minimum board space impact

• Availability
  - Now
Audience Voice Processor Benefits

• **Subscribers: excellent call quality all the time**
  - Freedom
  - Privacy
  - Respect
  - Integrated voice/data services
  - Longer talk time in noisy environments

• **Operators: bigger top line, lower cost**
  - More Minutes, Higher ARPU for integrated services
  - Reduce returns, churn & support calls
  - Enhanced network capacity
Audience Improves Voice Quality

MOS (Mean Opinion Score)

Excellent

Bad

SNR in dB

Customer Complaint Threshold

Audience Noise Suppression On

Noise Suppression Off

Source: Dynastat Test, March 2008; Using GSM AMR 12.2 Codec
FOMA™ SH705iII Phone from Sharp
Clear Talk by Audience

• Available through NTT DoCoMo April 9, 2008
• Market Leading “Triple Kukkiri Talk”™ (Clear Talk)
  - Advanced Noise Suppression
  - Acoustic Echo Cancellation
  - Voice Equalizer
  + Voice Stretch

• Japan First Market for Advanced Noise Suppression

• Multiple other design wins

FOMA is a trademark or registered trademark of NTT DoCoMo, Inc. in Japan and/or other countries.
Company Overview

• **Voice Processor Company**
  - Chips that enable high quality, noise-immune voice communications
  - Headquarters in Mountain View, California
  - Winner of Most Innovative True Mobile Startup at Mobile World Congress

• **Unique & Patented Technology**
  - Core technology based on the intelligence of the human hearing system

• **Audience-enabled mobile terminals shipping**

• **Strong Investors & Advisory Panel**
  - Including Carver Mead, Larry Rabiner, Bob Colwell, Ray Kurzweil
For Further Information

- **www.audience.com**
  - We are HIRING!
  - [http://www.audience.com/about_jobs.html](http://www.audience.com/about_jobs.html)

- **www.lloydwatts.com**

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Thank you!