Commercializing Auditory Neuroscience

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Chairman and CTO

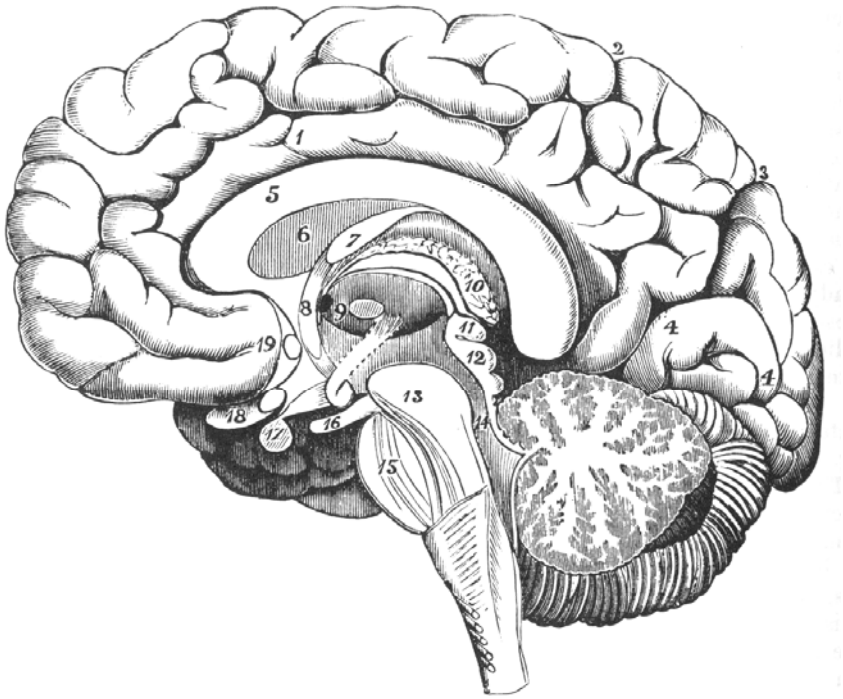
Telluride Workshop
July 3, 2008

www.audience.com
(We're HIRING!)

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?



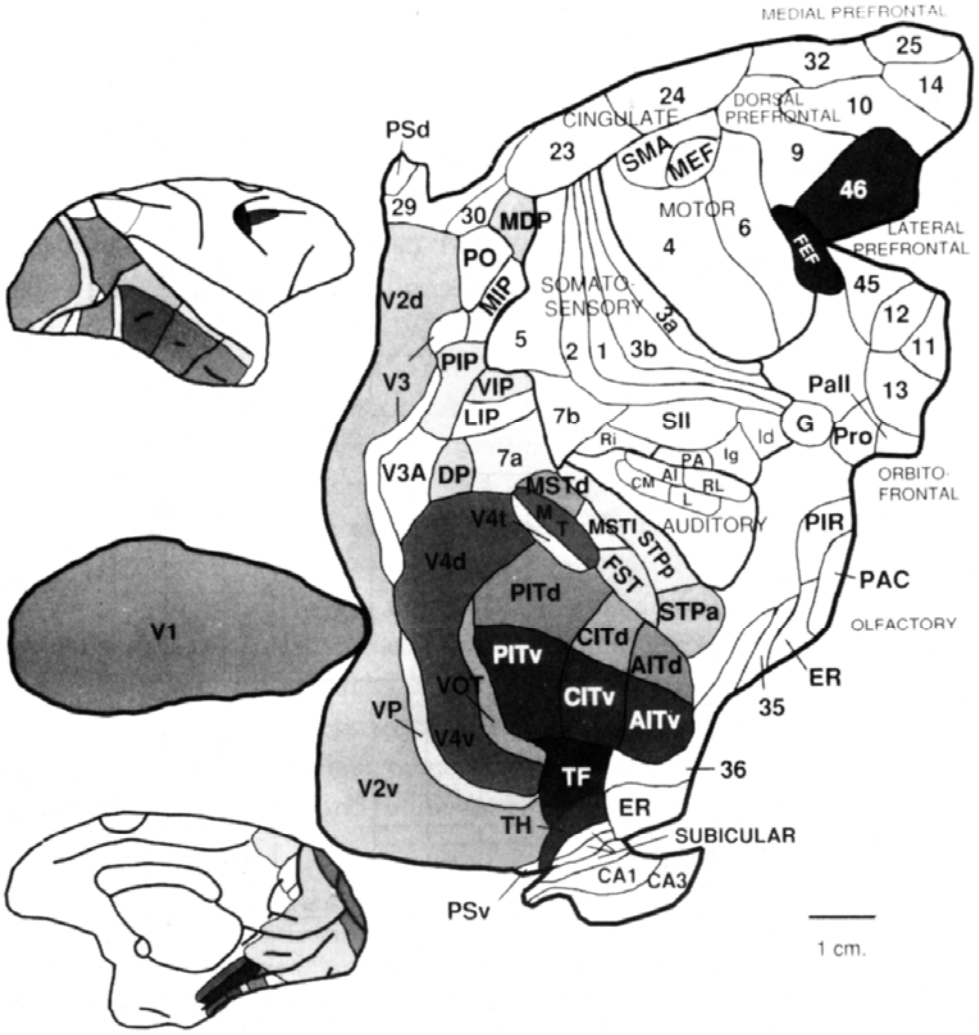
(Gray's Anatomy, 1901) (Moravec, 1998)
(Kozyrakis et al., 2001)

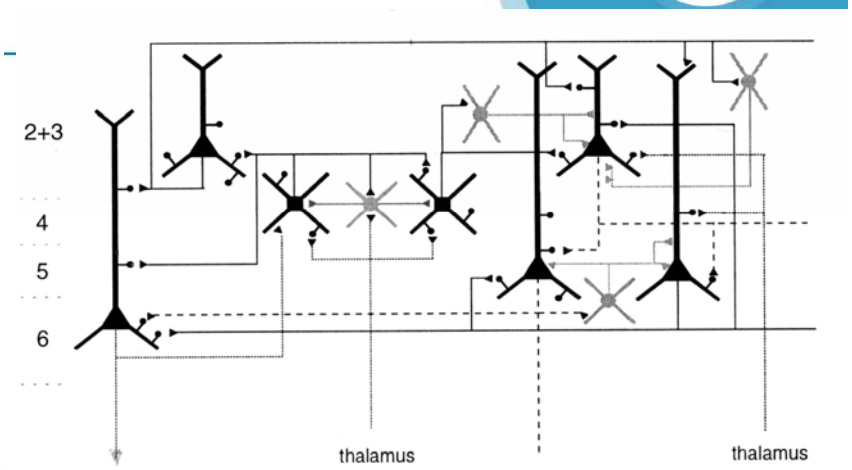
- ~10^{11} neurons, ~10^{14} synapses
- ~10^{16} Ops/s, ~ 10^{14} MByte
- ~20 W power consumption
- ~10^{6} GOPs/W efficiency (compared with ~3 GOPs/W for current HW)
- V_{dd}(brain)=80mV accounts for nearly 3 orders of magnitude of power efficiency, trades power consumption against area/cost/yield $P=CV^2f$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

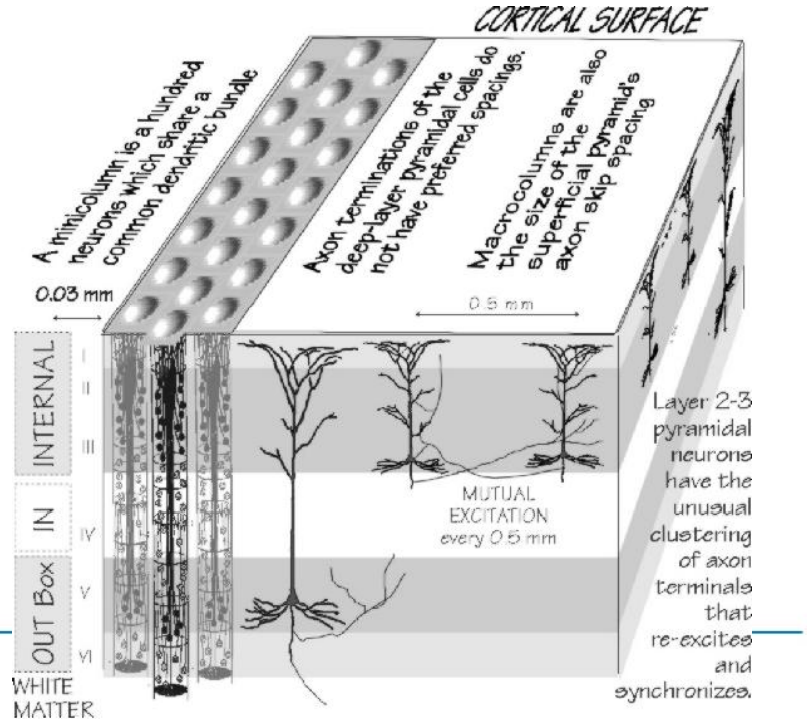
being studied by

- ~30,000 neuroscientists
- **No individual knows everything.**

Dramatic increase in knowledge in last 20 years…





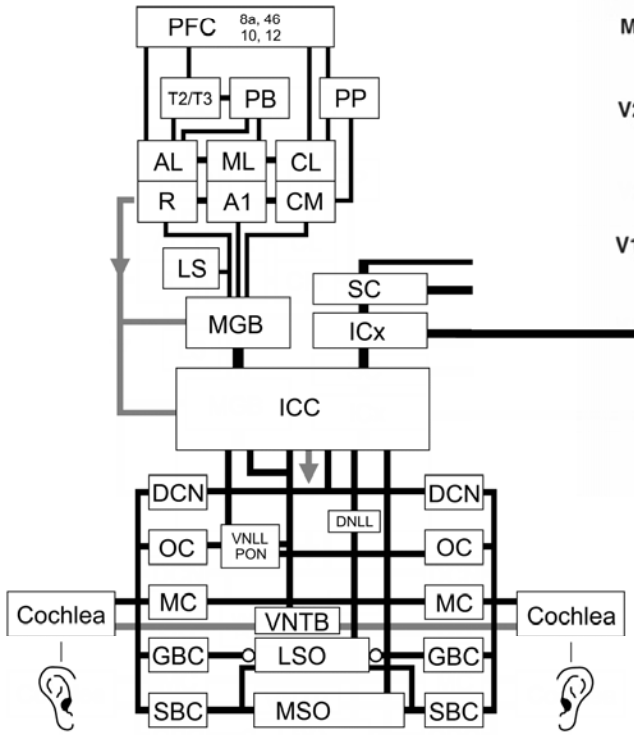


(van Essen and Anderson, 1990)

(Douglas and Martin, 1998), (Calvin, 1996)

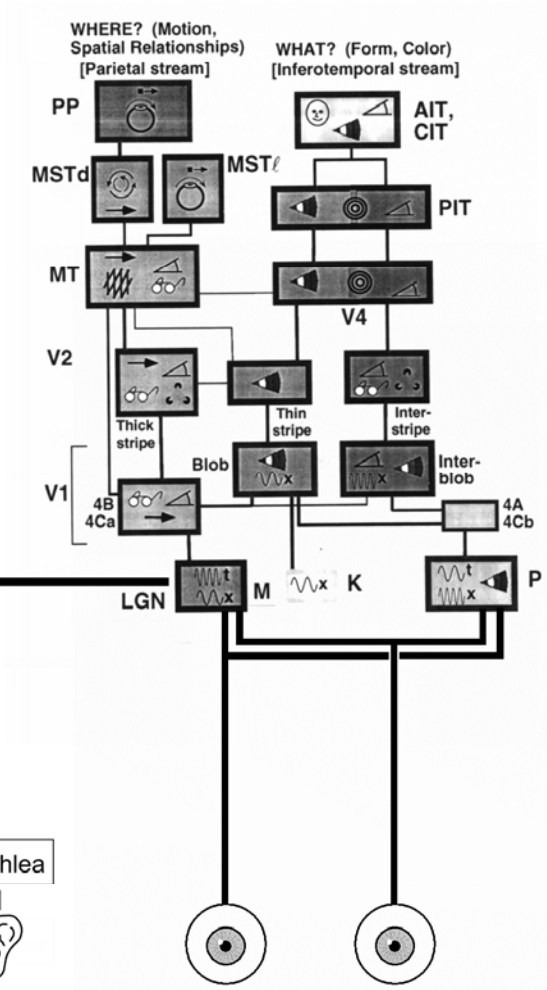
Collectively, we know enough to begin…

Auditory



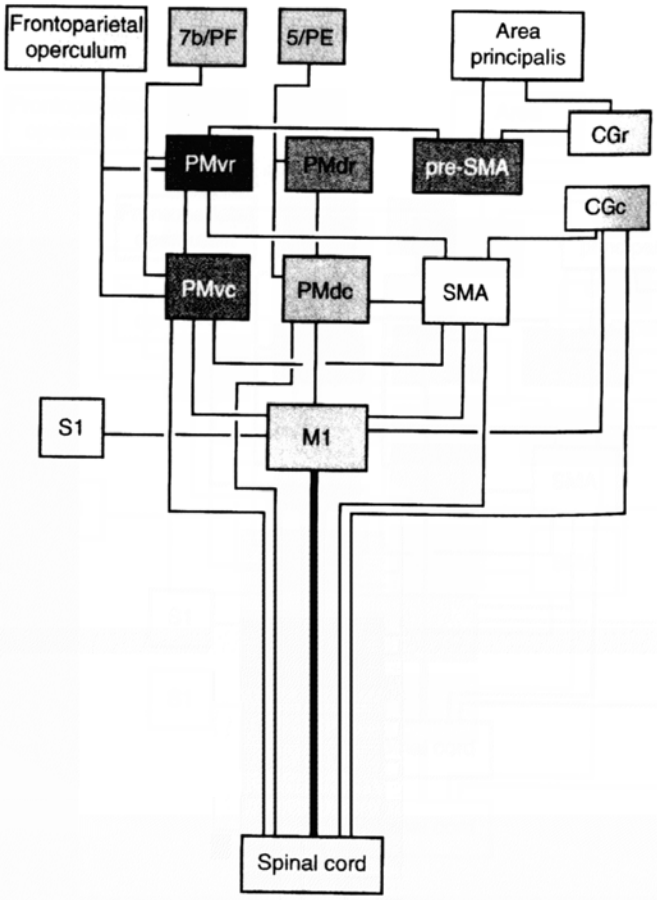
(Kiang, Oertel, Covey, Rauschecker)

Visual



(van Essen and Gallant, 1994)

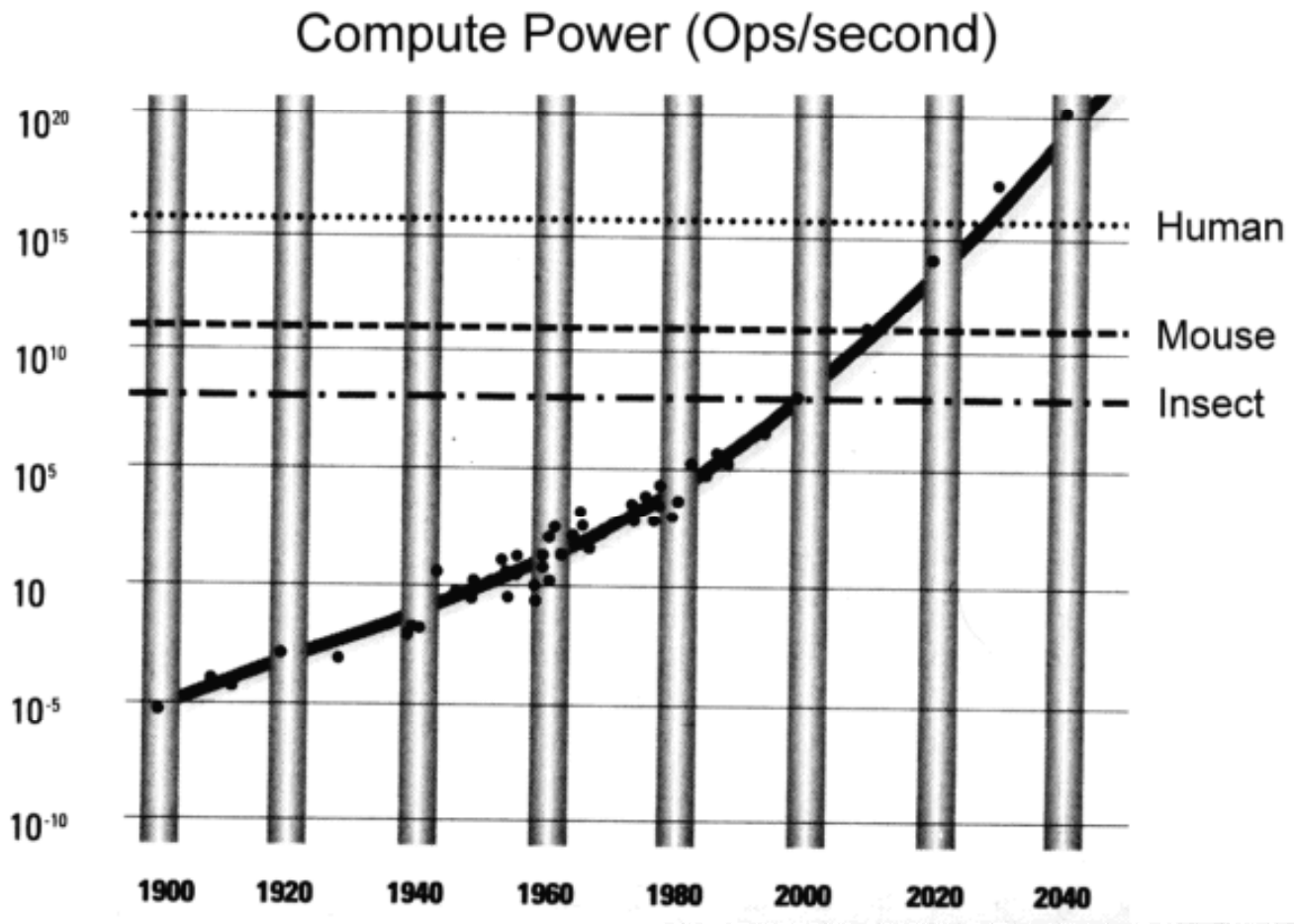
Motor



(Zigmond et al., 1999)

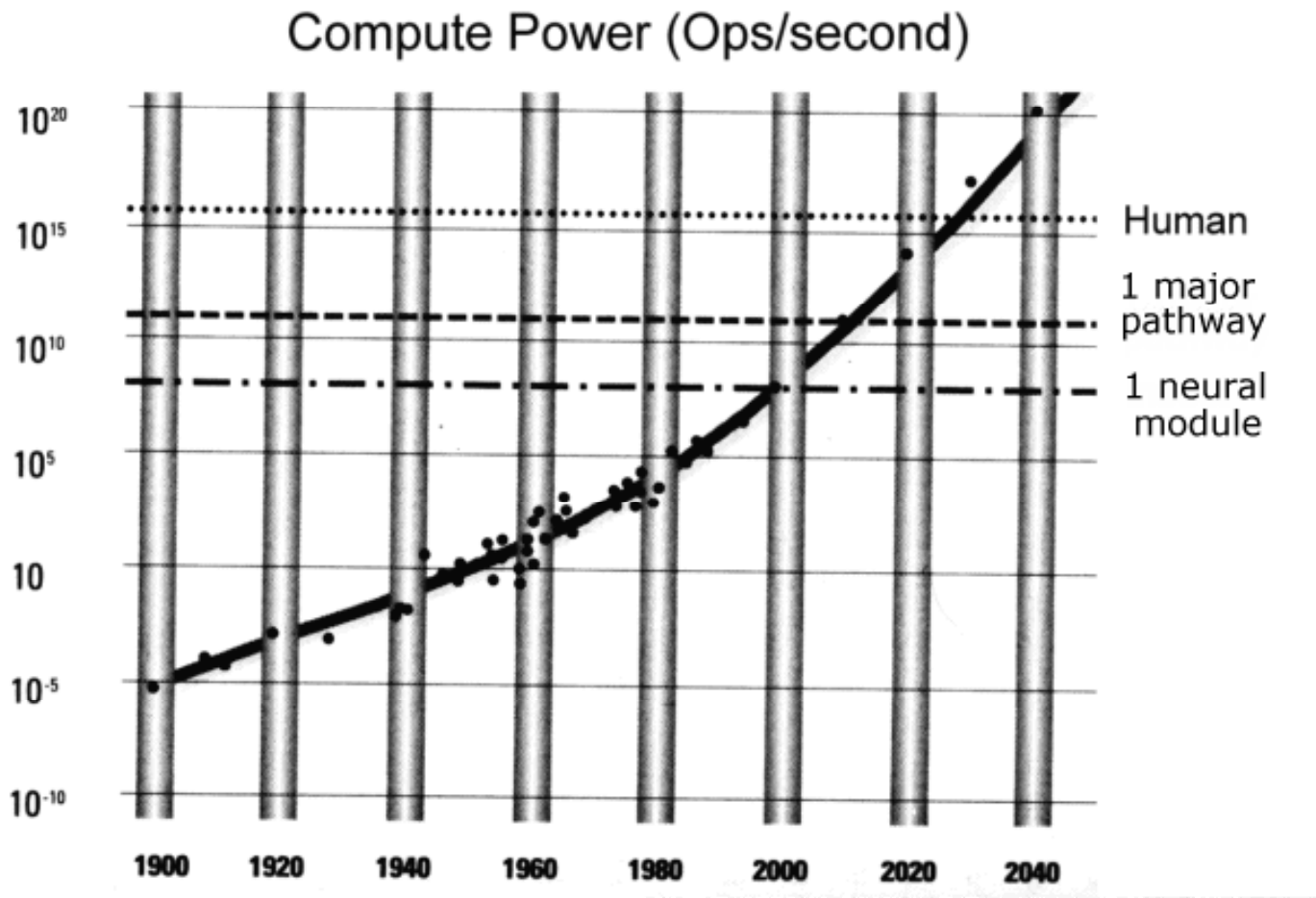
etc…

Brain-like Computing Capability by 2025

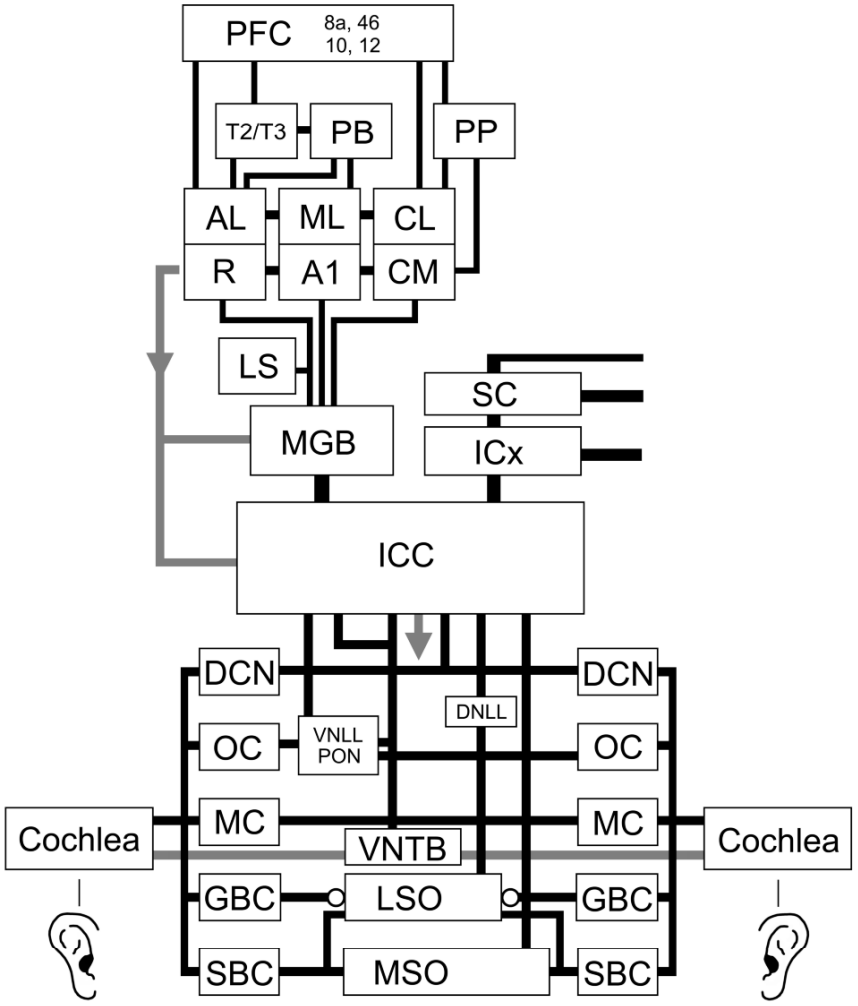


(Ray Kurzweil, *The Age of Spiritual Machines*, 1999)

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

•http://www.lloydwatts.com/wcci.pdf

Real-time demos

- Lloydograph, presented live

Mobile is Noisy (Audio Demo)

Mobile call today

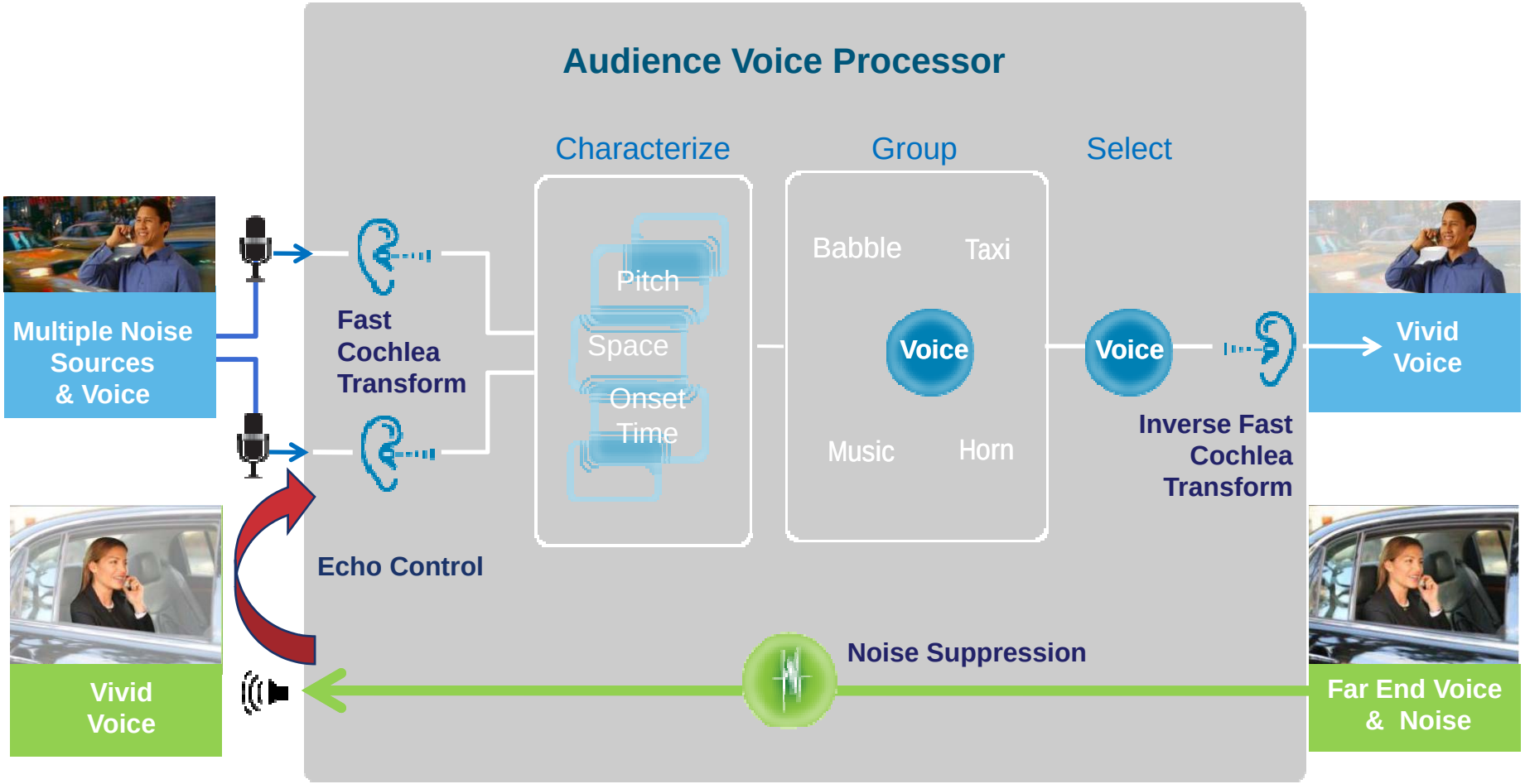
- **Hard to hear, hard to be heard**
- **Speakerphone is much worse**
- **Noise burns battery power & network capacity**

Hear and Be Heard with Audience

Mobile Call
with Audience

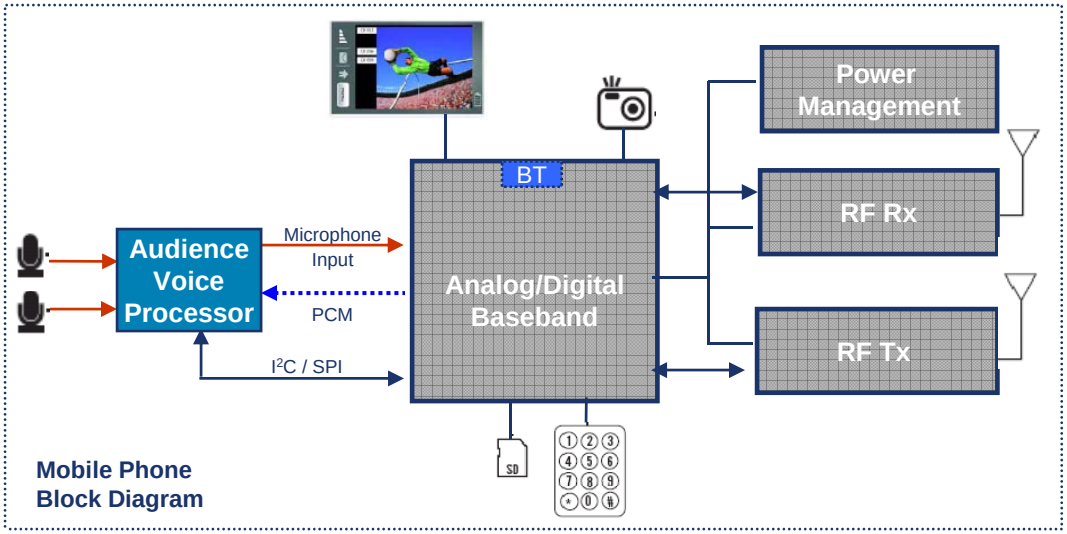
- **Audience Voice Processor makes it easy to communicate**
- **Clear, comfortable voice communication anywhere**
- **Technology based on intelligence of the human hearing system**

Reverse Engineering the Human Hearing System



Audience A1010 Voice Processor

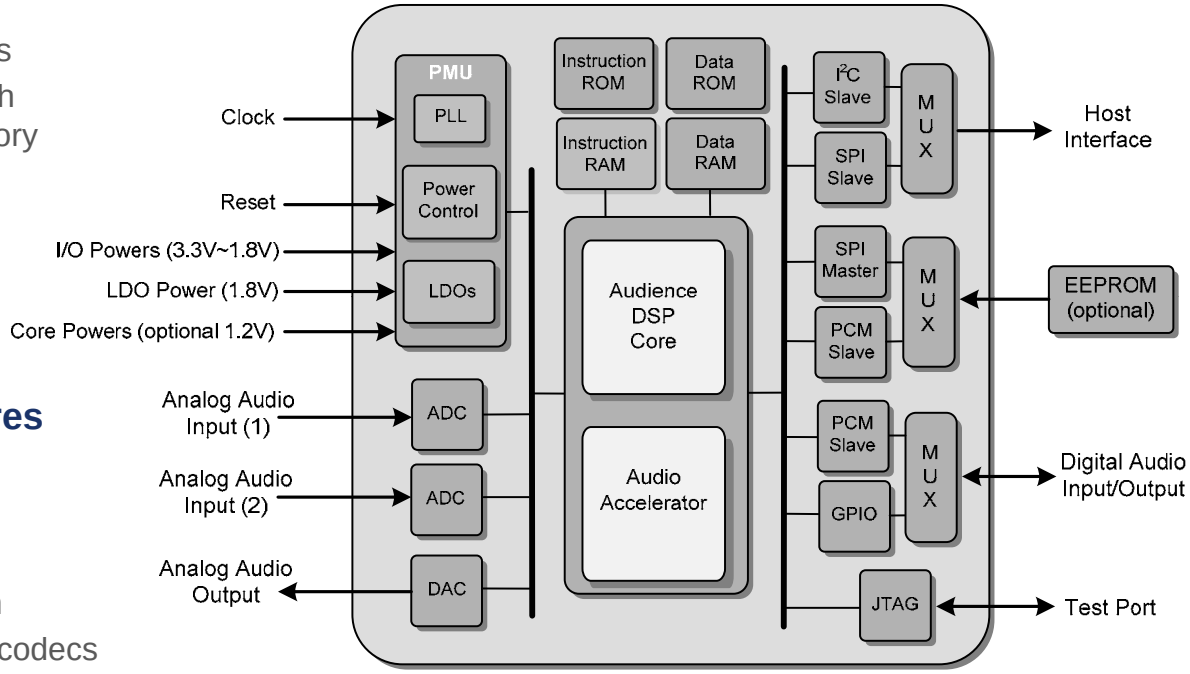
- **Targeted at mid to high tier mobile phones**
- **“Drop-in” design for easy integration, fast Time To Market**
- **Supports both analog & digital audio interfaces**
  - Clean signal mic output to baseband
- **Flexible control interface (I²C & SPI) to all basebands**
  - Works with CDMA, GSM, WCDMA,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



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

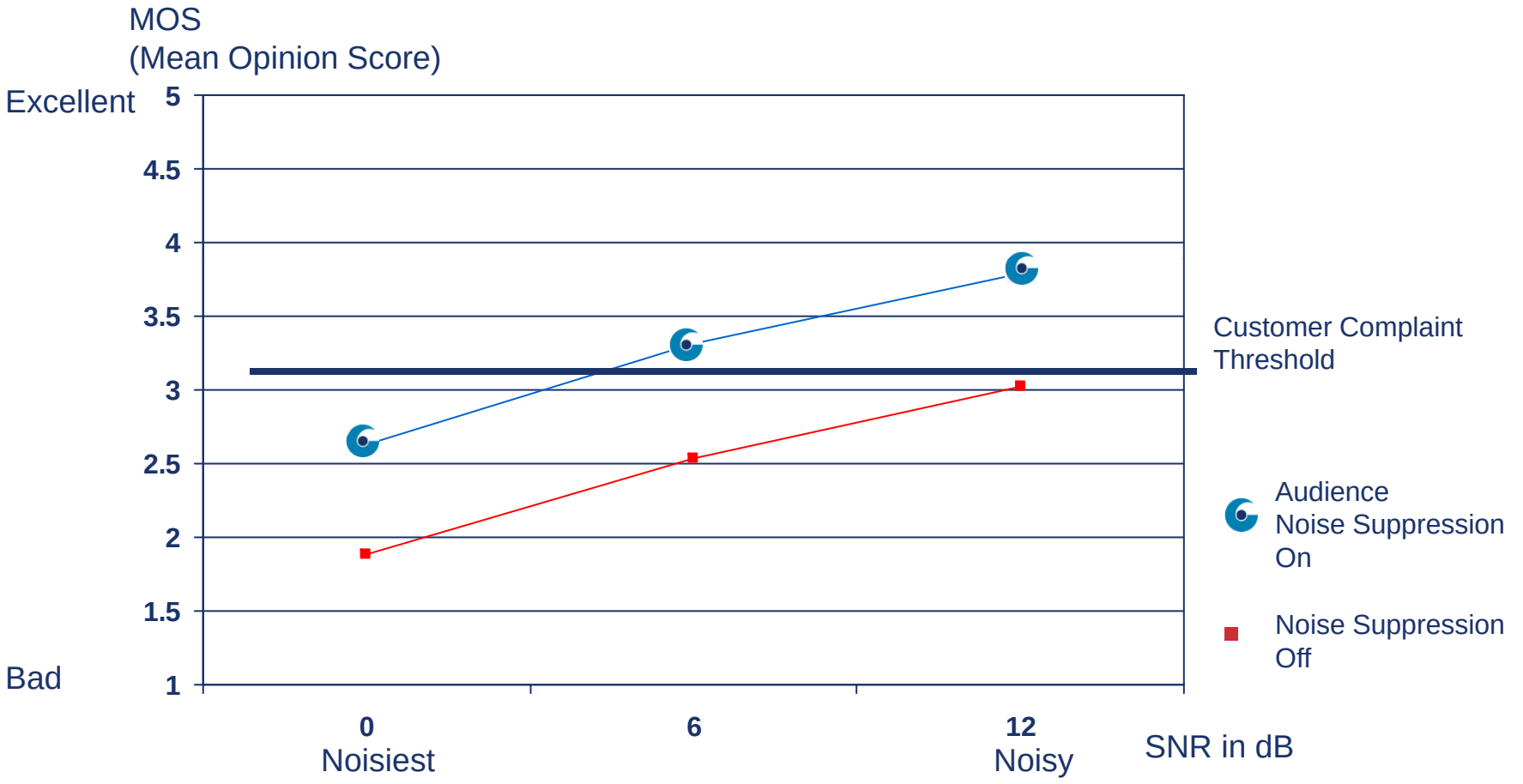


Audience Voice Processor Benefits

- **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



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

VULCAN Capital

NEA. Performance at Every Stage

TALLWOOD Venture Capital

VentureTech Alliance

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Audience™

Thank you!