Enabling Embedded AI for Healthcare

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Presentation Agenda

- Intro - What do we need?
- Device categories for personal healthcare
- What is required to make these devices happen?
- Device categories - examples
- Challenges
- Key elements of an Enabling SoC
- How VeriSilicon can help?
- Conclusion

VeriSilicon – A SiPaaS Company

What we do

- IP-centric
- Platform-based
- End-to-end turnkey service

What we don't do

- No fab
- No branded product
  - No NRE investment
  - Limited inventory risk

We call it **Silicon Platform as a Service**, or **SiPaaS®**

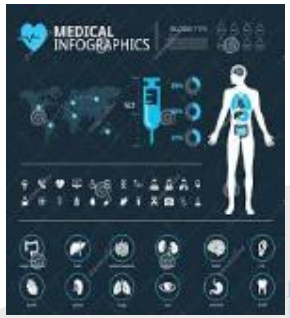
Microsoft

SAMSUNG

Google

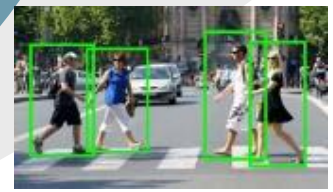
VeriSilicon IP Portfolio – Scalable STAR IPs for Licensing

- NPU
- Compute
- GPU
- ISP
- Video
- Audio/Voice
- Compression/ Encryption
- Display
- Computer Vision Imaging DSP
- FLEXA API



Server Class

Automotive



Tablets

Smartphone

Wearables & IoT

VeriSilicon is The Leader in Embedded NPU IP Since 2016

- Global Leader in Embedded NPU (Neural Processor Unit)
- First To Introduce Programmable, Scalable, High Performance, Low Power NPU
- First NPU To Support Common Neural Network plus OpenCL
- Leading in number of licensed customers (30+)
- Leading in number of SOC designs engaged (50+)
- Leading in embedded products shipped in mass production
- VIP9000 is applied to wide range of applications in AI Vision, AI Voice, and AI Pixels
- VIP9000 expands into all major market segments

VeriSilicon Vivante NPU Engagements Market Segments & Applications

Surveillance IPC Cameras	AIOT
Smart Home	Wearable
Automotive	Industrial
Edge Sever Data Center	Mobile Phone

AI VISION **AI VOICE** **AI PIXEL**

Introduction

- Personal healthcare – why?
  - Comfort, privacy
  - Customized service, 24-7 care
  - Great improvement in quality of life
- What we need
  - Advanced AI enabled personal healthcare devices
  - Sensors, monitors, aides
  - Sensing/sensor fusion, Interpret, Alarm / Act

What Device Categories Can Help Us?

- Non-intrusive
  - Wearable, body contact, consumer devices
- Intrusive
  - Capsule camera, implants under the skin or in the body
- Semi-intrusive
  - Earbud, hearing aid

What Is Needed To Make These Devices Happen?

- **Sense**: MEMS sensors
- **Interpret**: AI engines
- **Act**: DSP engines
- **Communicate**: Wireless
- **Design**: low power / always on

Device Examples Today - Non Intrusive

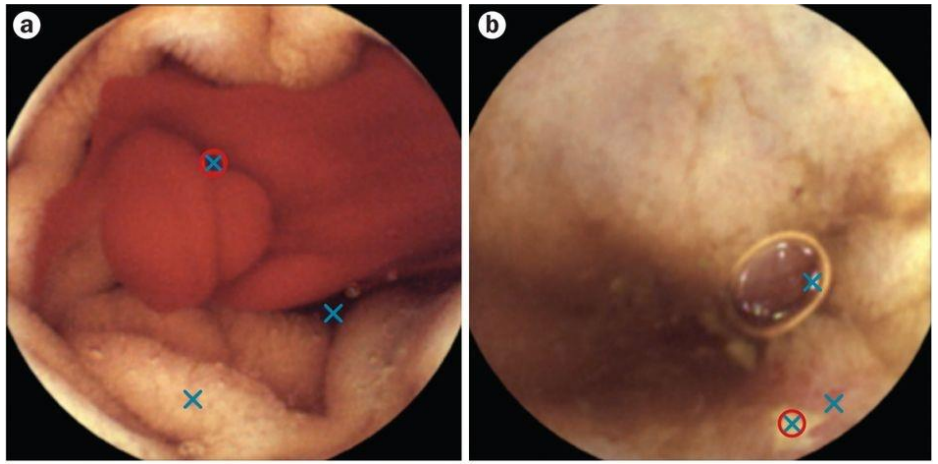
- Fitness Tracker Ring

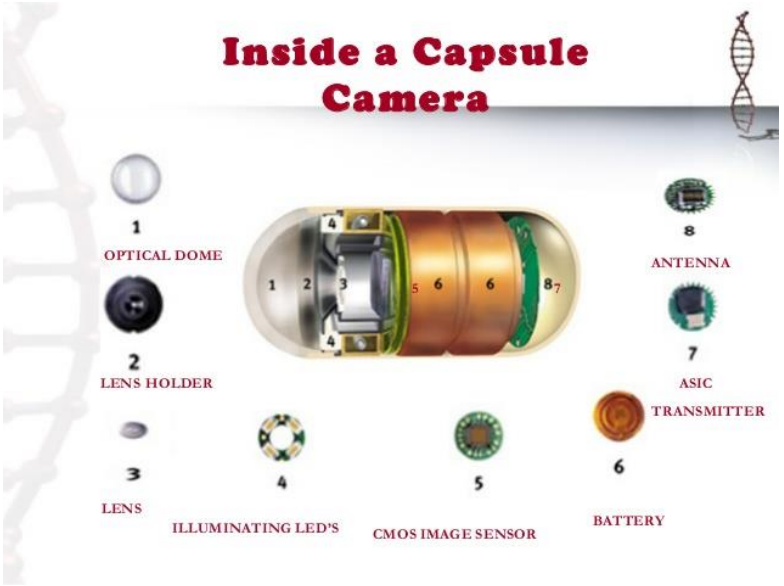
- Wrist band

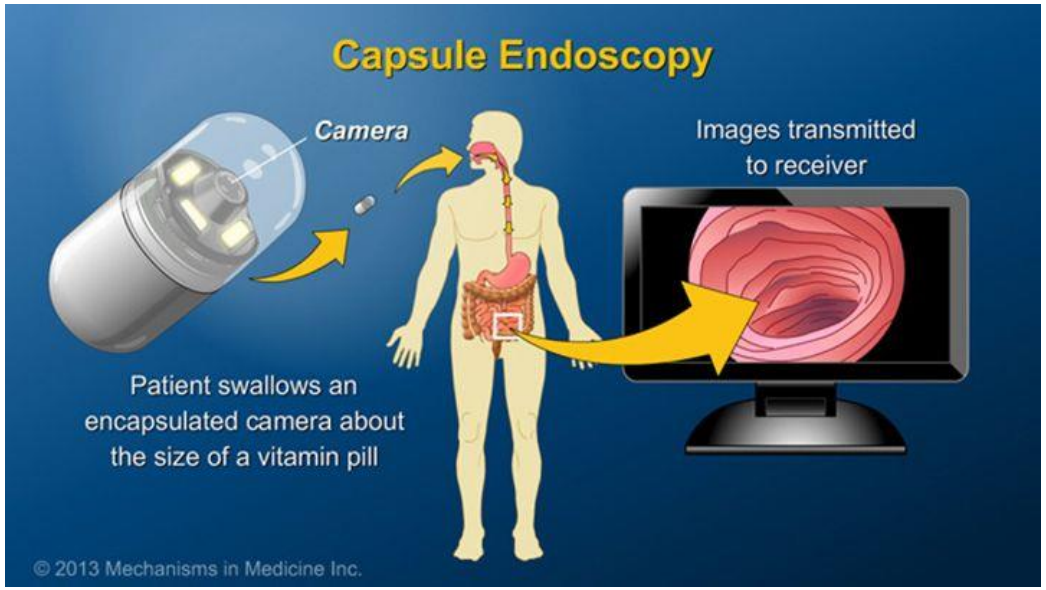
- Chest band

Intrusive Devices For Personal Healthcare

- Capsule Camera
  - Battery operated device; low power inference is crucial
  - Location detection
  - Hemorrhage and lesion detection

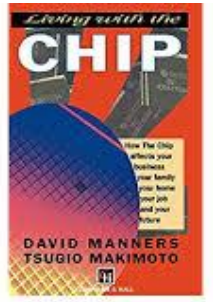






Semi-Intrusive

- Advanced Hearing aid examples:
  - In 1994, Hitachi's Dr. Makimoto spoke about his vision – a realtime language translator device
  - In 2005, *The Hitchiker's Guide to the Galaxy* suggested a solution called Babble Fish
  - At CES 2019, Google assistant does real time translation



- Moving forward, we anticipate advanced, AI-powered in-ear devices in market
  - Active noise treatement
  - AI-enabled DSP audio signal enhancement
  - AI-enabled natural user interface

Challenges

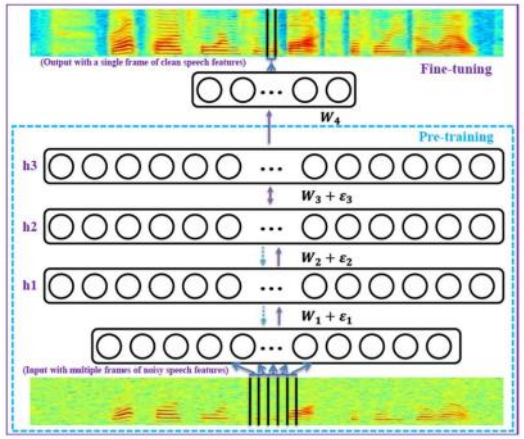
- Always On – lowest power
- Small footprint
- Efficient wireless communication
- Wireless charging and energy harvesting
- Safety and reliability to obtain FDA approval
- Security – hacker safe!

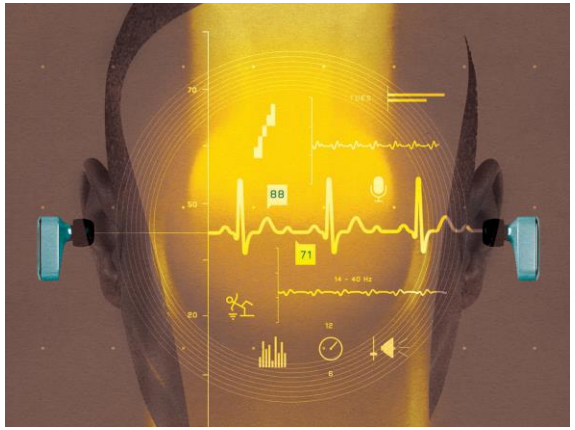
Key Elements of An Enabling SoC

- Sensor Fusion
- Wireless communication
- AI engine
- DSP engine
- Optimized memory subsystem for lowest power operation

AI Functions For True Wireless Earbud Systems (TWS)

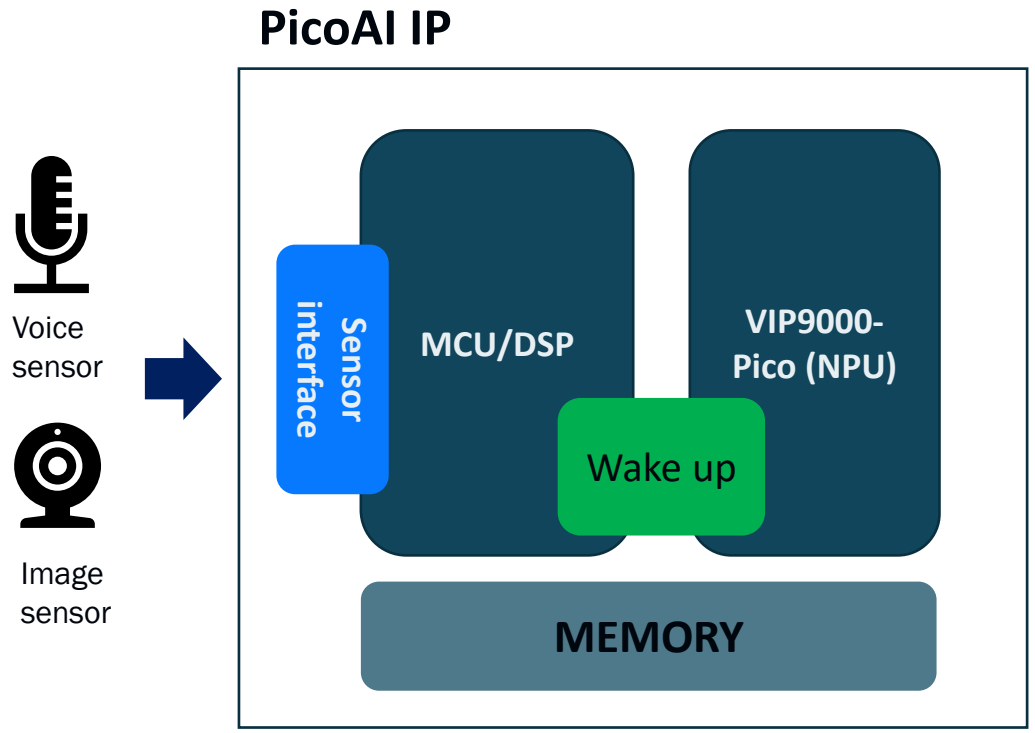
- Environmental Noise Cancellation (ENC)
  - Suppress background noise
  - Hybrid with ANC
- Wake Word Trigger
  - “OK Google”, “Alexa”…
- Voice Assistant
  - Speaker identification
  - Voice command recognition
  - Speech recognition, machine translation
- Biometric Sensor Fusion
  - Heart rate, temperature, EKG, VO2…





Optimizing System Design – Example: VeriSilicon PicoAI IP

- Tiny AI Solution for Mass Market AIOT devices
  - Voice and Vision Wake up
  - AI Voice, AI Vision Applications
  - 200+ GOPS NPU (VIP9000Pico)
  - 1 mm^2 in TSMC 12nm
- Extremely low power Always-on Wakeup capability
- Highly integrated, self-contained solution
- All Wakeup operations can be achieved without DDR support
- Extremely low power design and implementation
- Low latency Wakeup
- Light weight software stack - RTOS OS, Bare Metal



System Partitioning Is Crucial – Power Hierarchy And Minimizing Memory Accesses

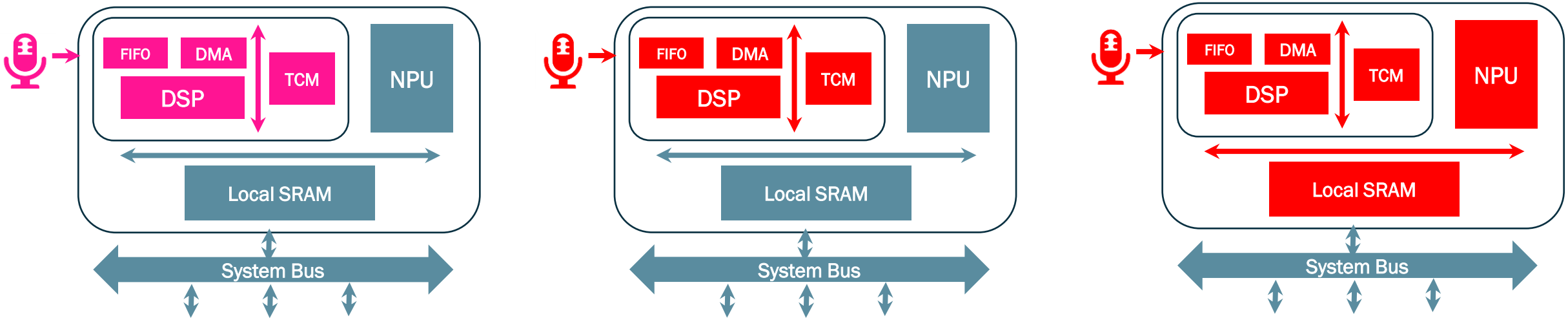
3-Level Waking Up

Sensing → Processing → AI inferencing

- Voice Activity Detection (VAD)
- ~50 uW
- 24 hours/day (Always-On)

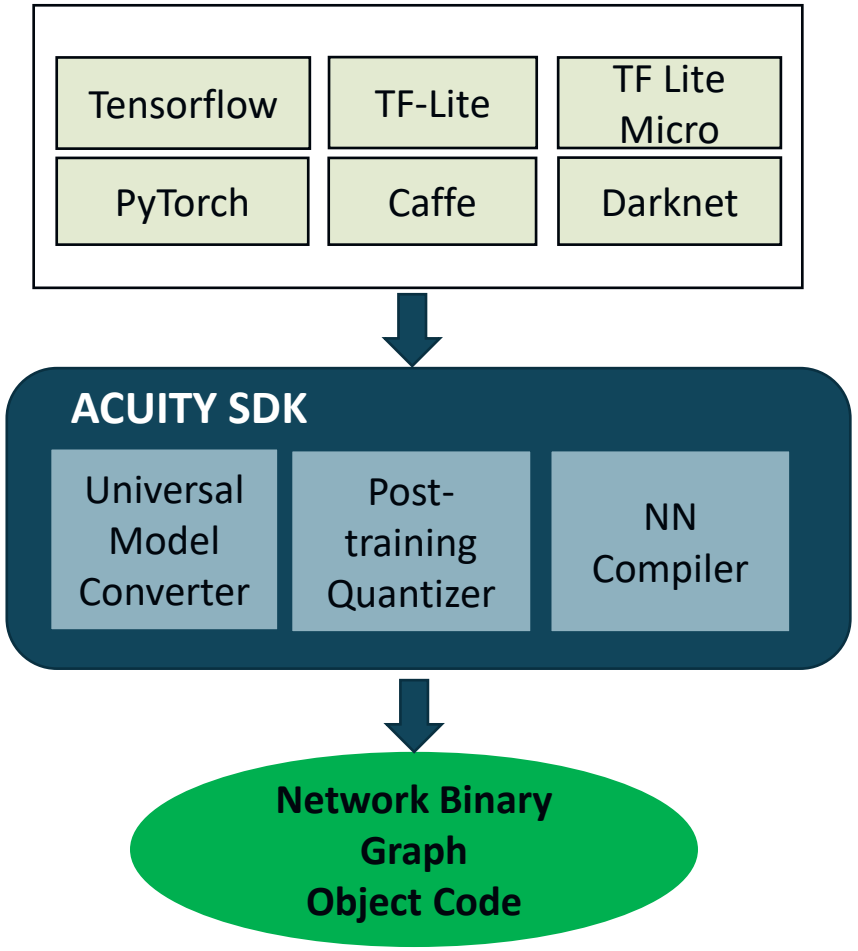
- Key Word Spotting (KWS)
- ~150 uW
- ~30 min/day

- Voice Command, ASR
- 1 mW – 10 mW
- ~1 min/day

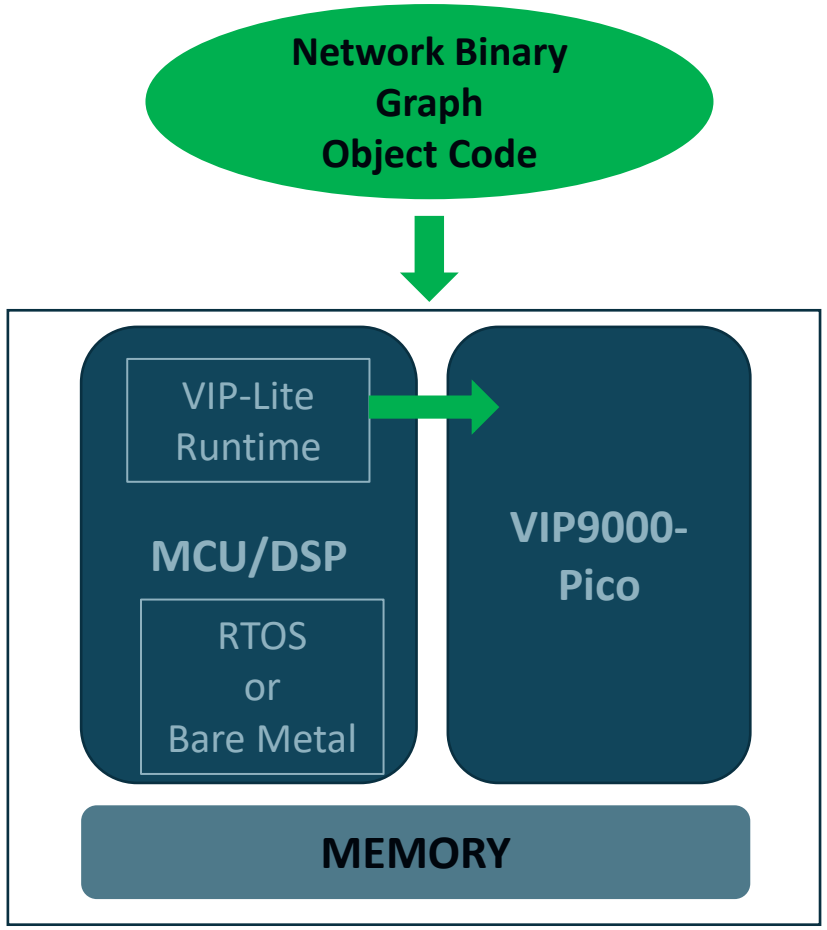


System Software Design Is Crucial – Software System for Deeply Embedded Systems

Offline Compiling on the Host



Run Time On the Target



Conclusion

- Challenges are ahead
- Solutions are starting to form
- VeriSilicon is here to help
- Let‘s make this Embedded Vision happen together!

Resources

Wearable devices:

- https://mymotiv.com/the-ring/
- https://www.t3.com/us/features/best-heart-rate-monitor

AI-Powered TWS:

- https://www.androidcentral.com/best-noise-canceling-true-wireless-earbuds

PicoAI, VIP9000, VIP9000Pico:

- http://www.verisilicon.com/en/IPPortfolio/VivanteNPUIP

ACUITY SDK:

- https://github.com/VeriSilicon/acuity-models

2020 Embedded Vision Summit

- Visit VeriSilicon's virtual booth to speak with technology experts and watch exciting demos.