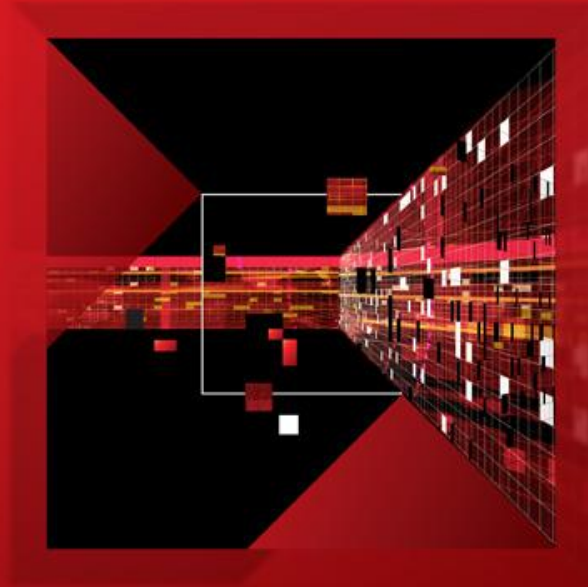


***Natural User Interface -
The Second Revolution in
Human/Computer Interaction***



Agenda

- Human-computer interface revolution #1: Interactive computing
- Human-computer interface revolution #2: Natural user interface (NUI)
- Three layer architectural model for NUI
- Platforms requirements for NUI
- Summary

Revolution – a fundamental change in the way of thinking about or visualizing something : a change of paradigm

Merriam-Webster's Collegiate Dictionary

“Though the world does not change with a change of paradigm, the scientist afterward works in a different world.”

Thomas Samuel Kuhn, [The Structure of Scientific Revolutions](#), 1962

Historical Context: Human-Computer Interface

“HCI” began as “CI”

- Early computers were not interactive
 - Machine input: Cards, tapes, console
 - Machine output: Print, plot, character CRT



CI becomes HCI - “Interactive”

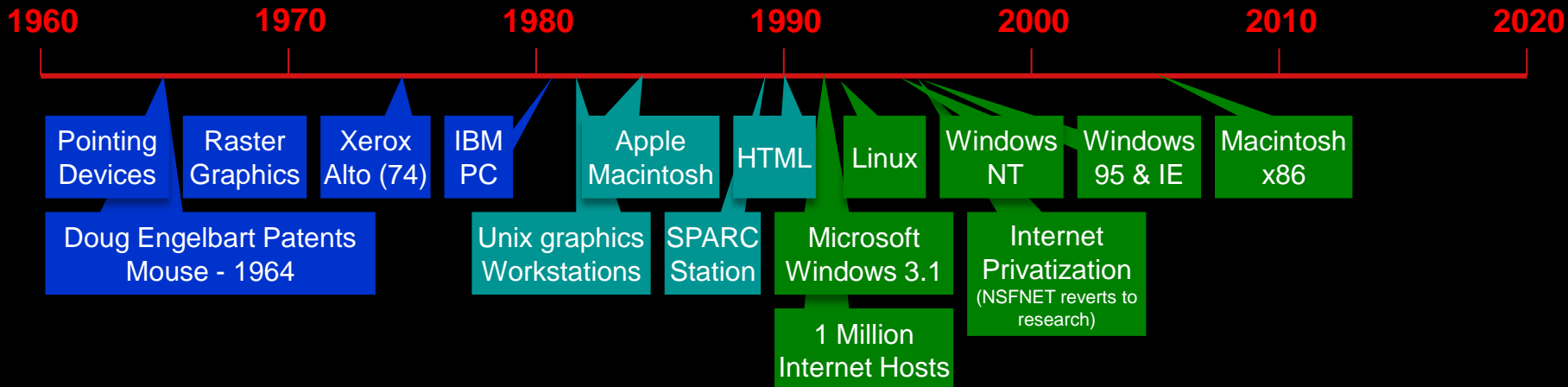
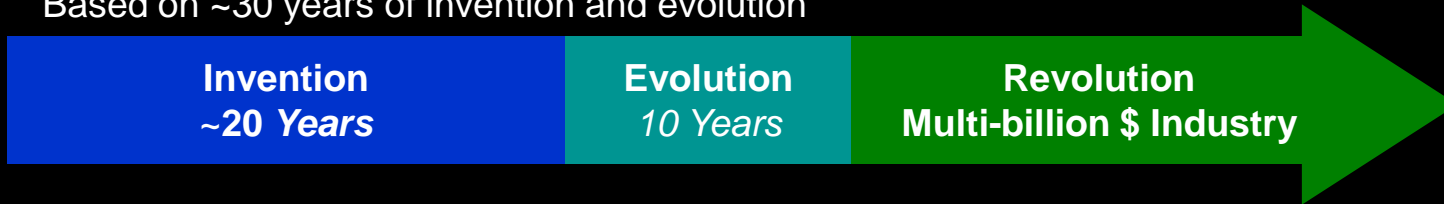
- For >40 years, we’ve been trying to make computing interactive by simulating the real world and emulating direct controls
 - Direct human input
 - Keyboards, pointing devices, handheld controllers
 - Interact with metaphorical controls
 - Computer graphics
 - Realistic rendering – metaphorical worlds, game simulations
 - Desktop, buttons, knobs, menus, forms



Result: Interactive computing

Revolution 1 | Interactive Computing

Based on ~30 years of invention and evolution



What happened in the early 90s to trigger the interactive revolution?

**Invention
and evolution**
(~30 years)

Complete platform

- CPU, GPU
- Interactive computing
- OS - Multi-purpose

Mature ecosystem

- Software framework
- Apps - lots of them
- Content - WWW

User acceptance

- Familiar, Intuitive
- Affordable
- Productive and fun

Natural User Interface
Second revolutionary change in Human/Computer Interaction

Interpret natural human communication

Computers communicate more like people

*The user interface becomes invisible
or looks and feels so real that it is no longer iconic*

NUI Proof Points

- **Multi-touch** – Gesture manipulation of graphic objects
 - Tablets, phones, multi-touch applications
 - Realism replaces icons
- **Gestures** – Interpretation of human motion
 - Handheld physical sensors – Phone sensors, Wii
 - Free space – Kinect
- **Speech** – Moving beyond “trained dictation”
 - Voice dial, voice search, Ford SYNC®
- **Sensors** – Environmental awareness
 - Make mobile devices part of your life

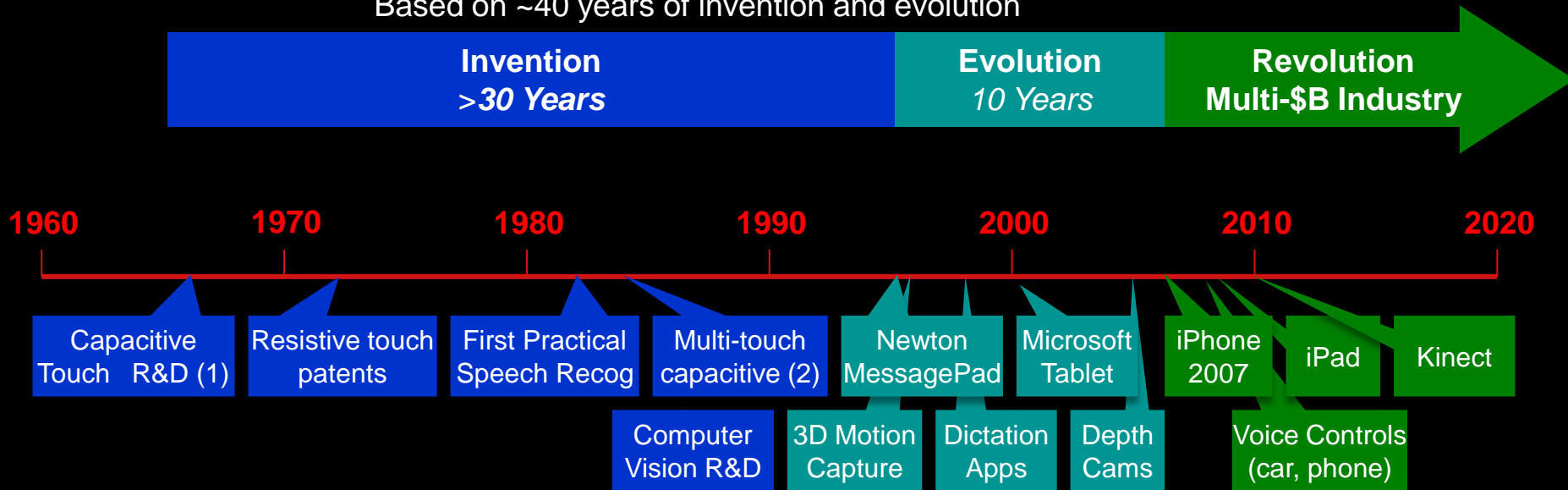


“Destination:
Nearest gas
station”



Revolution 2 | Natural UI

Based on ~40 years of invention and evolution



1 – E.A. Johnson (1967). "Touch Displays: A Programmed Man-Machine Interface" *Ergonomics* 10 (2): 271-277

2 – <http://www.billbuxton.com/multitouchOverview.html>

What's happening NOW to trigger the NUI revolution?

**Invention
and evolution**
(>40 years)

Complete platform

- CPU, GPU
- **Natural computing**
- OS - **Fit-for-purpose**

Mature ecosystem

- Software frameworks
- Apps - **tailored**
- Content - **curated**

User acceptance

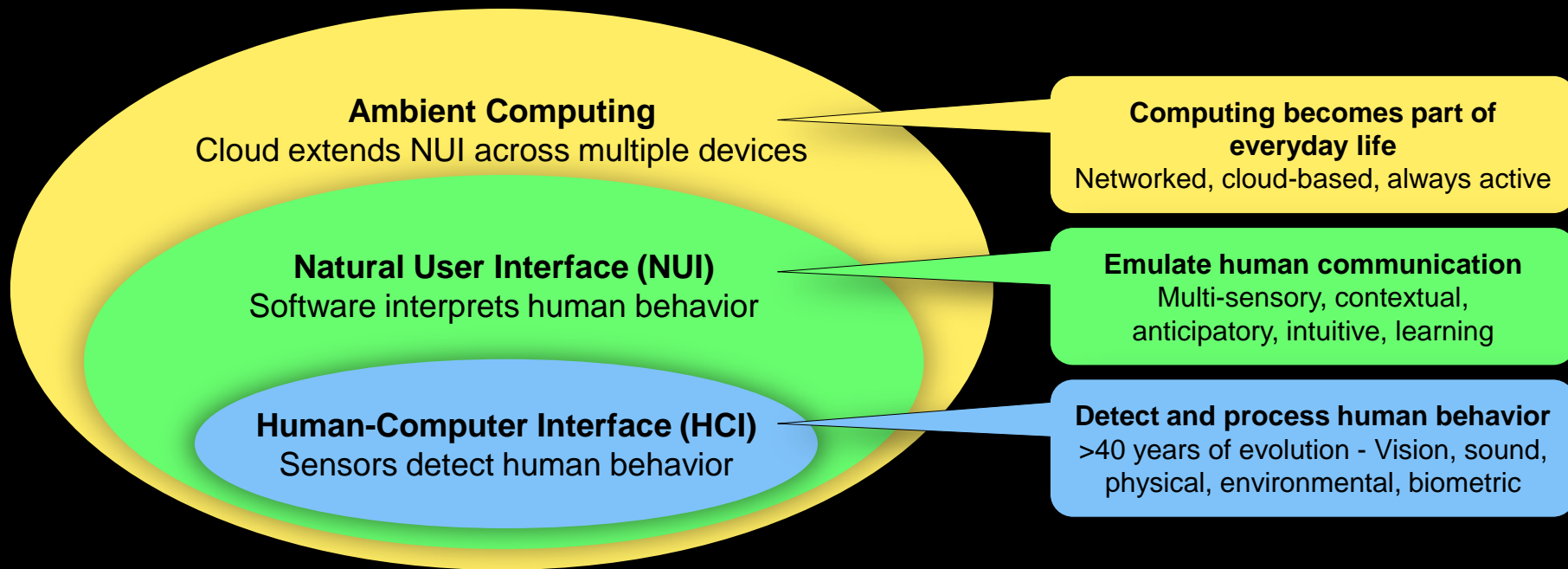
- **Natural**
- Affordable
- Productive and fun

The second “NUI Revolution” is just getting started.

Where is it heading?

***“If you don’t know where you’re going, you might not get there.”
-Yogi Berra***

Three Layer NUI Model

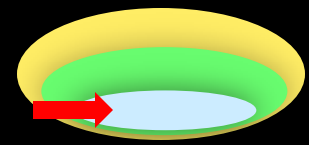


"The most profound technologies are those that disappear.

They weave themselves into the fabric of everyday life until they are indistinguishable from it."

- Mark Weiser, Xerox PARC, 1991

Three Layer NUI Model



Layer 1: HCI – Human interface devices and software *Detect and process human behavior*

Physical

- Multi-touch
- Tactile, haptics
- Game controllers
- Physical objects



Visual

- Cameras
- Depth cameras
- Stereo cameras
- Display panel video sensors
- Video input processors
- Eye, gaze tracking processors
- Gesture recognition subsystems



Auditory

- Microphones
- Array microphones
- Environmental microphones
- Audio input processors
- Ambient sound processors
(always listening)



Environmental

- GPS, RFID
- Magnetometer
- Temperature, pressure
- Gyros, accelerometers
- Molecular detection

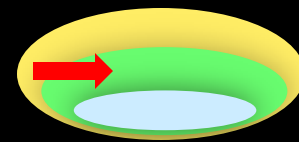


Biometric

- Brain-Computer Interface (BCI)
- Implantables
- Neuroprosthetics
- Security sensors
- Medical sensors



Three Layer NUI Model



Layer 2: NUI – Middleware and Application Framework

Translate human behavior into action

Ambient Computing Cloud Services

NUI Apps

Examples:

Collaboration	Conferencing	Education	Healthcare
Gaming	Location-based	Security	Multimedia

NUI Middleware

Examples:

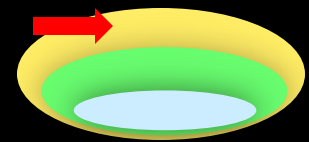
Image processing	Recognition – gestures	Point, select, manipulate	Anticipatory cues, prompts
Recognition – object, face	Recognition – voice, sound	Common controls	Ambient context

HCI Sensors

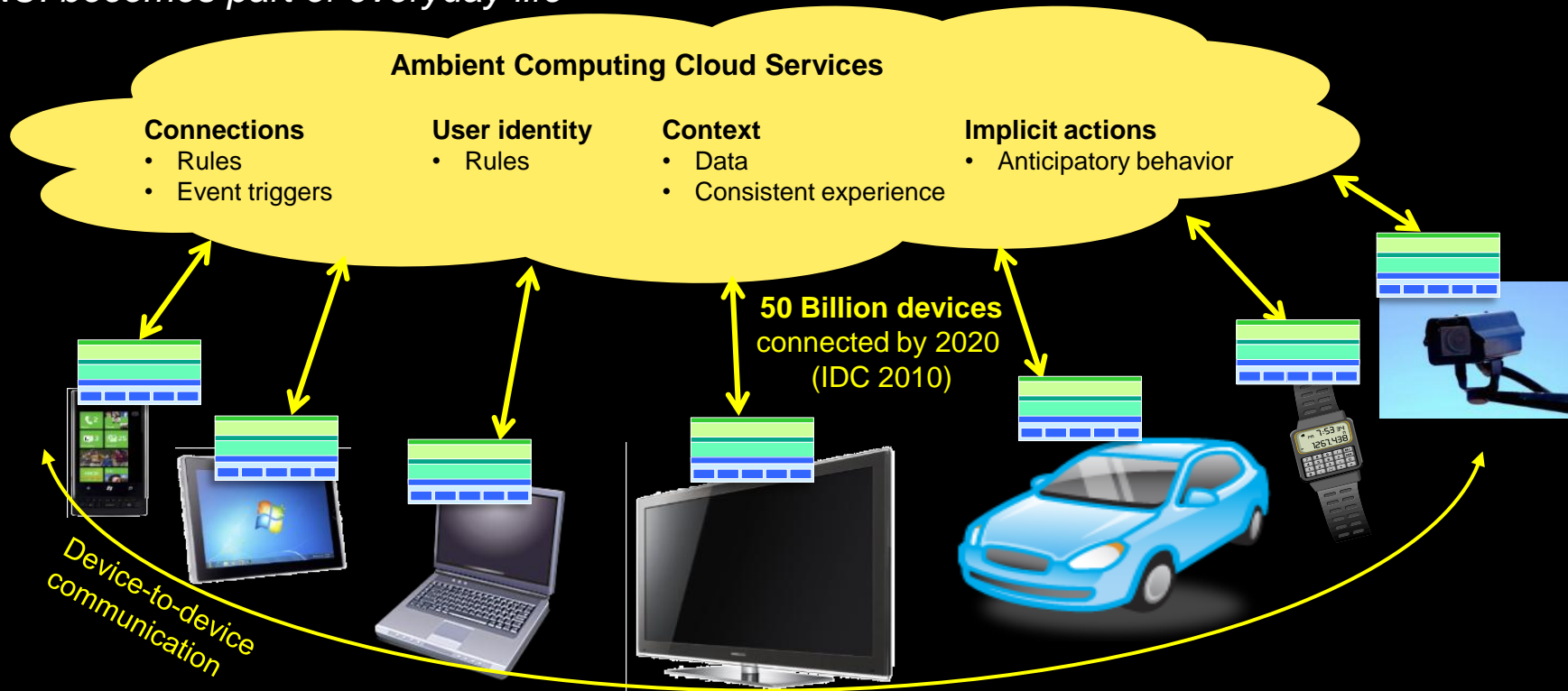
Examples:



Three Layer NUI Model



Layer 3: Ambient Computing – Orchestrate billions of devices
NUI becomes part of everyday life

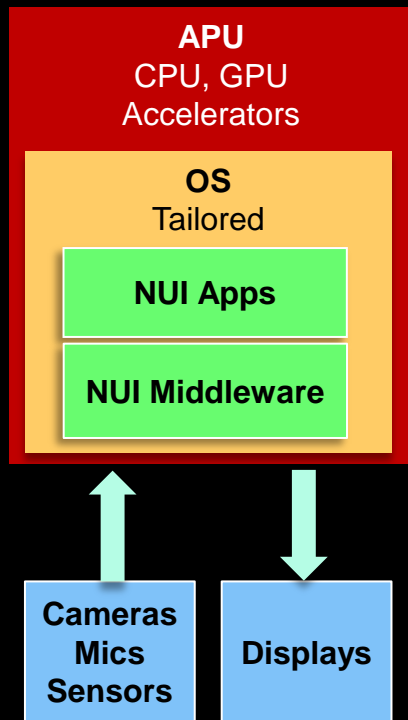


“Revolutionary” Platforms for NUI

Revolutionary Platforms for NUI – Characteristics

Silicon platform requirements:

- High performance CPU, GPU
- Graphics – high “realism”
- Heterogeneous processing
- Deep optimization for computer vision
- Video processing accelerators
- Audio processing accelerators
- Extremely low latency
- Performance for anticipatory behavior
- Efficient video and audio I/O
- Balance performance and power
- Power efficiency (100% duty cycle)



System platform requirements:

- APU sized to the target NUI experience
- Optimize to accelerate NUI algorithms
- Long term: Custom accelerators, I/O
- OS tailored to the NUI experience
- Application ecosystem framework, NUI enabled
- Apps designed specifically for NUI ecosystem
- Apps optimized for middleware and platform
- Middleware optimized for the platform
- Examples: OpenCV, OpenNI, Kinect SDK, Kivy, IISU (SoftKinetic), Cocoa, ...
- High bandwidth, power efficient interfaces
- High resolution, high performance sensors
- High realism – “natural” graphics and audio

Revolutionary Platforms for NUI

Design objectives: What's needed for a “natural” user experience?

What are developers compromising?

Examples: Gesture, sound/voice

Technique	Objective	Compromises	Platform requirements
Gesture	Wide field of view, HD video	Narrow view, motorized tilt/pan	<ul style="list-style-type: none">• Local processing• Large computational power• GPU compute• High resolution cameras• Specialized lenses• Software lens correction• Efficient camera interface• Camera video pre-processing
	Large depth of field	Limited depth range	
	Multi-user tracking	Single user	
	Background object immunity	Assume clean background	
	Extremely low latency	Latency-tolerant apps	
	Detailed body models	Specific body parts	
	Low power consumption	Limited duty cycle	
Sound and Voice	Large vocabulary	Keywords only	<ul style="list-style-type: none">• Local processing• Large computational power• GPU compute• Array microphones• Room microphones• Audio input pre-processing
	Speaker independence	Limit vocabulary & accuracy	
	No training	Per-user training	
	Multi-user isolation	Single user	
	Real-time speech recognition	Compromise user experience	
	Ambient sound classification	Treat as noise	

Summary:

- **NUI is a revolution**, not an incremental change. It's just starting now and it'll play out over the next 20 years
 - *User interfaces are becoming less visible as computers communicate more like people*
- **NUI requires significant processing power**
Intuitive, natural, anticipatory, no “training”, multi-sensory, multi-user, multi-cultural
- **NUI requires acceleration – don't compromise the user experience**
 - *GPU acceleration can be 10..20X more efficient on data-parallel algorithms*
 - *Yes, you have to write data-parallel code*
- **Go for mass markets**
 - *Consumers love this stuff. Think beyond specialized niche markets*
- **Help us optimize APUs for NUI**
 - *We're just gettin' started!*

Disclaimer & Attribution

The information presented in this document is for informational purposes only and may contain technical inaccuracies, omissions and typographical errors.

The information contained herein is subject to change and may be rendered inaccurate for many reasons, including but not limited to product and roadmap changes, component and motherboard version changes, new model and/or product releases, product differences between differing manufacturers, software changes, BIOS flashes, firmware upgrades, or the like. There is no obligation to update or otherwise correct or revise this information. However, we reserve the right to revise this information and to make changes from time to time to the content hereof without obligation to notify any person of such revisions or changes.

NO REPRESENTATIONS OR WARRANTIES ARE MADE WITH RESPECT TO THE CONTENTS HEREOF AND NO RESPONSIBILITY IS ASSUMED FOR ANY INACCURACIES, ERRORS OR OMISSIONS THAT MAY APPEAR IN THIS INFORMATION.

ALL IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE ARE EXPRESSLY DISCLAIMED. IN NO EVENT WILL ANY LIABILITY TO ANY PERSON BE INCURRED FOR ANY DIRECT, INDIRECT, SPECIAL OR OTHER CONSEQUENTIAL DAMAGES ARISING FROM THE USE OF ANY INFORMATION CONTAINED HEREIN, EVEN IF EXPRESSLY ADVISED OF THE POSSIBILITY OF SUCH DAMAGES.

AMD, the AMD arrow logo, and combinations thereof are trademarks of Advanced Micro Devices, Inc. All other names used in this presentation are for informational purposes only and may be trademarks of their respective owners.

© 2011 Advanced Micro Devices, Inc. All rights reserved.