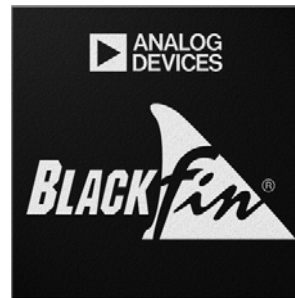


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# DSP Primer & Considerations

## Форум DEDF'2009 Minsk

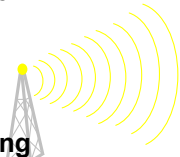
Johannes Horvath  
TBDM EU,EEU,RUSSIA



# Example DSP Applications....

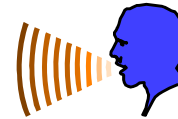
## COMMUNICATIONS

- Echo Cancellation
- Digital PBXs
- Line Repeaters
- Modems
- Global Positioning
- Sound/Modem/Fax Cards
- Cellular Phones
- Speaker Phones
- Video Conferencing
- ATMs
- Wireless Local Loop
- Private Data Comms Systems

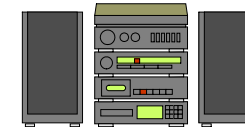


## VOICE/SPEECH

- Speech Recognition
- Speech Processing/Vocoding
- Speech Enhancement
- Text-to-Speech
- Voice Mail



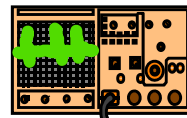
## PRO-AUDIO



- AV Editing
- Digital Mixers
- Home Theater
- Pro Audio

## INSTRUMENTATION

- Spectrum Analyzers
- Seismic Processors
- Digital Oscilloscopes
- Mass Spectrometers



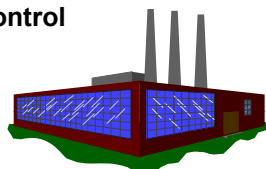
## CONSUMER

- Radar Detectors
- Power Tools
- Digital Audio / TV
- Music Synthesizers
- Toys / Games
- Answering Machines
- Digital Speakers



## INDUSTRIAL/CONTROL

- Robotics
- Numeric Control
- Power Line Monitors
- Motor/Servo Control



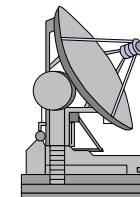
## MEDICAL

- Patient Monitoring
- Ultrasound Equipment
- Diagnostic Tools
- Fetal Monitors
- Life Support Systems
- Image Enhancement

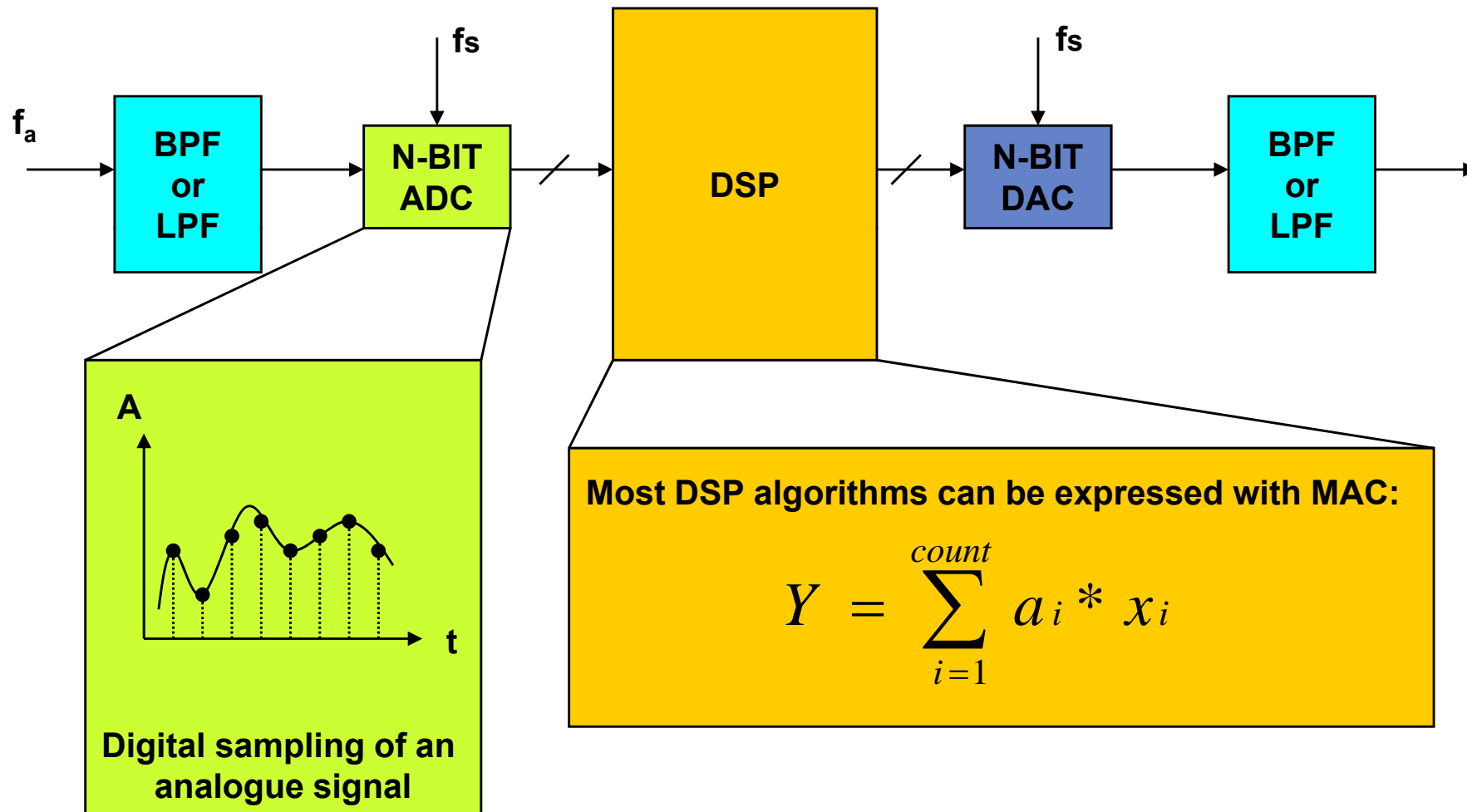


## MILITARY

- Secure Communications
- Sonar Processing
- Image Processing
- Radar Processing
- Navigation, Guidance



# Traditional DSP Signal Chain





# Anatomy of a DSP

- ◆ **Fixed point and/or floating point math and computes in a single cycle**
  - Multipliers, ALUs, shifters
  - Optional special instructions for tasks related to communications, video, etc.
- ◆ **Multiple core resources to access data**
  - Many data and address registers
  - Large accumulator registers to hold the results
- ◆ **High frequency operation is important but these features also are typical**
  - Multiple operations can be done each core cycle
    - ◆ Computes, data accesses, and address updates
  - Deeper pipeline good for higher speed but unfriendly to change of flow
  - Zero overhead looping
  - DSP addressing for circular buffers and FFT bit reversal
- ◆ **Fast and deterministic interrupt service routines**
  - High speed peripherals, timers and real-time budget drive requirements
- ◆ **DMA controller to move data while the processor does other work**
- ◆ **Memory**
  - Single cycle internal memory with banking to allow simultaneous DMA and core access



# System Development with a DSP

- ◆ **Almost all development occurs in C/C++ but many developers still program their most frequently executed code in assembly**
  - **Interlocked pipeline and algebraic assembly are important**
    - ◆ Interlocked pipeline means that programmer doesn't have to mentally schedule cycles; much easier to maintain as well
  - ◆
- ◆ **Compiler friendly but ...**
  - **The more compute units that exist, the harder it is for a compiler to take advantage of all the units**
- ◆ **Even if developers have DSP-specific assembly, today's developers almost always have Matlab and C functional models**
  - **Makes porting to a new processor easier**
- ◆ **System bandwidth is just as important a consideration (and in many cases it is more important) than other development items**
  - **Time needs to be spent up front planning this out**

# Anatomy of a controller

- ◆ **Branching and change of flow**
  - ◆ Occurs often in a control application
  - ◆ Shorter pipelines and branch prediction help
- ◆ **High performance caching**
  - **Instruction and data cache widely used to manage accesses from larger, slower external memories**
- ◆ **Byte addressability is friendly to networking apps**
- ◆ **Memory protection and translation**
- ◆ **Most frequently used instructions encoded as the smallest size possible to improve code density**
- ◆ **Stack and Frame pointer support**
- ◆ **User and Supervisor modes for operating systems support**

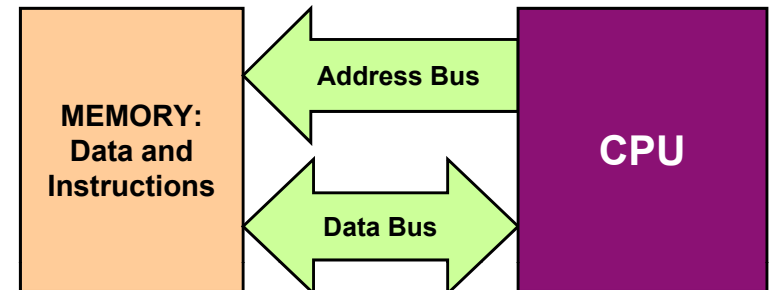
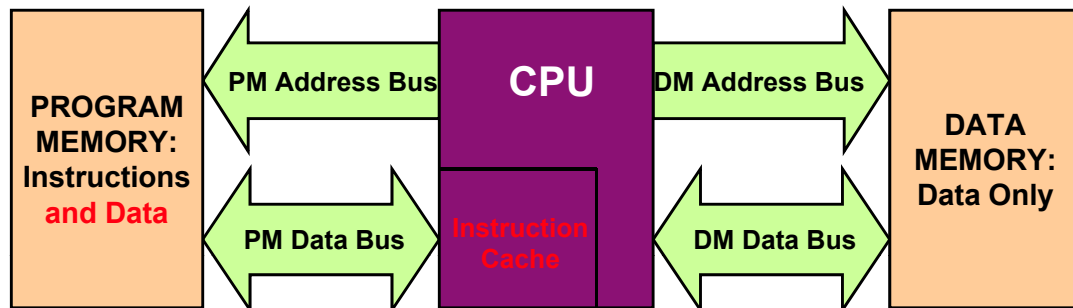
# DSP vs. Microcontrollers

## ◆ DSP Architecture

- **Harvard Architecture**
  - ◆ Separate Program & Data Memory Space
- **Dedicated Hardware Multiplier**
- **Single Cycle MAC**
- **Efficient Computation**
- **Less Memory Required**
- **Algebraic Assembly Language**
- **Can Combine Many Advanced Control Features**

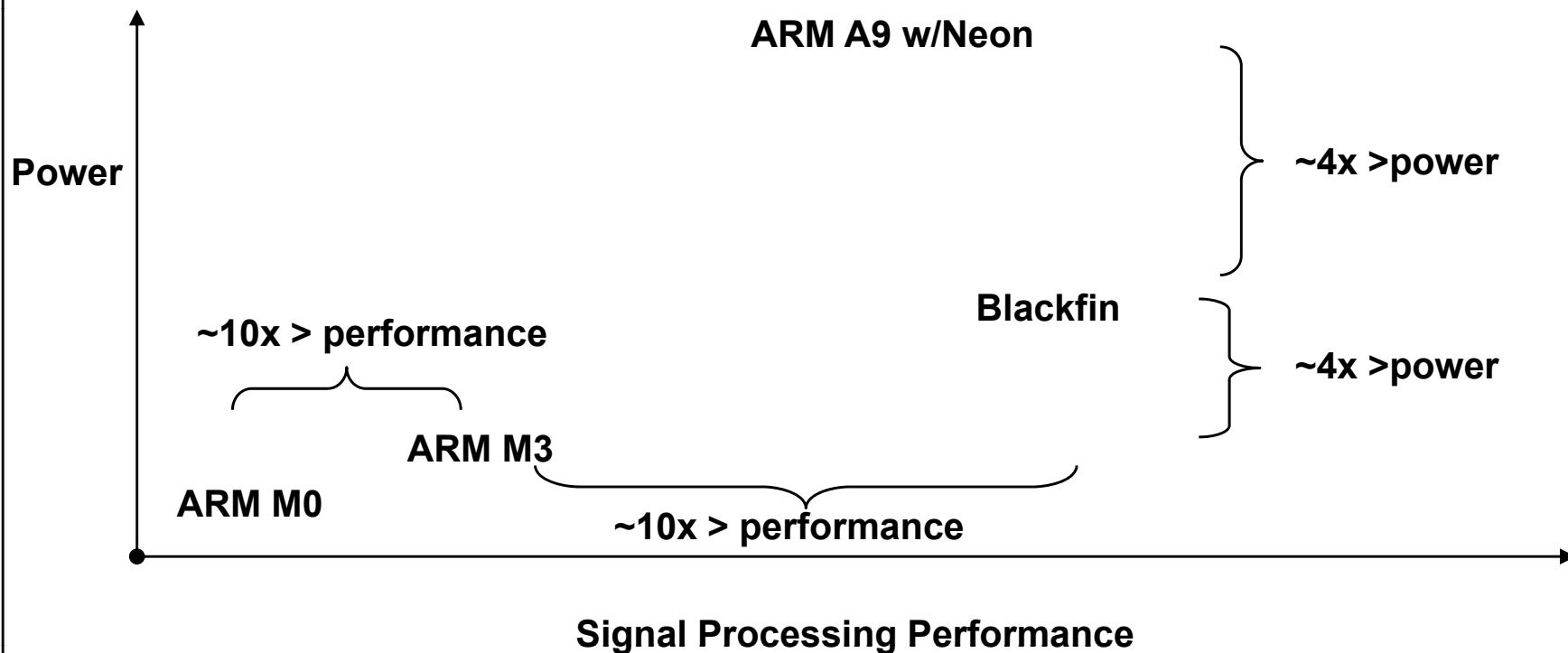
## ◆ Microprocessor Architecture

- **Von Neumann Architecture**
  - ◆ Common Program & Data Memory Space
- **Multiplication in Software (multiple cycles)**
- **Large Amount of Memory Needed**
- **Mnemonic based Assembly Language**

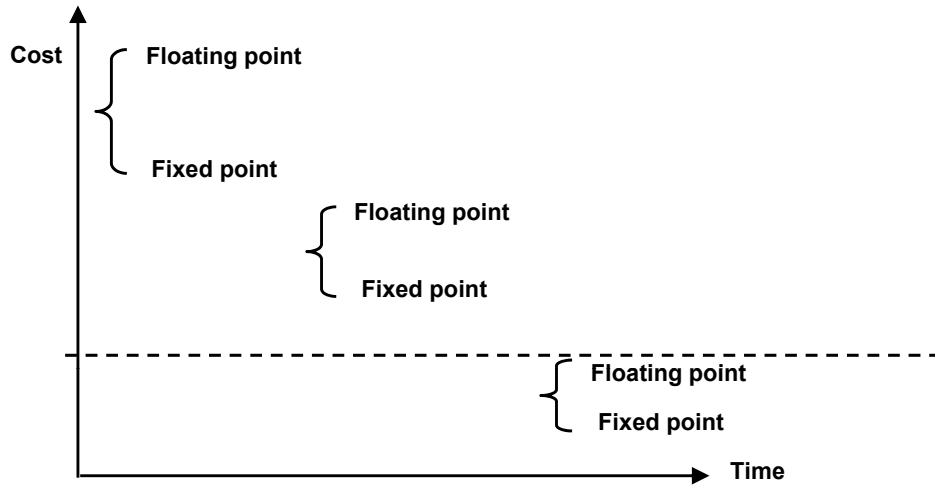


# The Industry landscape

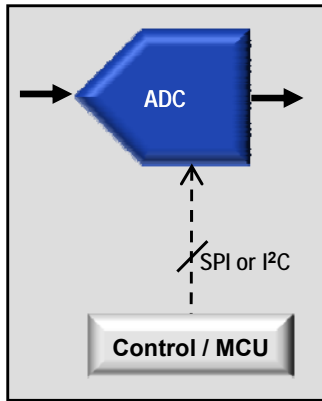
- ◆ DSP's have continued to add integrated controller features
- ◆ Microcontrollers have continued to add DSP features
- ◆ FPGAs have added support for embedded cores



# Trends in the applications domain



**Floating point is becoming more common in traditional fixed point applications as cost drops**

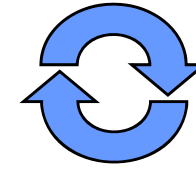


**More modes and complexity on the digital side our analog components increases the need for integrated processors**

**Biometric Security**

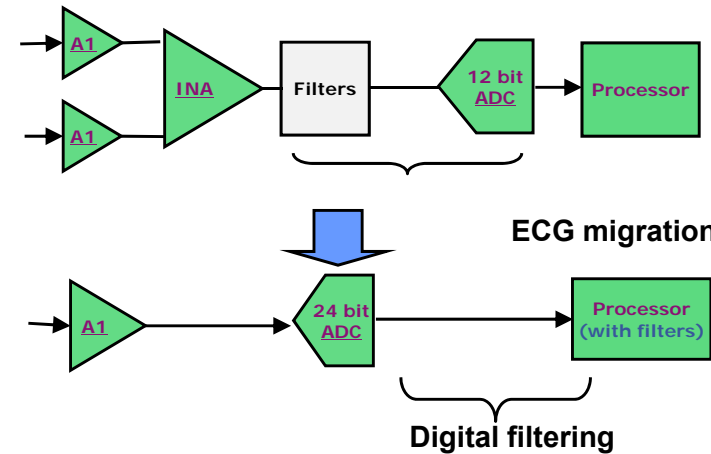


**Surveillance Systems**



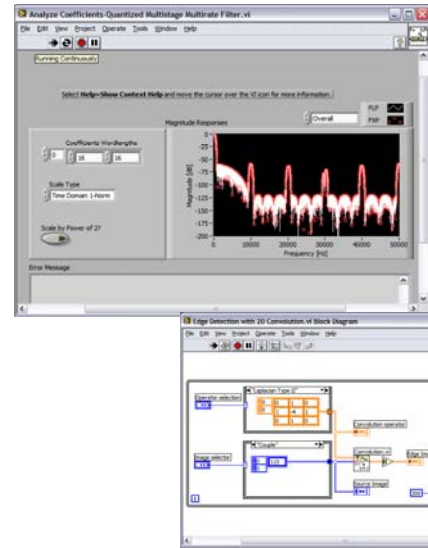
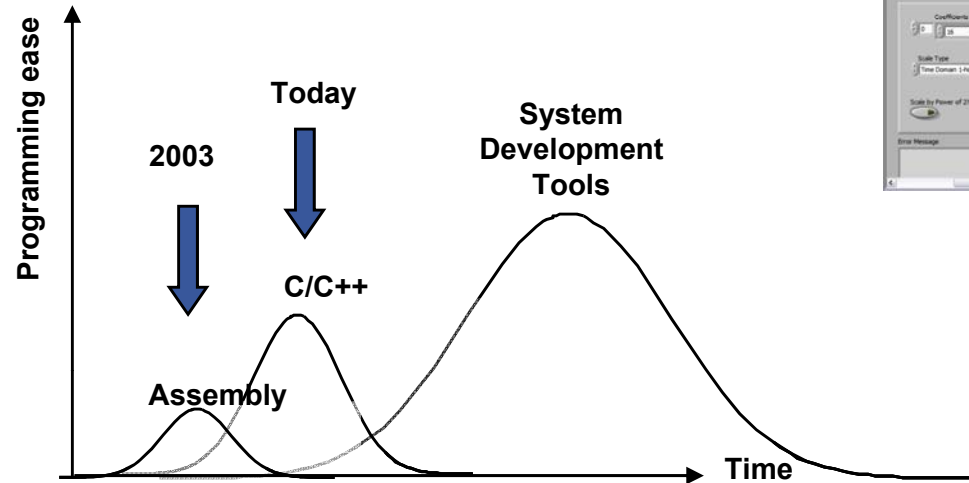
**Industrial Control**

**Decisions, actions, data reduction moving to front-end of systems**

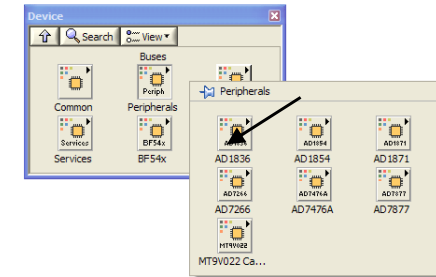


**Digital content moving "upstream" in the signal chain**

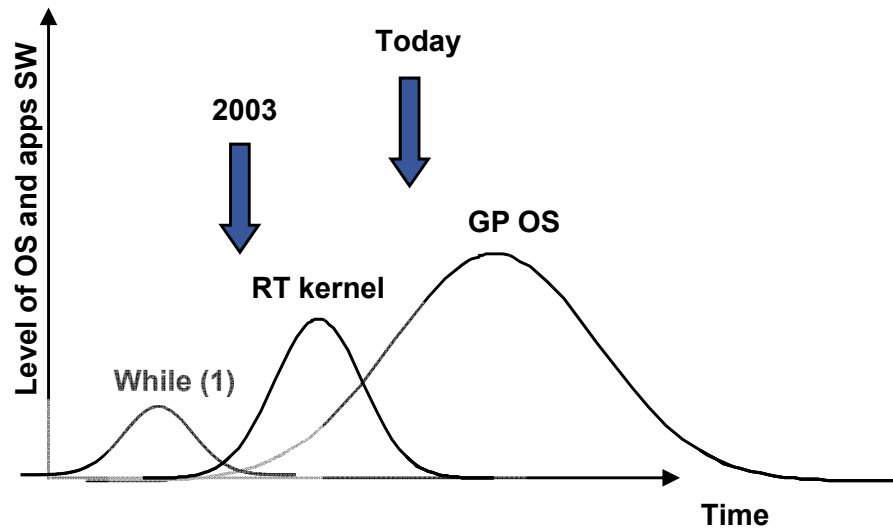
# Software development trends



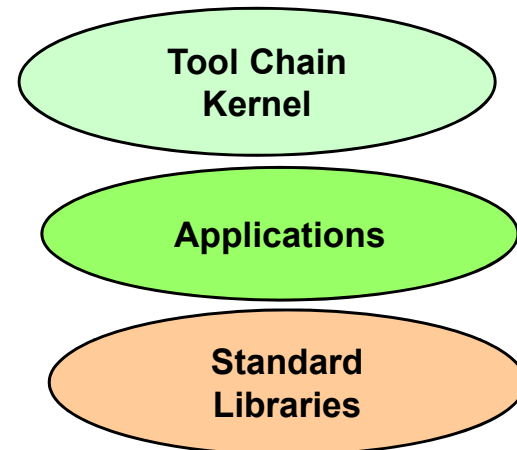
**Sigma Studio is a fine example of how the programming model is evolving**



**Move from to assembly to higher level language to abstracted programming language**



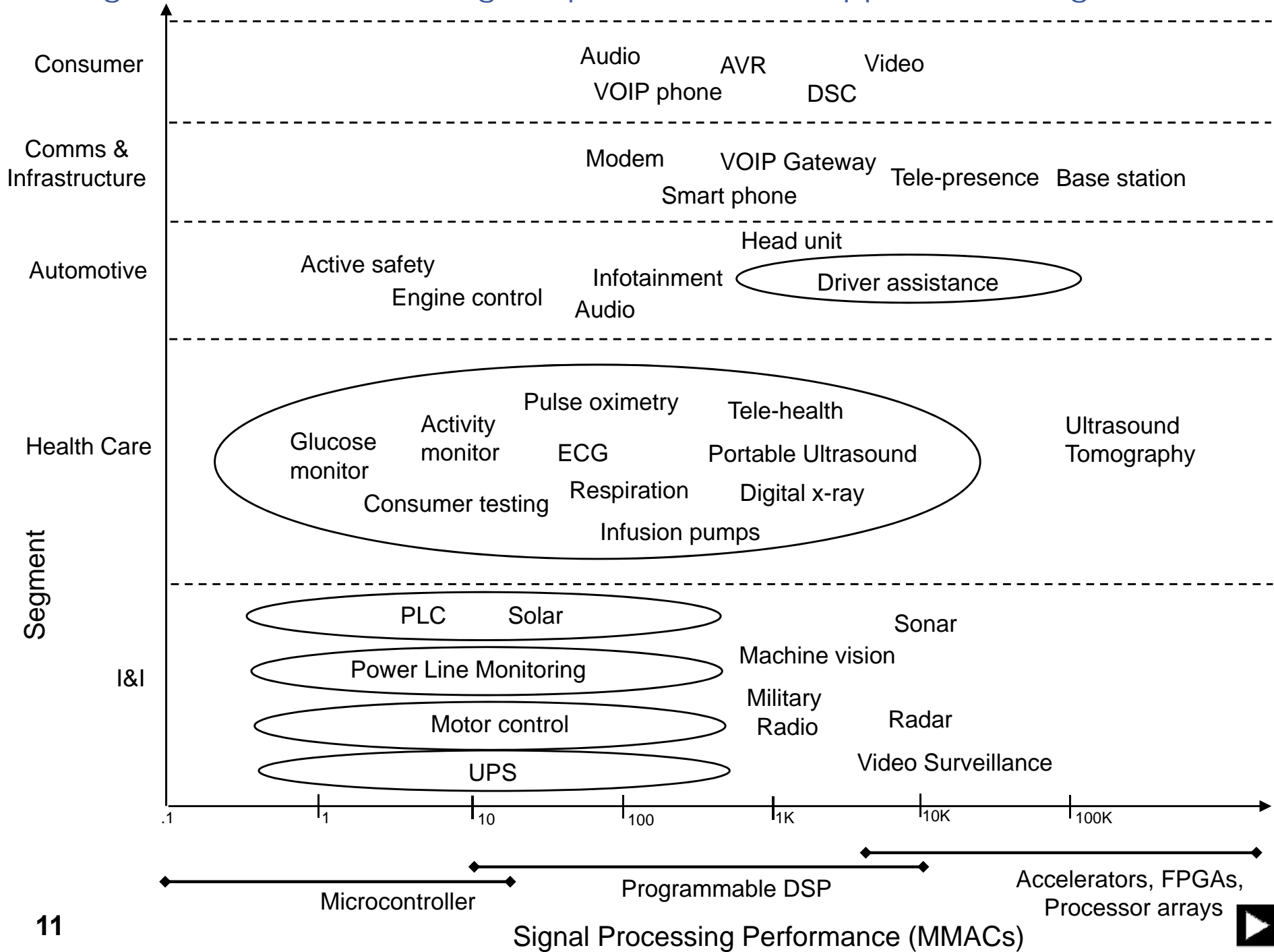
Open Source Community



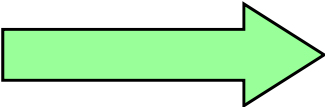
**More developers moving to linux and open source**



# Programmable Processing Requirements for Application Segments



# Project Progress

**6**  **24 Months**

◆ **Average time for the project:**

- **65% took less than 12 months**
- **17% took between 12 and 18 months**
- **18% were greater than 18 months**

} Longer development window  
Requires long term support

# What does performance mean?

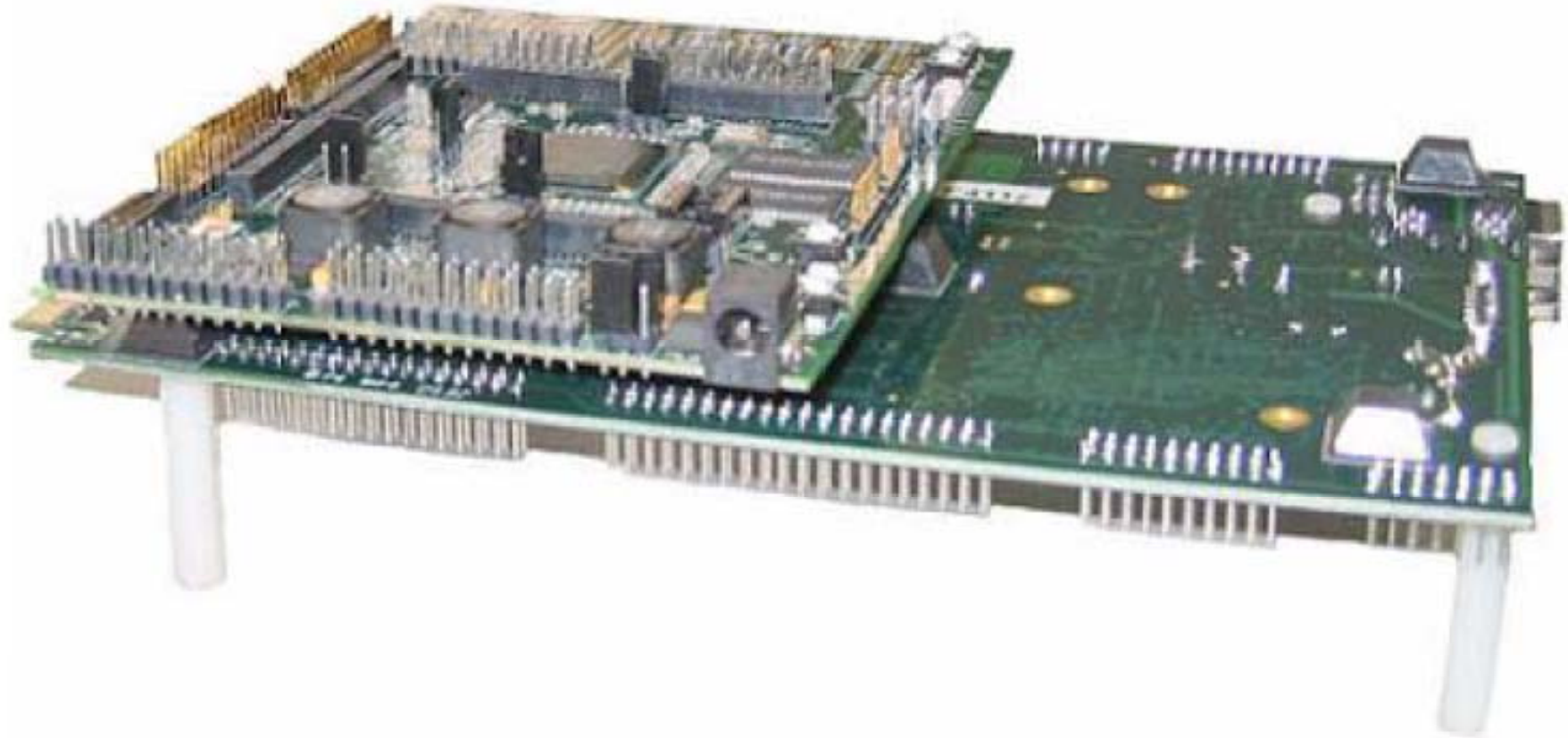
<b>Attribute</b>	<b>% Ranked 1 or 2 in importance when selecting Blackfin</b>
Performance	<b>42%</b>
Ability to Perform both DSP & MCU Functions	<b>37%</b>
Cost	<b>36%</b>
Development Tools	<b>31%</b>
Peripherals (specific peripherals and/or overall peripheral mix)	<b>28%</b>
Power	<b>24%</b>

From an ADI 2009 survey of customers that designed in a Blackfin processor

# FPGA Usage

- ◆ **50% of developer in CY2009 developers**
  - would use an FPGA and/or programmable logic in their next design
- ◆ **The other half**
  - Do not need the function
  - Too Expensive
  - Too much power
  - Too hard to use
- ◆ **Our processors do co-exist with FPGAs.**
  - In development phase to simulate a larger system
  - In the final system to add peripherals or IO
  - In the final system to co-process

# ADI Evaluation solutions with an FPGA



**FPGA Expander card for our EZKITs  
Verilog for connections to peripherals**

# Extensive network of partners ....



- ◆ [Mathworks](#)
- ◆ [ZP engineering](#)
- ◆ [Danville](#)
- ◆ [Schmid Engineering](#)
- ◆ [BlueTechnix](#)
- ◆ [Promwad](#)
- ◆ [Phytec](#)
- ◆ [Mega-F](#)
- ◆ [Kaztek](#)
- ◆ [Boston Engineering](#)
- ◆ [TechEN](#)
- ◆ [Impact Engineering](#)
- ◆ [PMDi](#)



# What is new with our Eval Platforms?

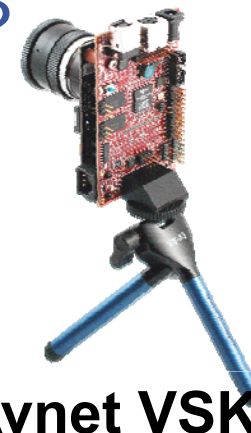
**SHARC EZKIT**



**BF518 EZKIT**



**Low-cost ICE**



**Avnet VSK**



**Bluetooth Extender**



**BF52x EZKIT**

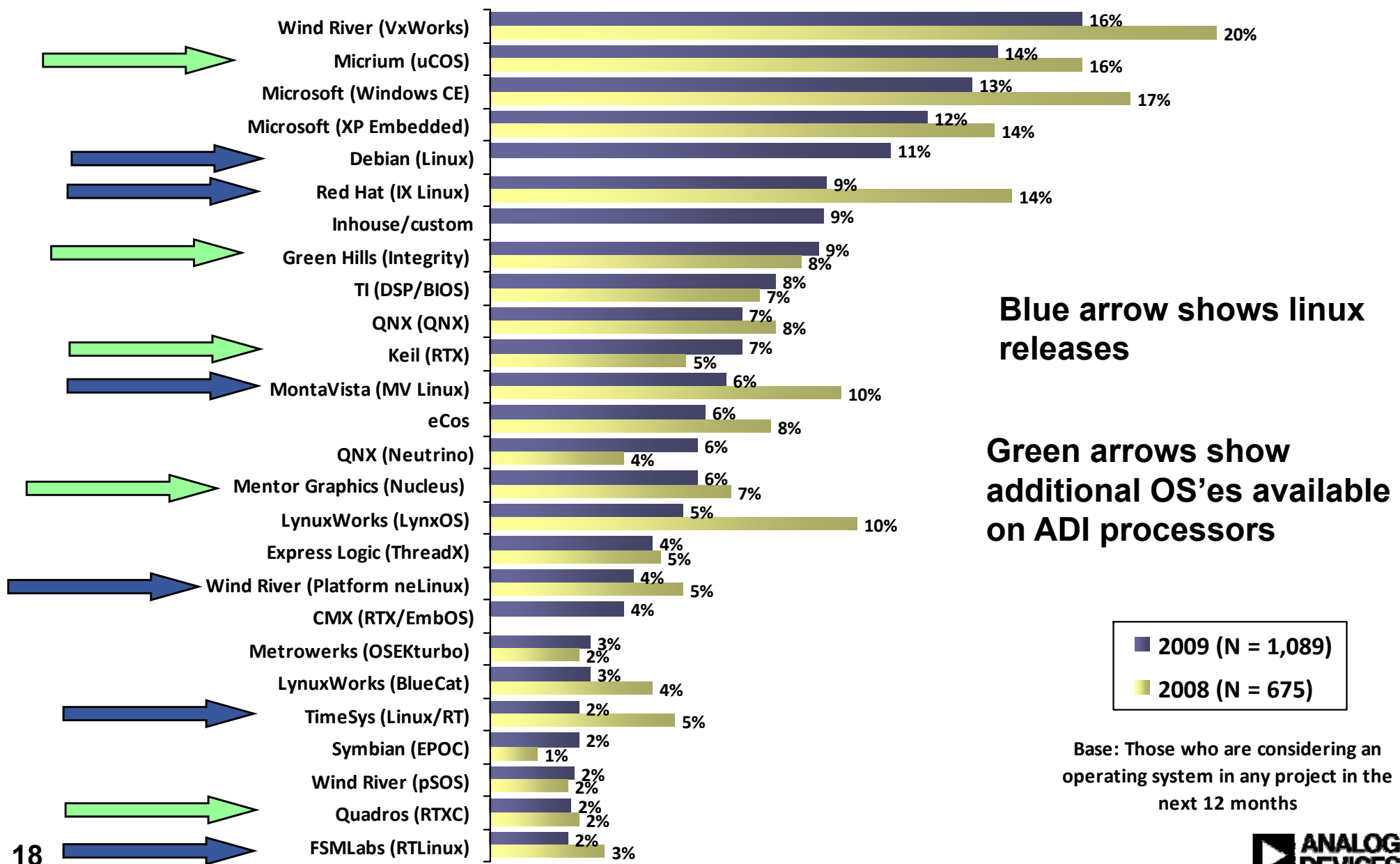


**BF54x EZKIT**

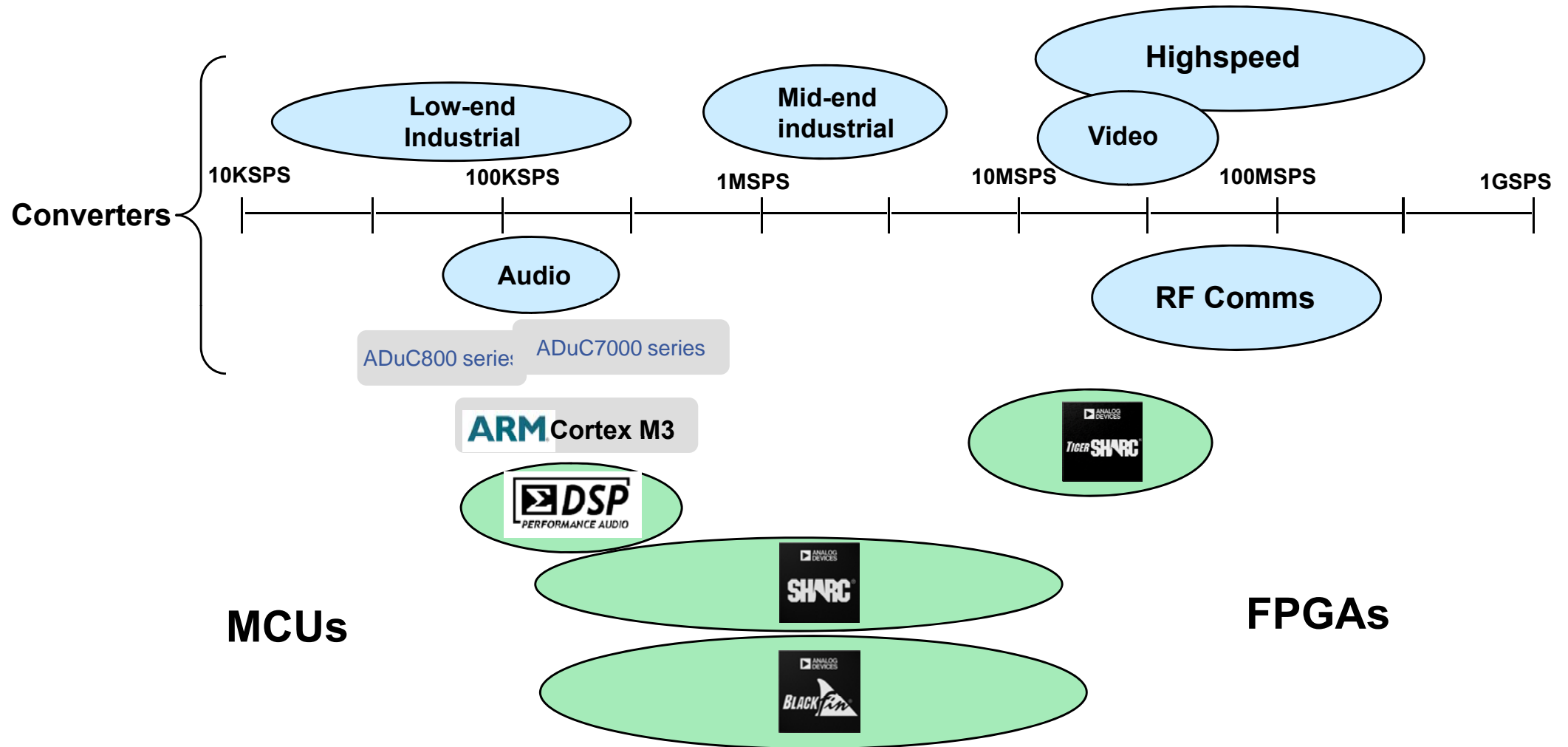


**BF508 EZKIT**

## Please select ALL of the operating systems you considering using in the next 12 months.



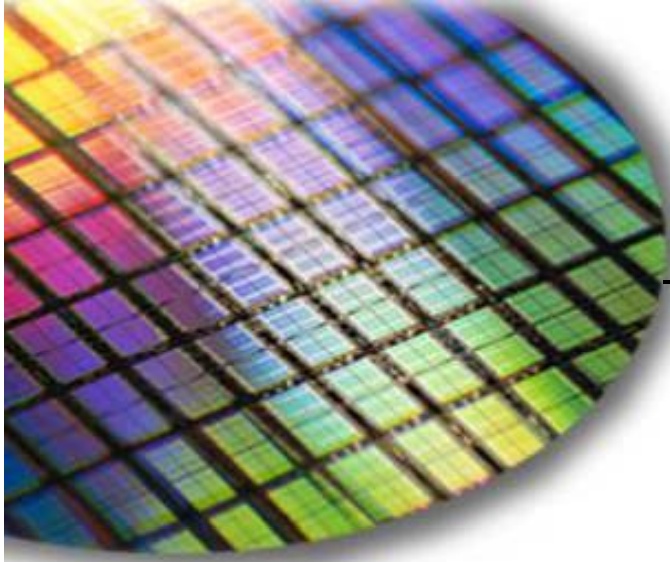
# The Converter-Processor Spectrum





# Important Questions/Thoughts you should ask

- ◆ **Does the C or C++ code exist for the customer's current processor application?**
  - It is straight forward to port this code to our processors
- ◆ **Fixed point or floating point?**
  - If the application requires floating point more than 5% of the time, SHARC is the answer
  - Blackfin does support software-based floating point
- ◆ **Which operating system is used?**
  - If it is one of the following, we have it available on our processors:
    - ◆ uCLinux, uC-OS II from Micrium, VDK Green Hills Integrity and Velocity, Quadros, Nucleus, Express Logic
- ◆ **Is networking and connectivity required?**
  - We have Ethernet, USB (device and host), Storage (NAND, SDIO, etc.), and the ability to add the 4 most popular wireless standards (wifi, Zigbee, Bluetooth, and proprietary wireless)



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Important Question  
to ask yourself

# Discovery Questions/Thoughts

- ◆ **In the portable health care space, many customers use a 3<sup>rd</sup> party design house**
  - We have multiple options in this area with success stories to show
- ◆ **Many customer use 3rd parties to order development**
  - Bluetechnix
  - Promwad
- ◆ **Processor roadmaps are important to customers**
  - We have fixed and floating point roadmap products on both ends of the performance and power spectrum
- ◆ **Design references are very important**
  - We have a wide variety available (future Distance learning session?)
- ◆ **Power and energy management**
  - We have collateral to help the customer understand our processors
  - Blackfin and SHARC options
- ◆ **In the I&I:**
  - IEEE1588, Signal Condition, Oscilloscope, Signal Generator, Real time, FFT, DFT, Capture, Flexibility, Screen controller, Analysis, Vector Control, Bandwidth, Integration, Flexibility, DC Brushless, AC Induction, Permanent Magnet

# Discovery Questions/Thoughts

- ◆ **What do you need in terms of performance?**
  - What do you mean by performance?
- ◆ **Do you need a connectivity processor or a high performing processor that can be connected?**
  - Blackfin can be either
- ◆ **75% of the developers that use Blackfin describe their use as either MCU or MCU and DSP**
  - Only 25% describe it as DSP only

# Help

- ◆ **ADI Processor communities via EngineerZone and uClinux are very active**
  - **Check them out at:**
    - ◆ <http://ez.analog.com/index.jspa>
    - ◆ <http://blackfin.uclinux.org/gf/>

