RWTH AACHEN UNIVERSITY

A Design Methodology for Software Defined Radios Reconciling Portability with Efficiency

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(on behalf of the Nucleus team)

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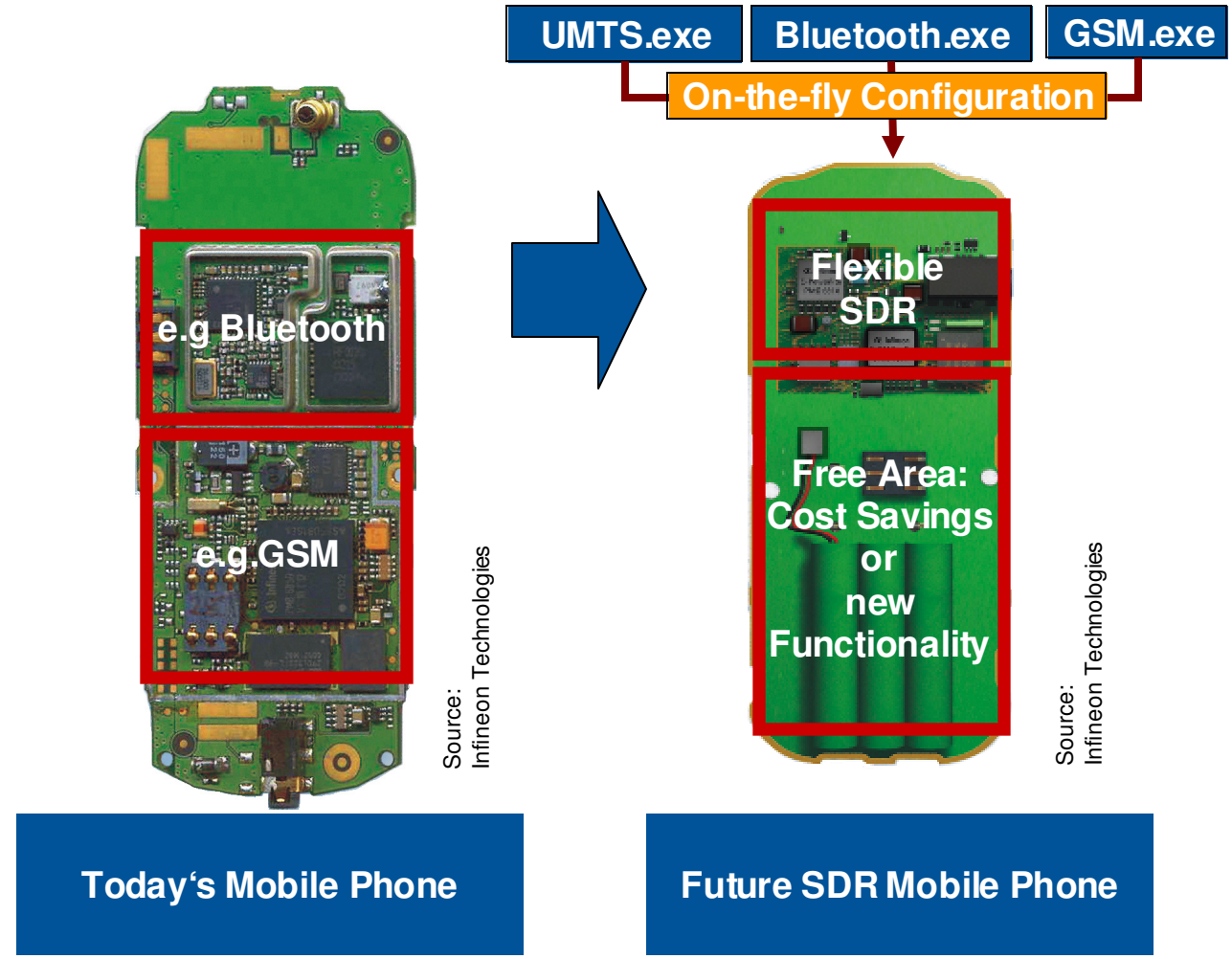
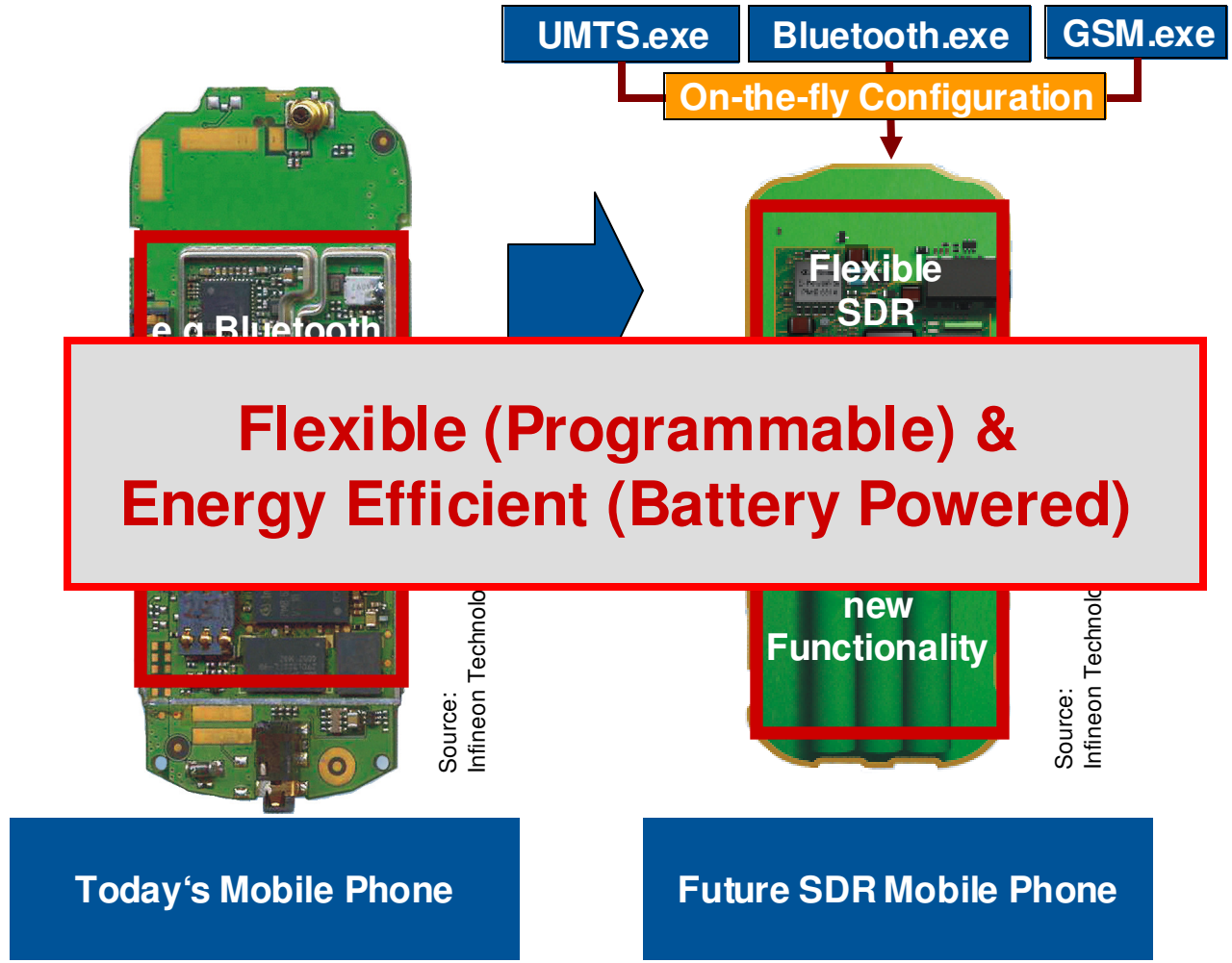
MPSoC 2009

Institute for Integrated Signal Processing Systems

Proposition of Software Defined Radios



Proposition of Software Defined Radios

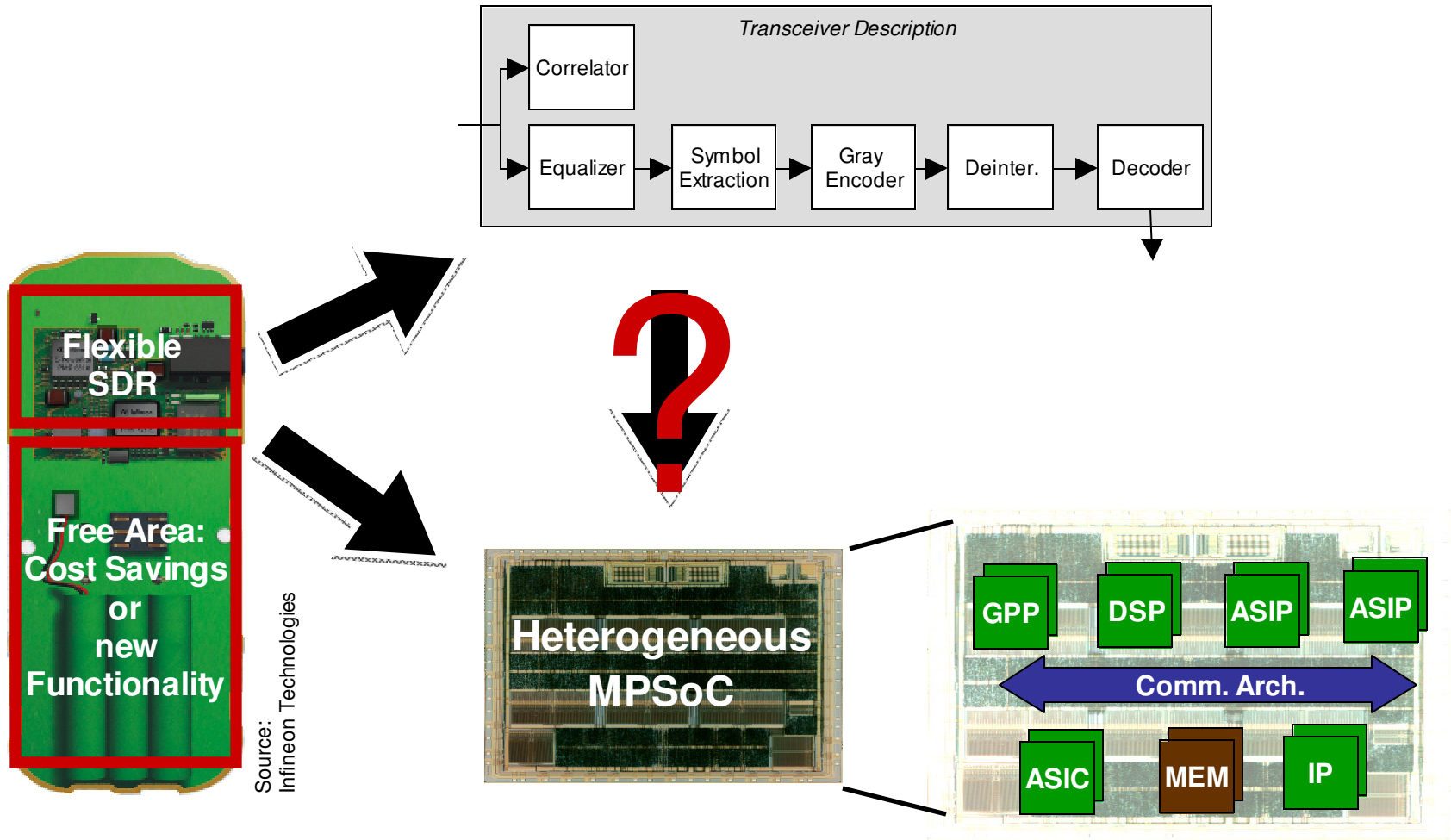


Flexible (Programmable) & Energy Efficient (Battery Powered)

Today's Mobile Phone

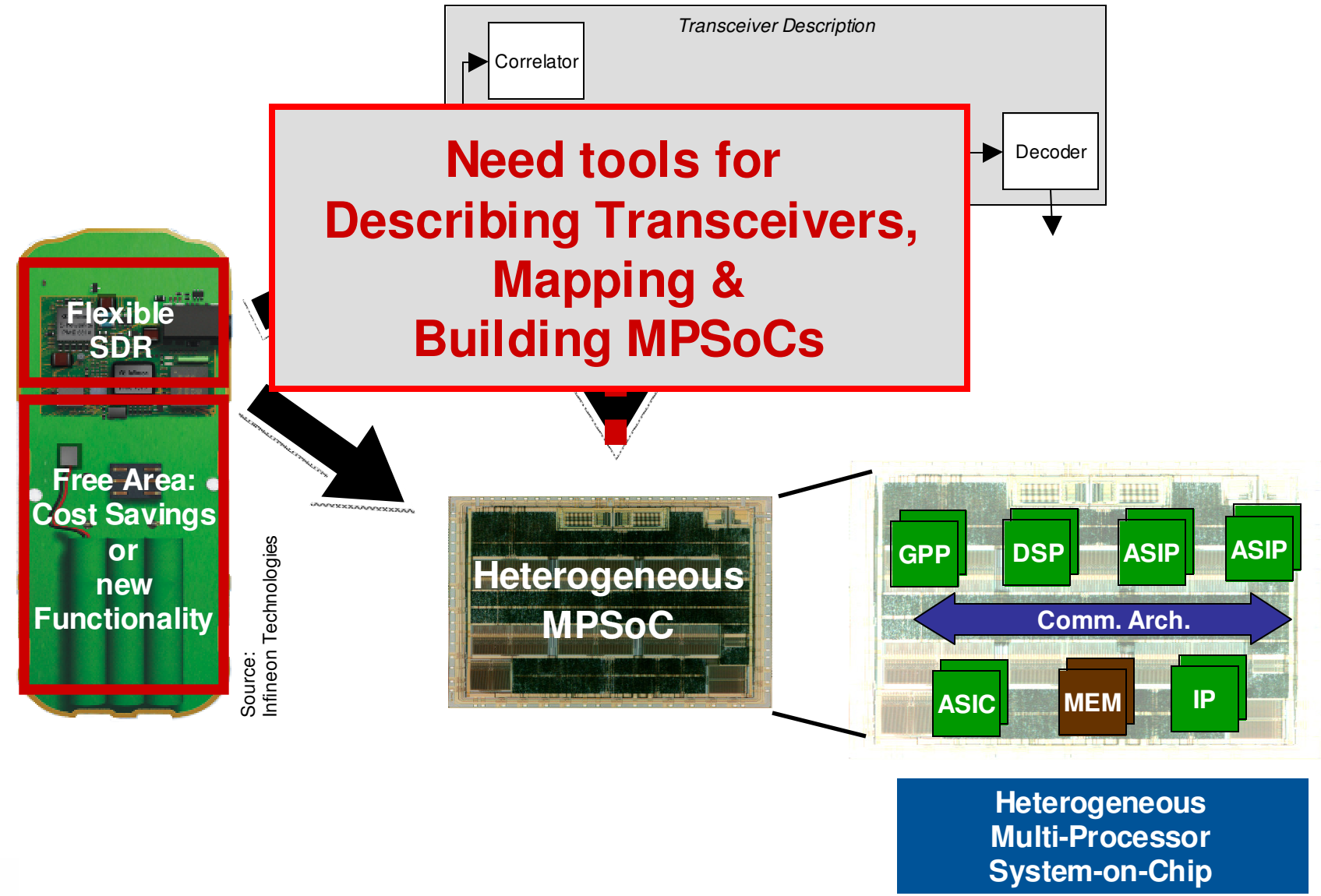
Future SDR Mobile Phone

SDR Development



Heterogeneous Multi-Processor System-on-Chip

SDR Development



Heterogeneous Multi-Processor System-on-Chip

Options for SDR Implementation

Software Designer's View

Portable Design

- Pure Software Solutions
- High Level Language Implementations

Efficiency?

Hardware Designer's View

Maximum Efficiency

- Pure Hardware Solution
- Minimize flexibility (e.g. ASICs)

Flexibility?

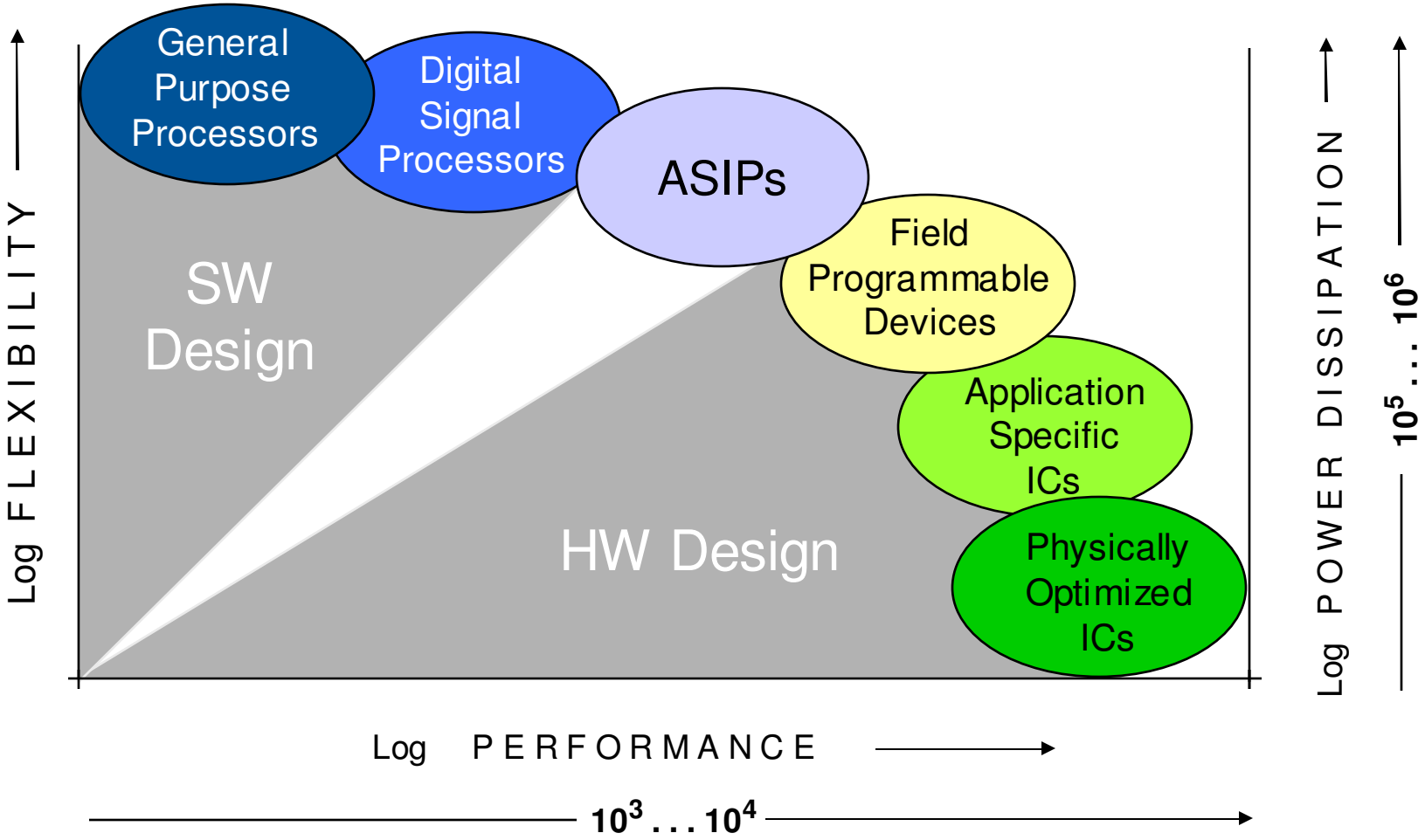
No!

Trade-off decision!

Cost Functions:

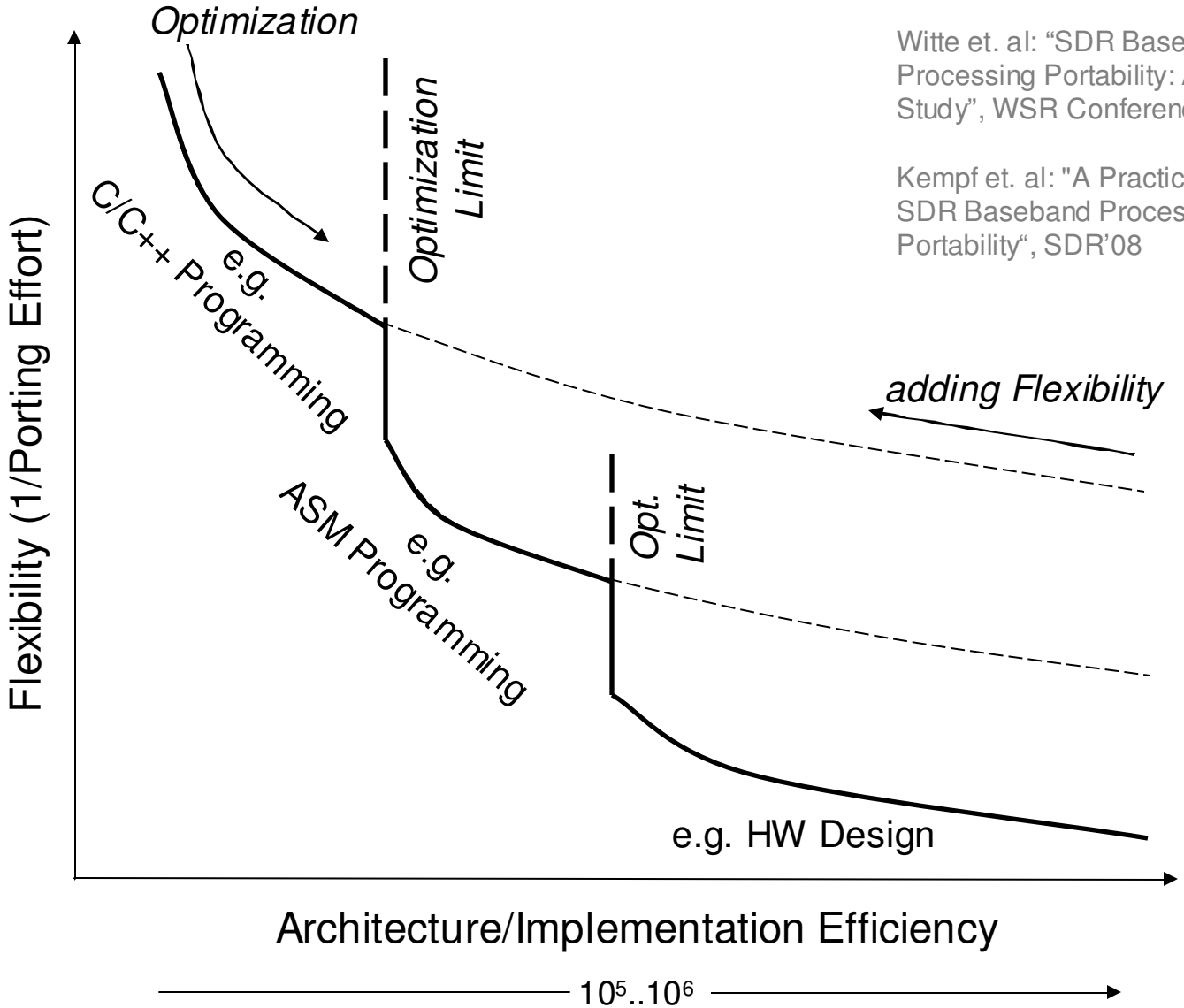
- Flexibility: e.g. Flexibility/Portability ~ 1 / Porting Effort
- Efficiency: e.g. Energy Efficiency ~ Bits / s / Watt

The Energy-Flexibility Gap



Source: T.Noll, RWTH Aachen

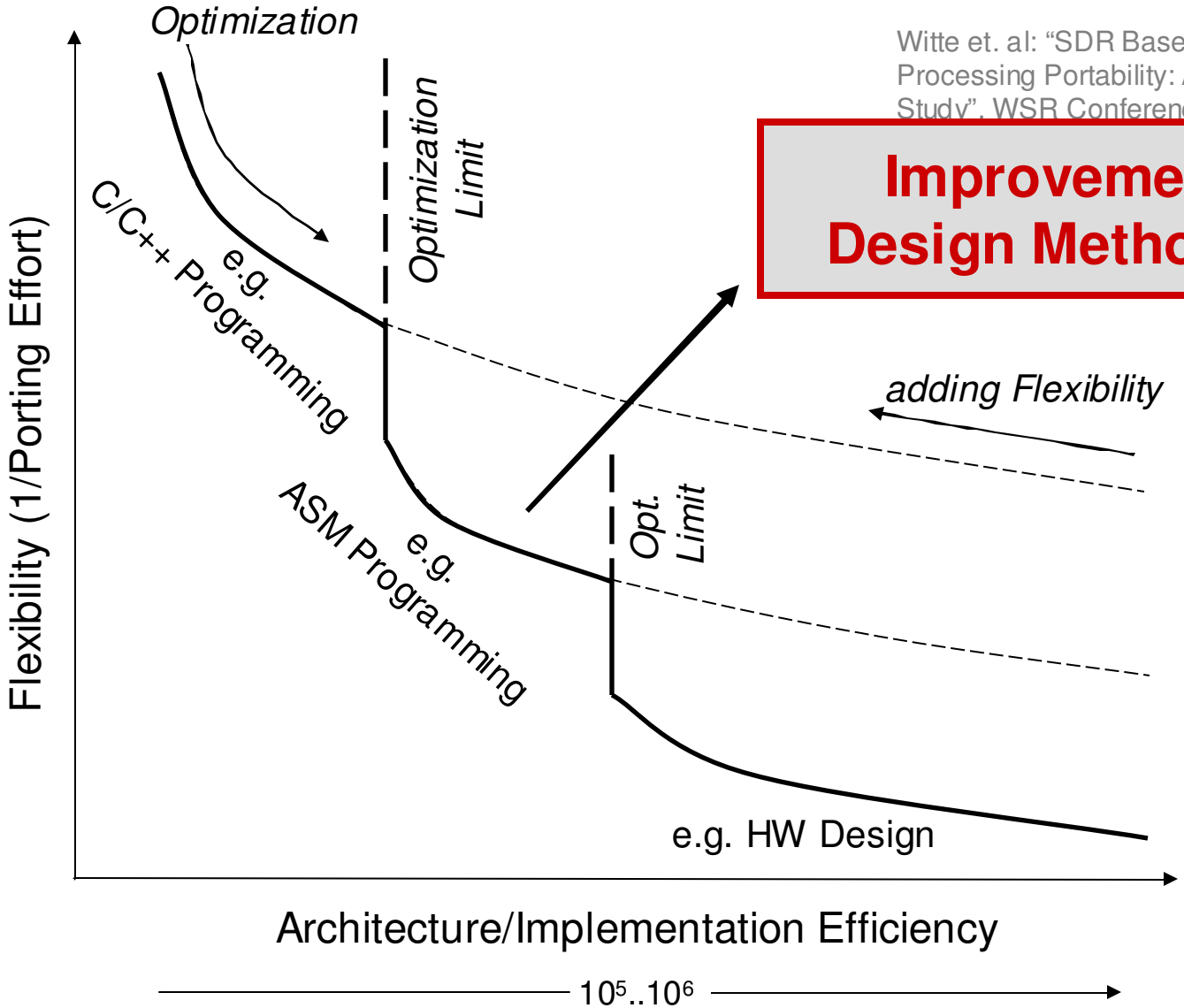
The Efficiency vs. Portability Trade-Off



Witte et. al: "SDR Baseband Processing Portability: A Case Study", WSR Conference 2008

Kempf et. al: "A Practical View on SDR Baseband Processing Portability", SDR'08

The Efficiency vs. Portability Trade-Off



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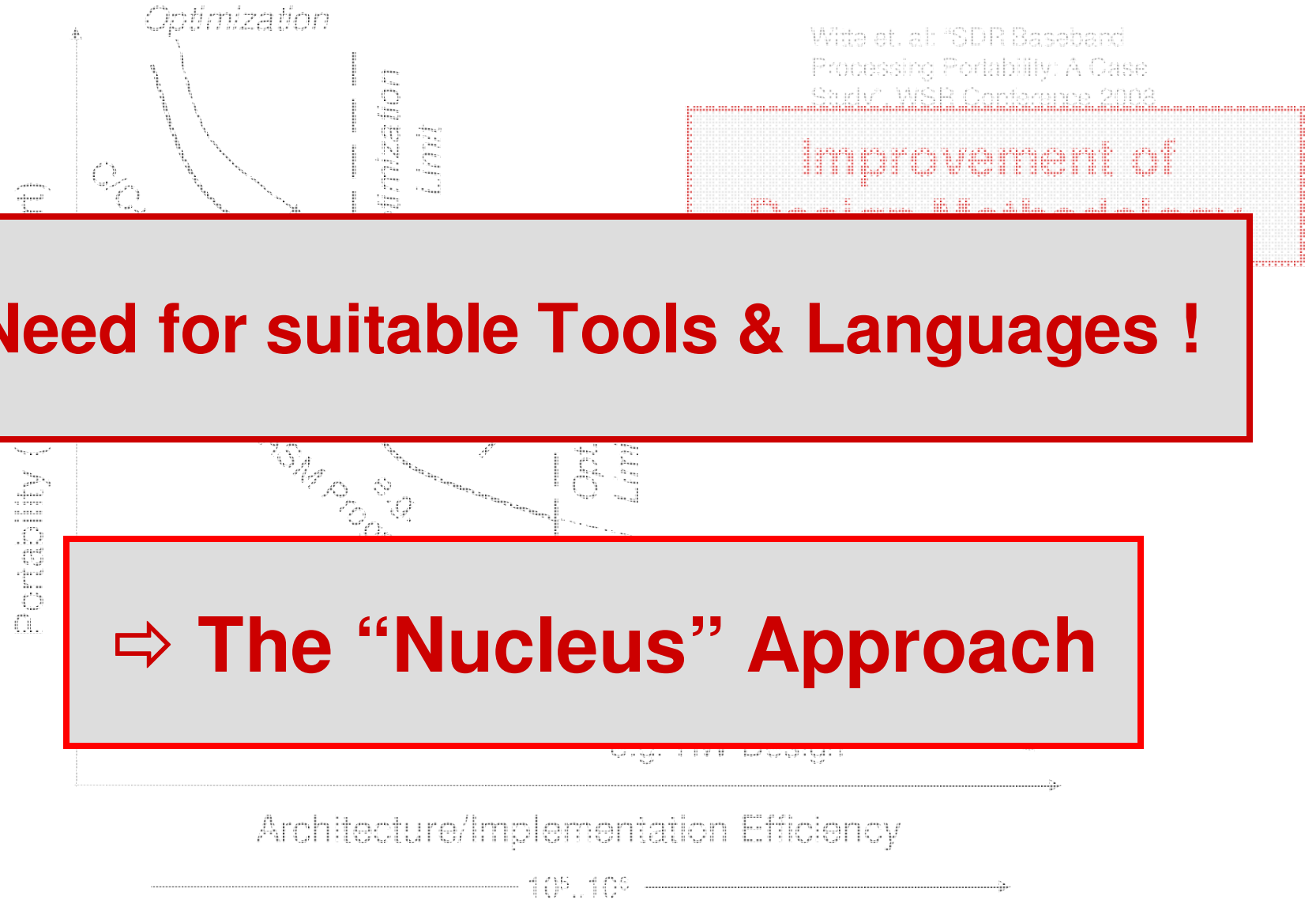
Improvement of Design Methodology

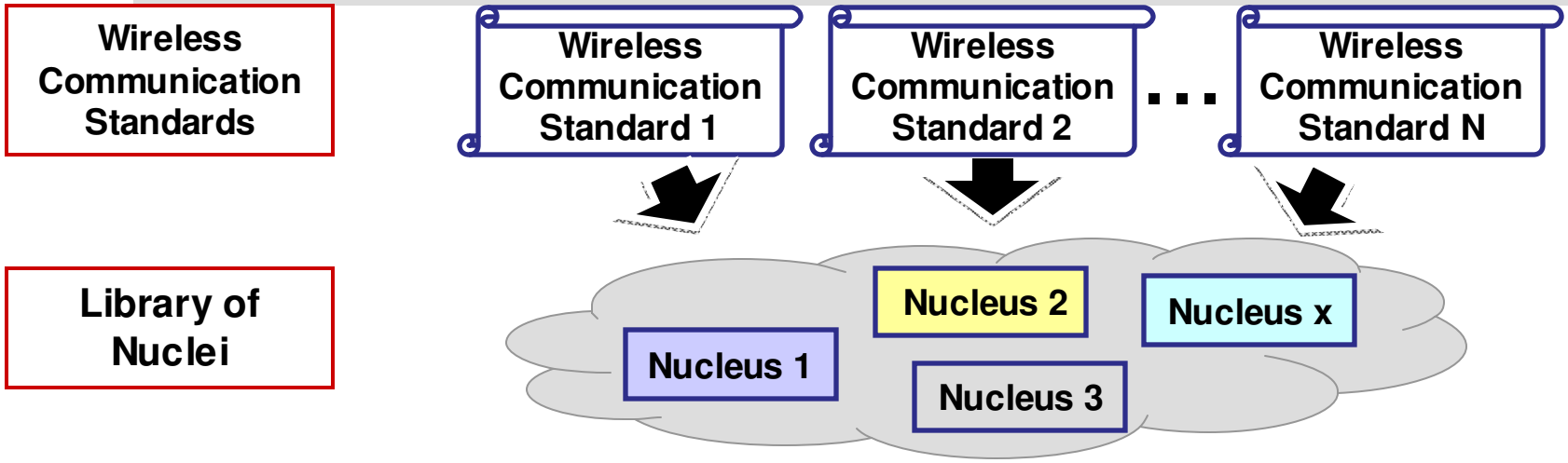
The Efficiency vs. Portability Trade-Off



Need for suitable Tools & Languages !

⇨ The "Nucleus" Approach

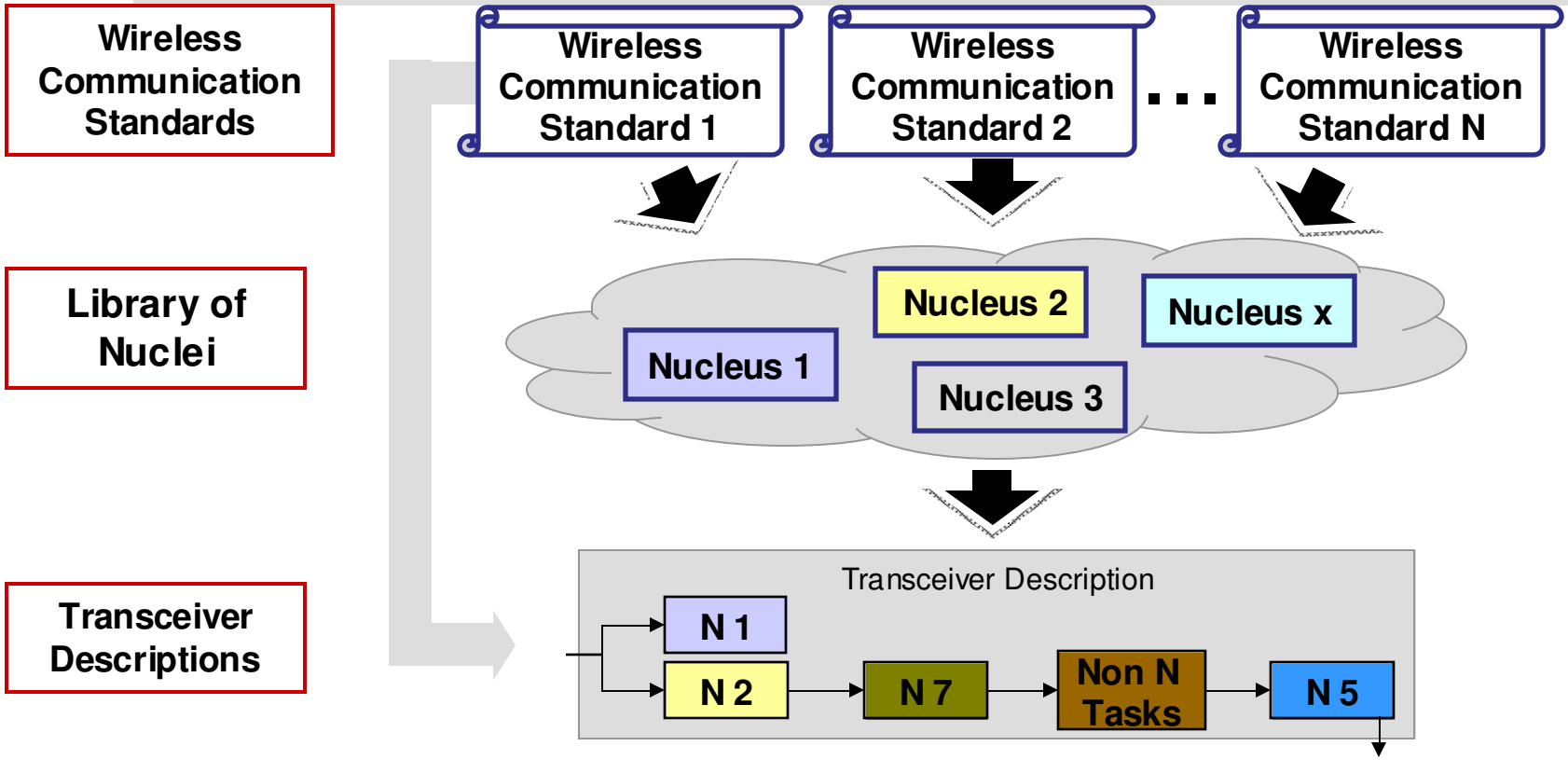
Nucleus Approach: Concept



Nucleus

- Critical, demanding, algorithmic kernel
- Captures common kernels among different transceivers
- Not waveform nor hardware specific

Nucleus Approach: Transceiver Development



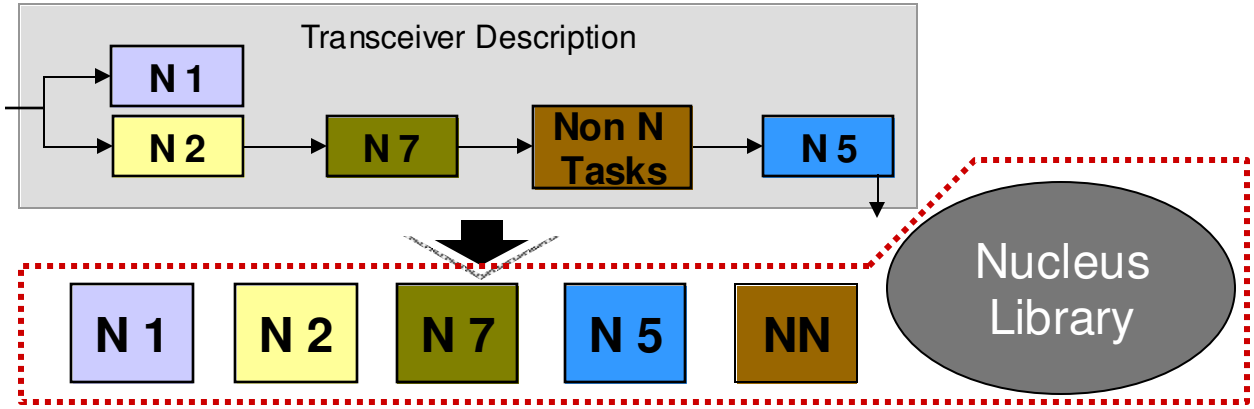
- **Transceiver description composed of**
  - Nuclei & Non-Nuclei
- **Advantages**
  - Portable and efficient
  - Reusable and interchangeable
  - Fast assembly of new transceiver descriptions
  - Interoperability
  - Loadability

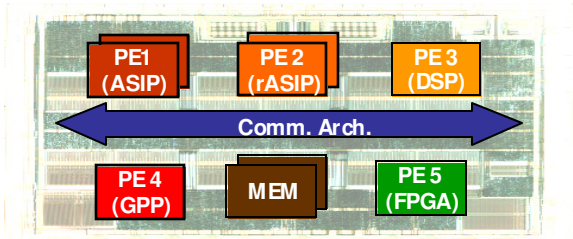
Nucleus Approach: Mapping (Spatial & Temporal)

Transceiver Description

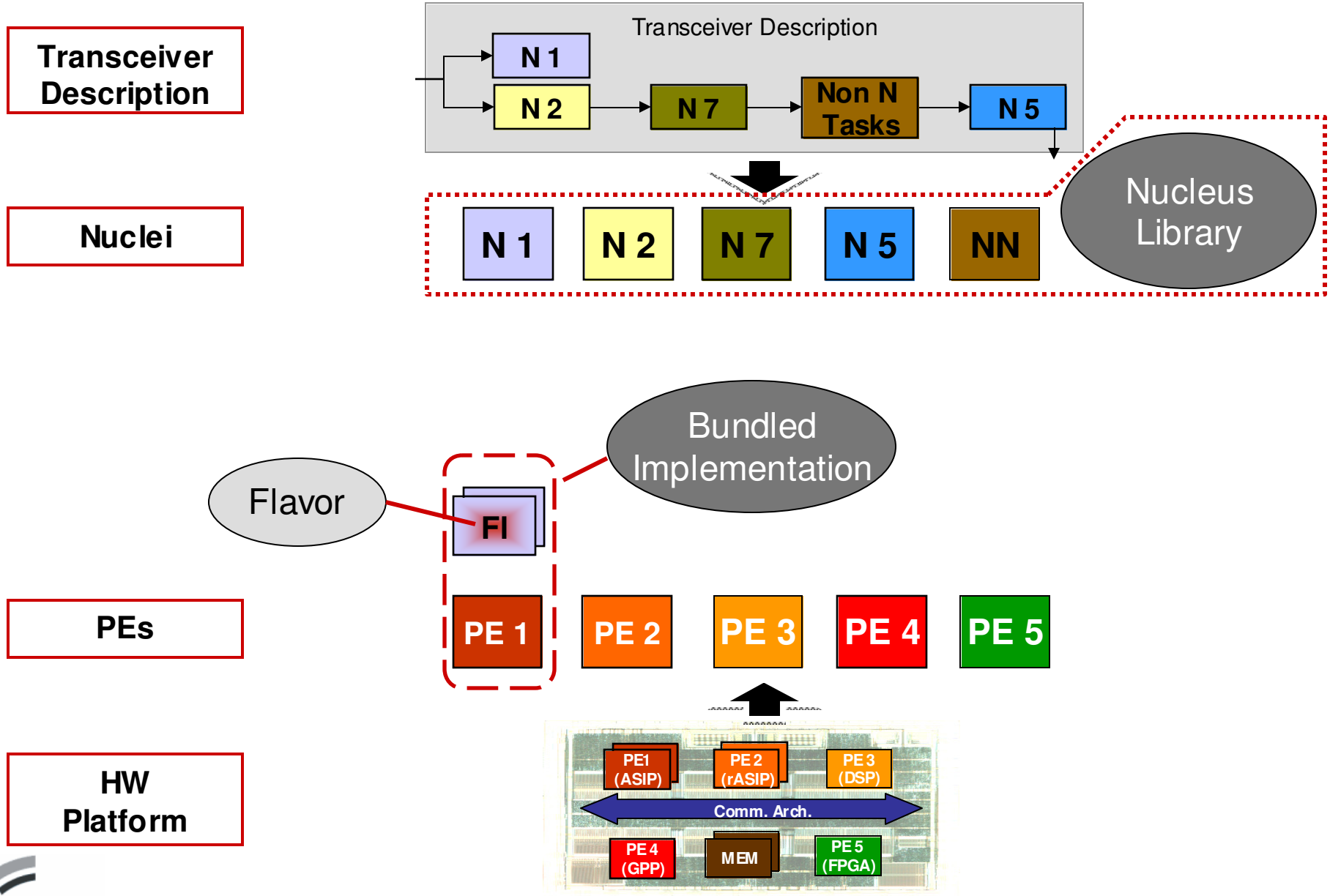
Nuclei

HW Platform





Nucleus Approach: Mapping (Spatial & Temporal)



Nucleus Approach: Mapping (Spatial & Temporal)

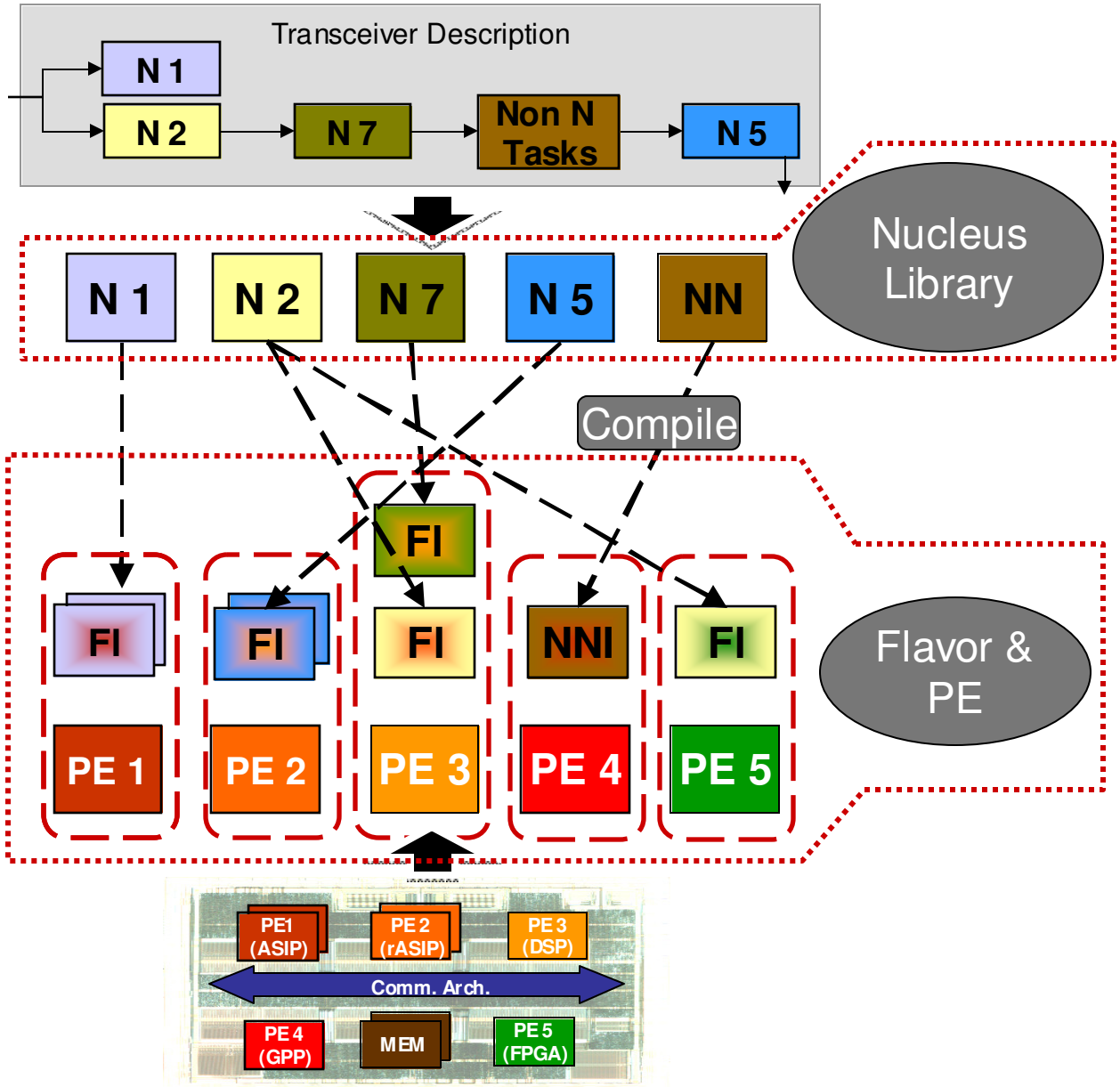
Transceiver Description

Nuclei

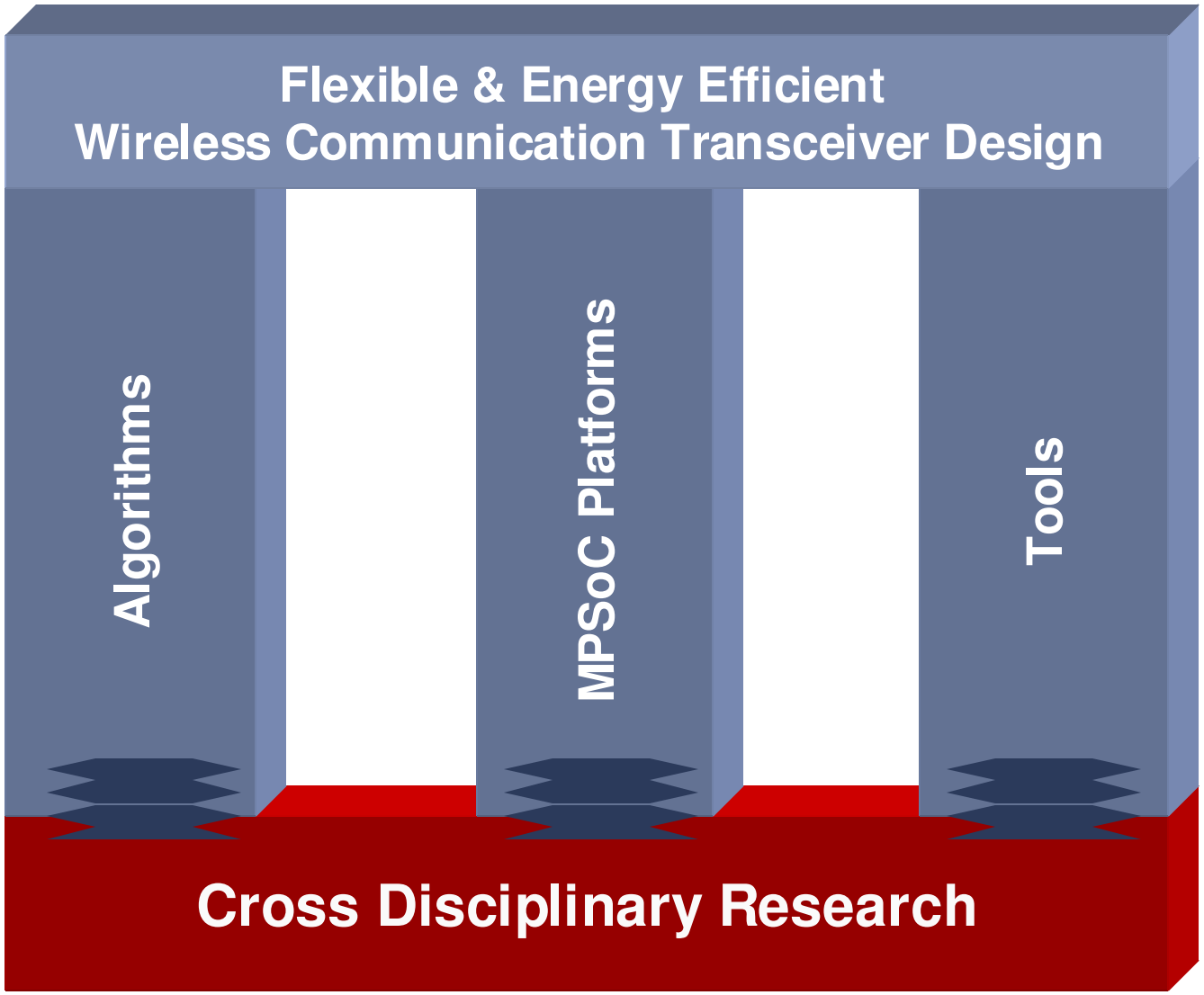
Mapping & Evaluation

Board Support Package

HW Platform



Nucleus Project Structure



Nucleus Project

has been recently launched as a

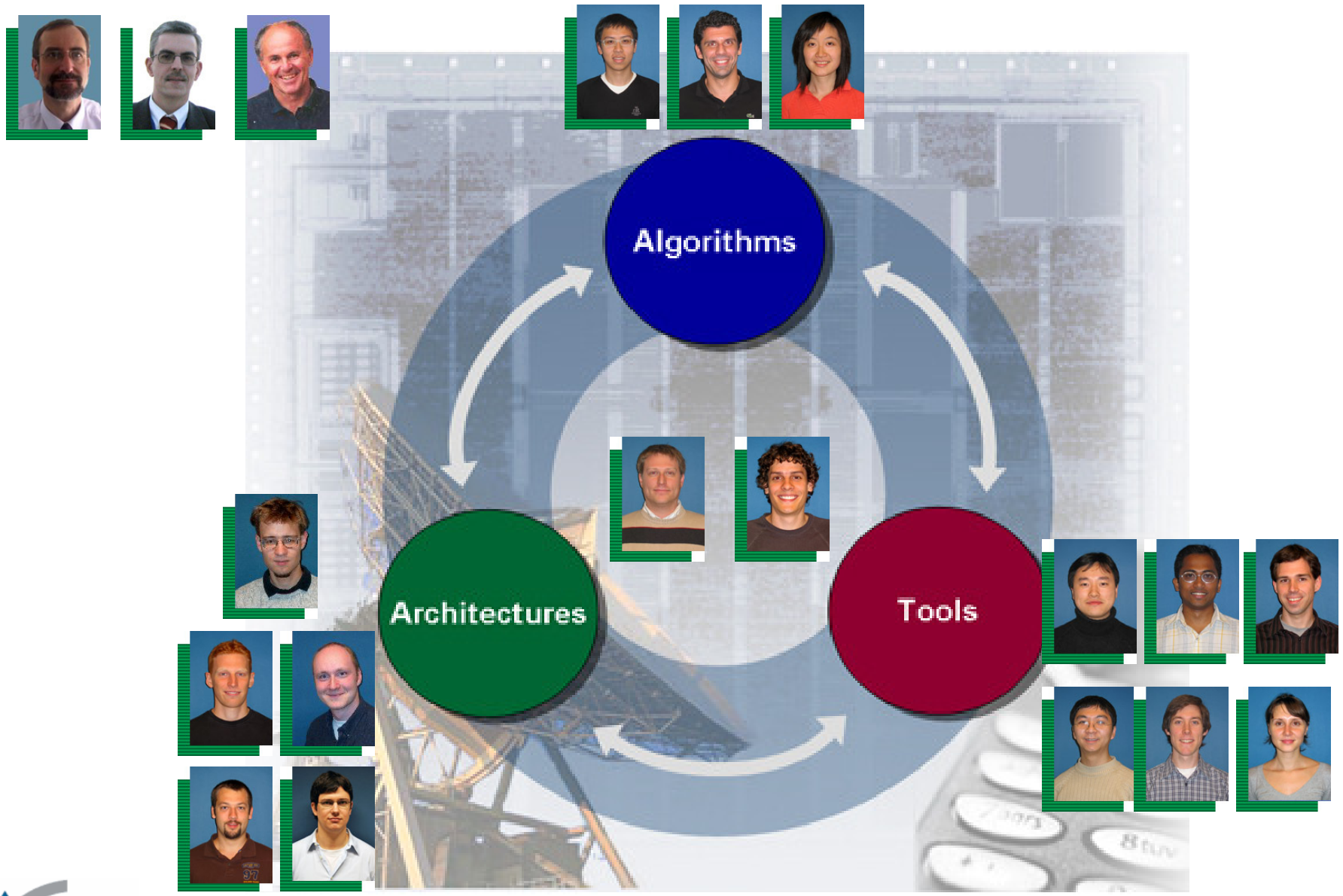
Flagship Project

within

(research cluster at RWTH Aachen University)

http://www.umic.rwth-aachen.de/

Nucleus Team



Thank you for your attention!

Any questions?