Universal Mobile Access to Information and Communication

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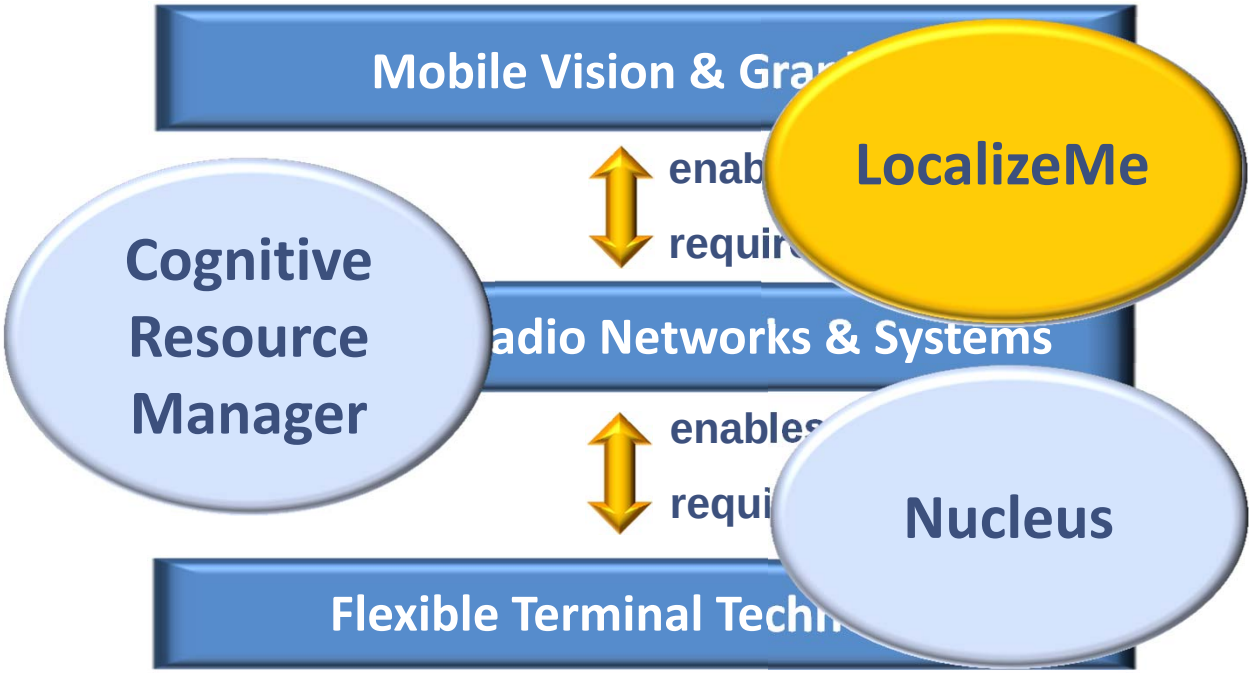
Key Research Challenges

- **Extraction and provision of information**
- **Providing coverage and 1000x data rate increase**
  - under the limited spectrum availability
  - at reasonable costs
- **Managing extremely complex systems**
- **Flexibility and huge processing performance under battery operation**

UMIC Major Research Fields

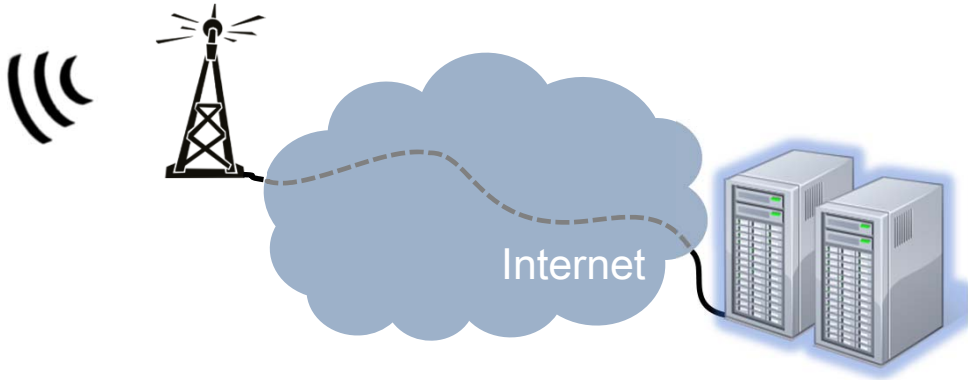


LocalizeMe: Motivation

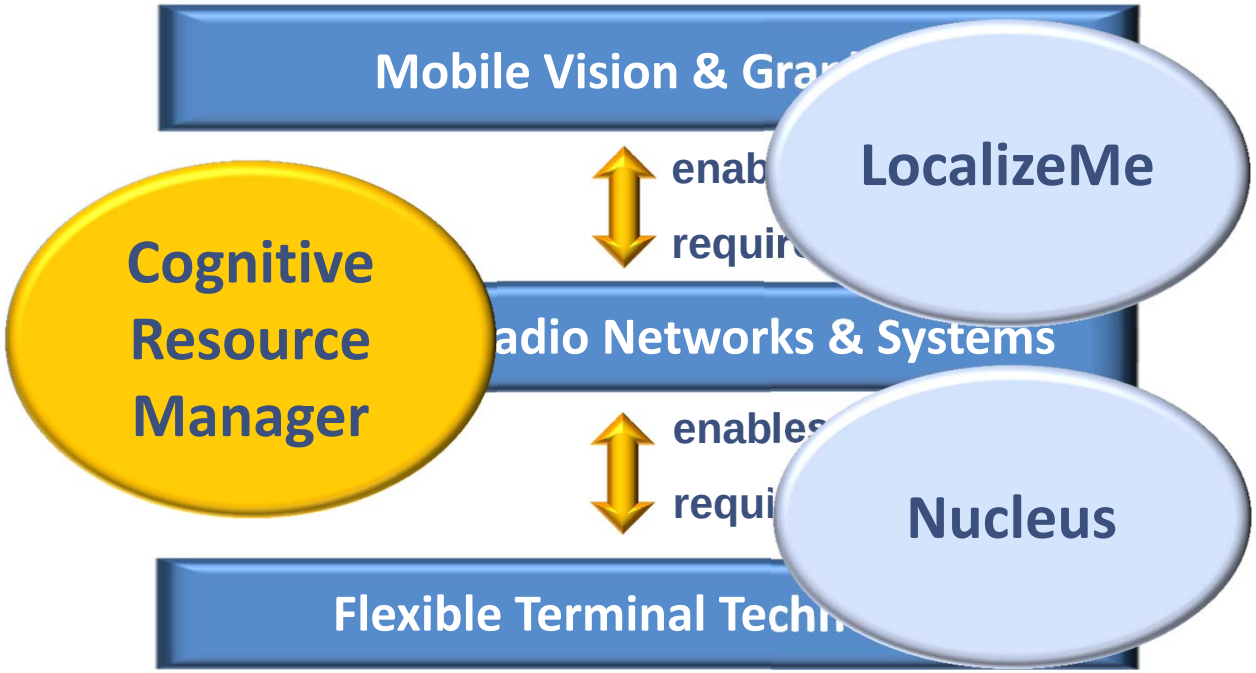
Vision-based mobile localization for user centric services

- **Basic functionality usable in many real-world applications such as *Google Goggles***

- **Our research question is broader**
  - How to build a service that can index, update, display, and facilitate interaction with content covering **entire cities**?
  - Identifying objects in large data bases

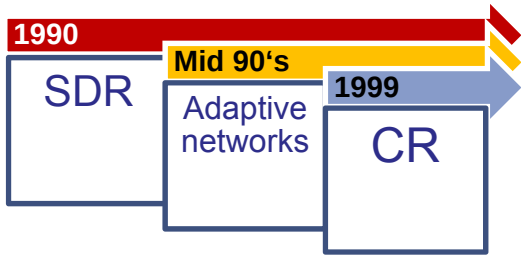


Key Research Fields



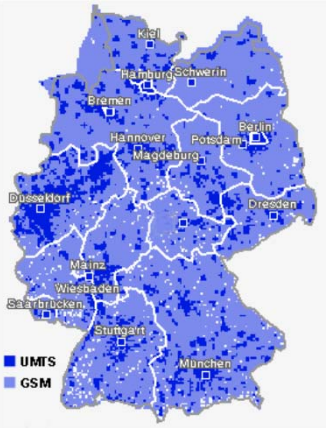
Objective: Making cognitive radios a reality

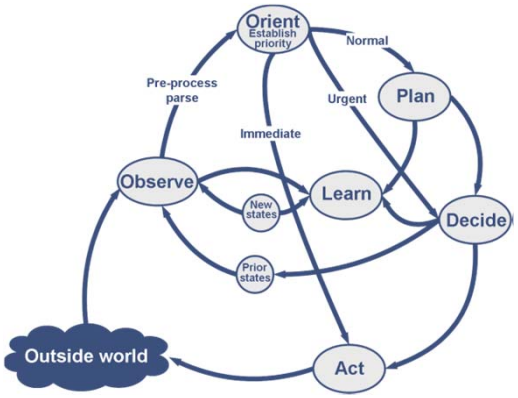
- **Key challenges**
  - Coverage and 1000x data rate increase
    - under the limited spectrum availability
    - at reasonable costs
  - Service variability
  - Heterogeneous networks
- **Approach?**

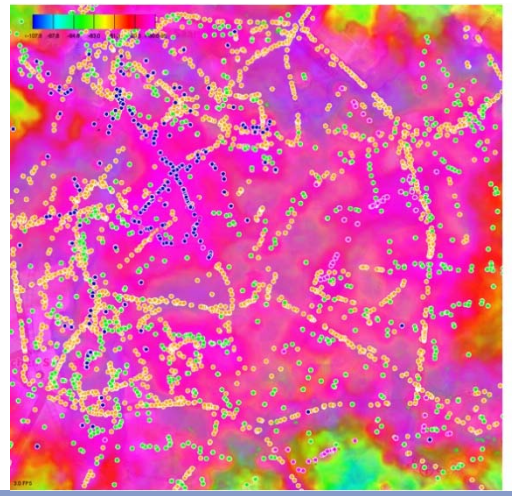


CRM in 4G+ Mobile Networks

- **Broadband coverage**
  - ***Issue*** for densely populated areas***:***
    - Aggregate data rate need exceeds cell capacity (spectrum limitation)
  - **Main *approaches***
    - Smaller cells: Pico cells, femto base stations
    - Heterogeneous access technologies (4G+, WiFi, …)
  - ***Requires***
    Cognitive devices and network organisation







Aachen downtown access points

- T-Mobile: 67
- RWTH: 300
- City WLAN: 900
- Individuals: 2400

3.600 APs / 3 km²
→ 1 AP / 30 m

(Sources: T-Mobile, Fon, BITKOM, OECD Report)

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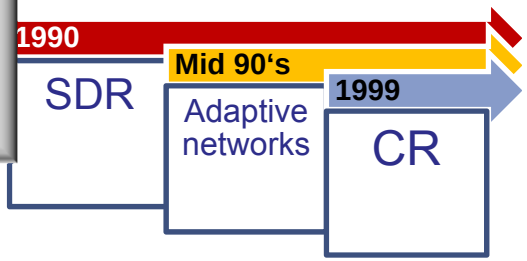
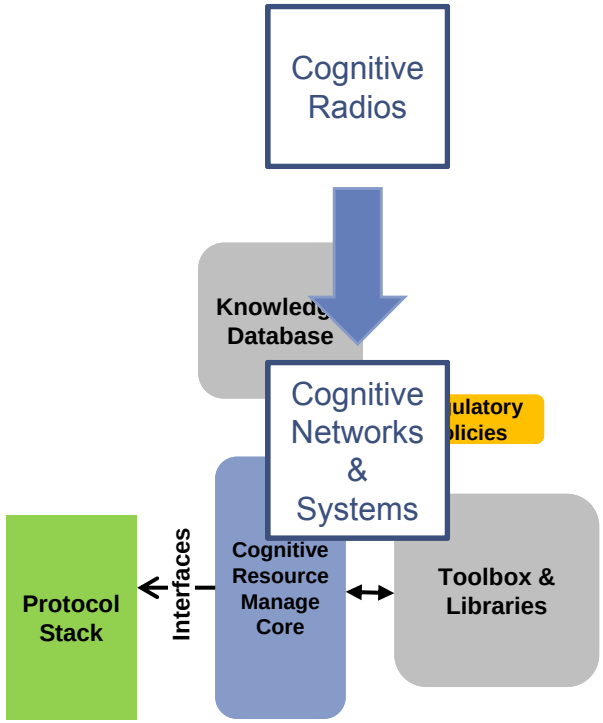
Objective: Making cognitive radios a reality

⇨Closing Keynote by Petri Mähönen

- **Key challenges**
  - Coverage and 10[illegible] data rate increase
    - under the limited spectrum availability
    - at reasonable costs
  - Service variability
  - Heterogeneous networks
- **Approach**
  - From Cognitive Radio (CR) to Cognitive Mobile Networks & Systems (CRNS)
  - Self-organization and cross-layer optimization
  - Based on the "Cognitive Resource Manager" Core





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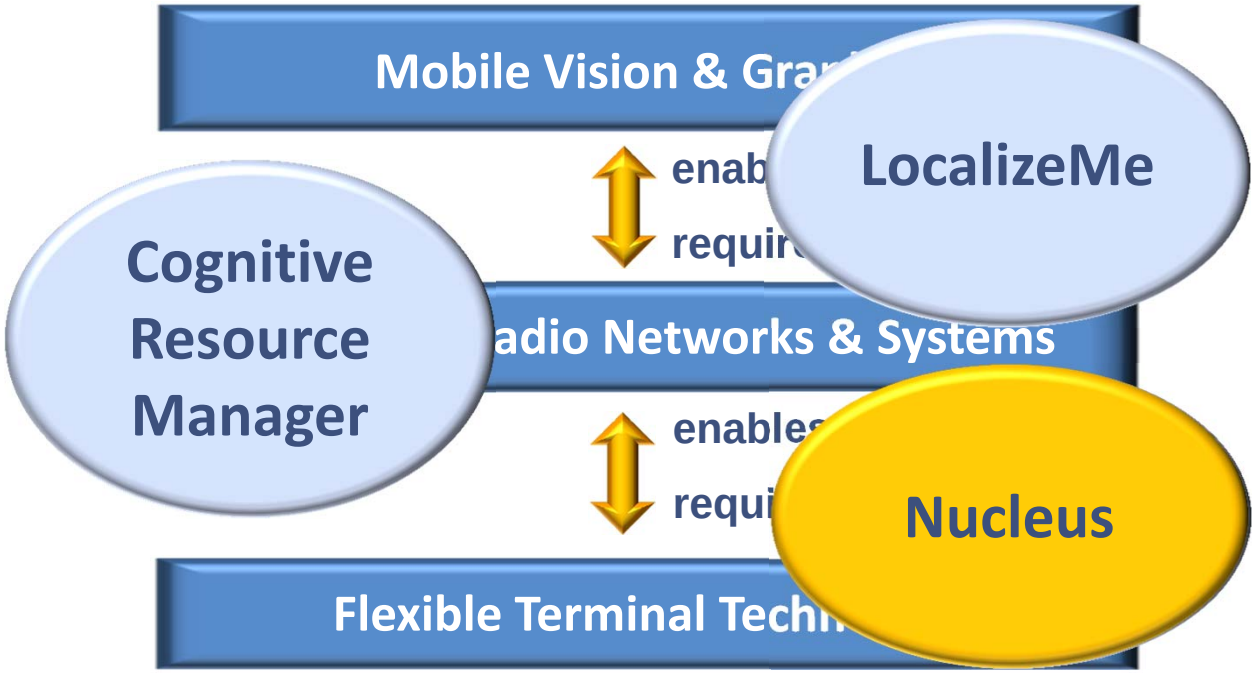


Nucleus: Motivation

- **Flexible, energy efficient baseband and MAC processing to support (cognitive) wireless systems**

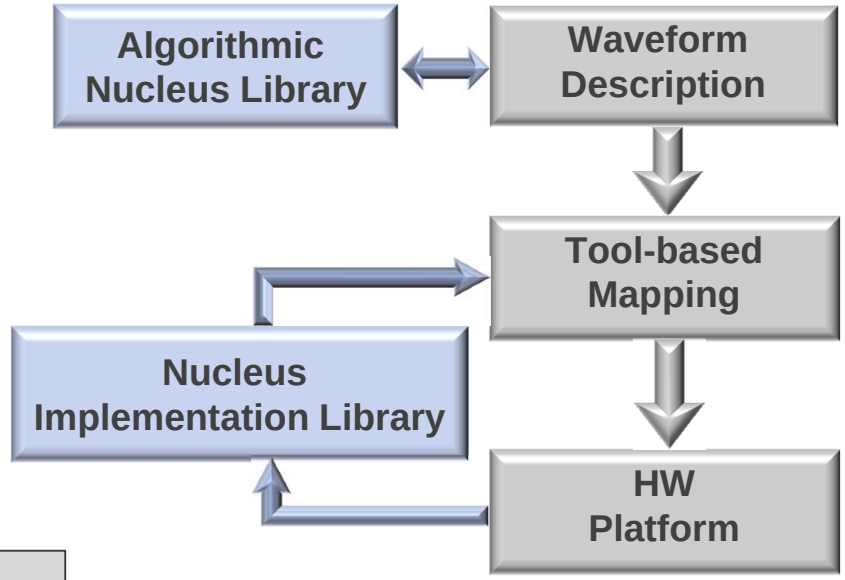
Signal processing applications are based on a small number of fundamental kernels – "Nuclei" – that represent a significant amount of the computation

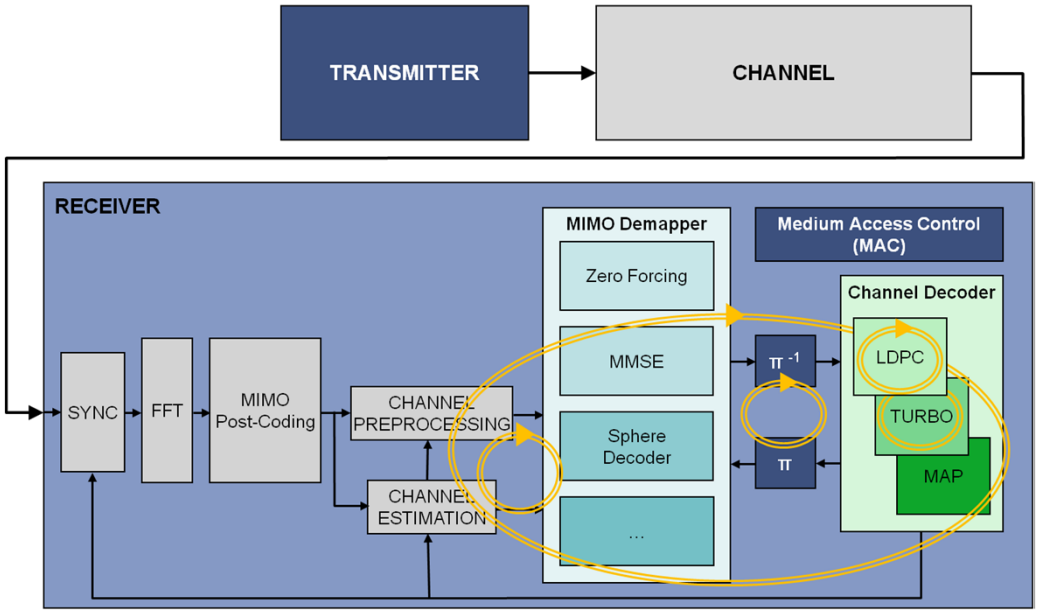
- **We found answers to the key questions:**

Identification	• What are the right Nuclei?
Implementation	• How to build efficient implementations (Flavors)? • What is the flexibility required?
Tools	• What is the appropriate design methodology? • How to abstract implementation to boost productivity?

Nucleus: Research Approach

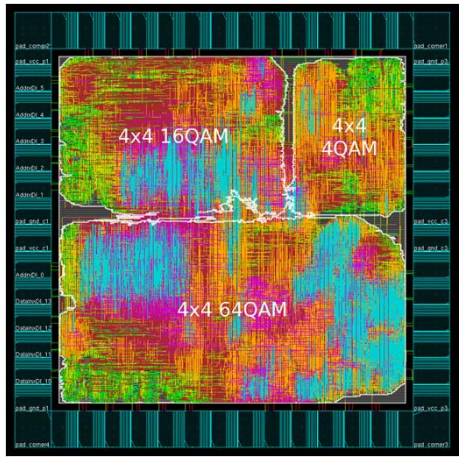
- Novel Nucleus aware design methodology
- Algorithms, architectures, and tools co-design
- Driver application: MIMO OFDM receiver PHY/MAC

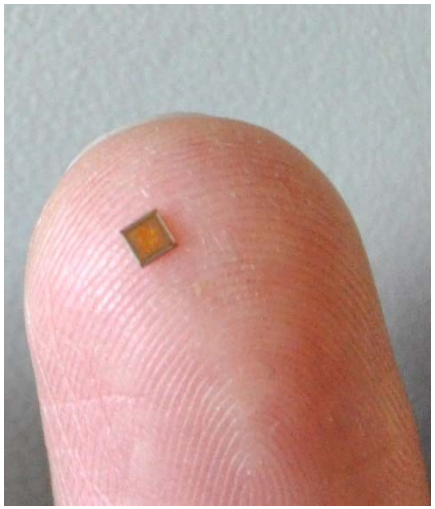


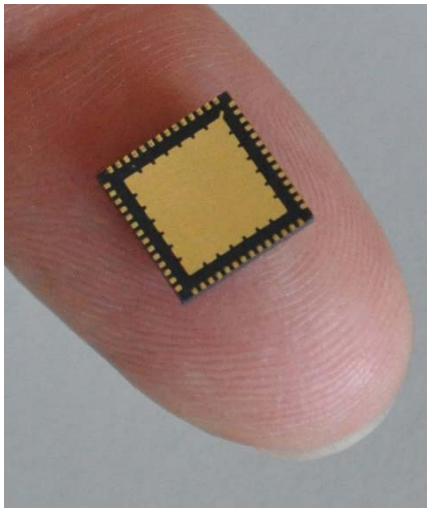


Nucleus: Key Results

- **Complex Nucleus block design**
  - MIMO demapper
  - Built 1st soft-input soft-output sphere decoder ASIP applying a single tree-search approach (CAE^{2}SAR chip)
  - Fully characterized w.r.t. performance, power efficiency and flexibility







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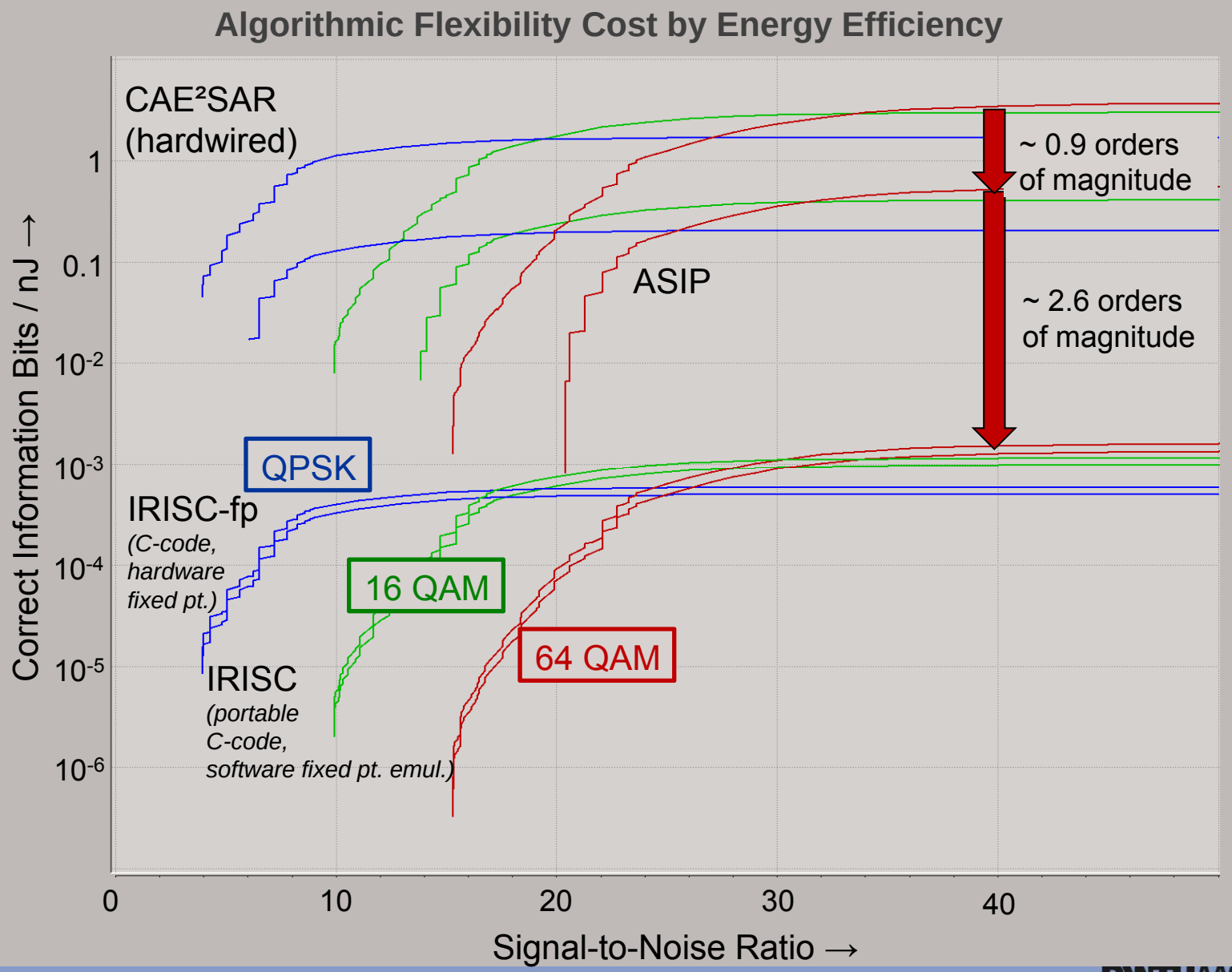

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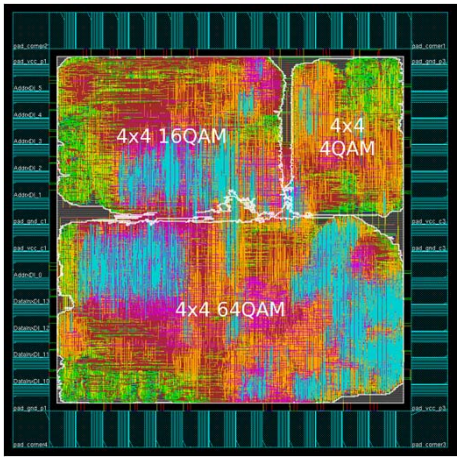
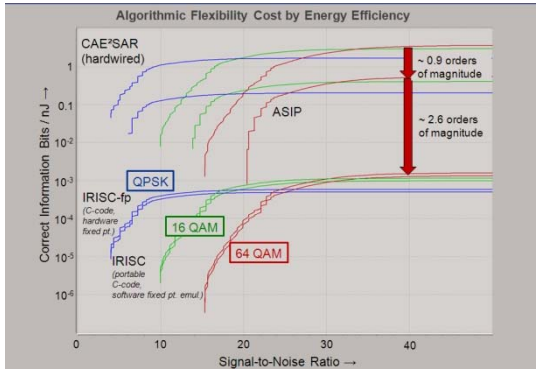


- **Nucleus project result**
  - Design and programming methodology for heterogeneous multi-core systems
    - CPN: description language
    - MAPS: tool approach
    - Nucleus: methodology
    - Functional performance based tradeoff between energy efficiency and flexibility



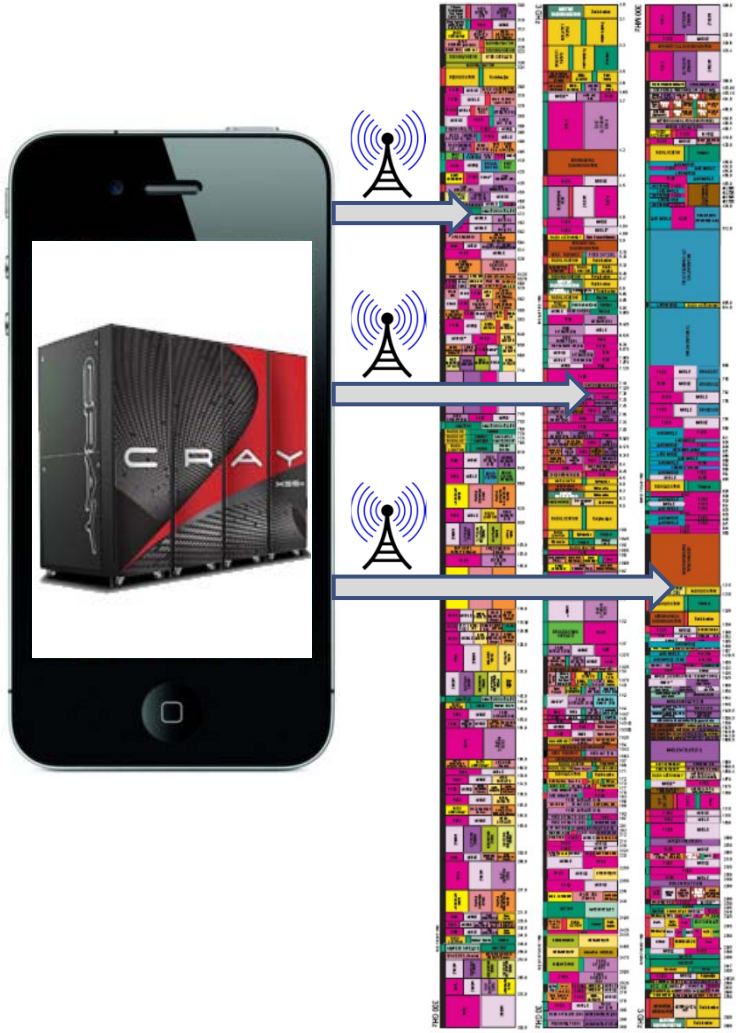
Future Flexible Terminal Technology

“The ultimate mobile terminal”

- Cognitive radio enabled
- Energy efficient
- Supporting challenging applications

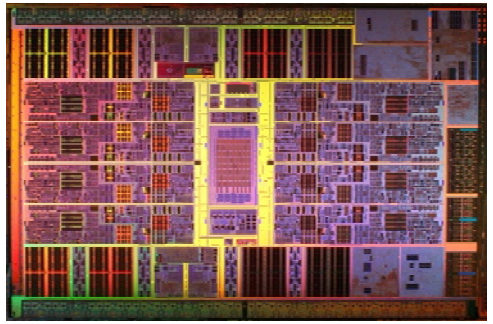
Key challenges

- Provide huge processing capacity with limited power consumption
- Multi-billion transistors, multi-million lines of code HW/SW platforms
- Covering an extremely wide range of frequency bands

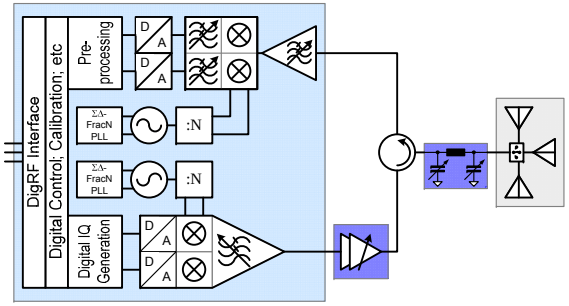


Future Flexible Terminal Technology

- **Manycore system architectures**
  - Expand UMIC's Nucleus approach
  - Explore opportunities of complex "Manycore" platforms
  - Demonstrator: Nucleus based "Manycore" chip



- **Flexible radio**
  - Cognitive radio platform, supporting efficient spectrum usage
    - High dynamic range, frequency agile RF without duplexer or SAW-filters from 400 MHz to 6 GHz
    - Efficient multimode CMOS power amplifier and RF DAC



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