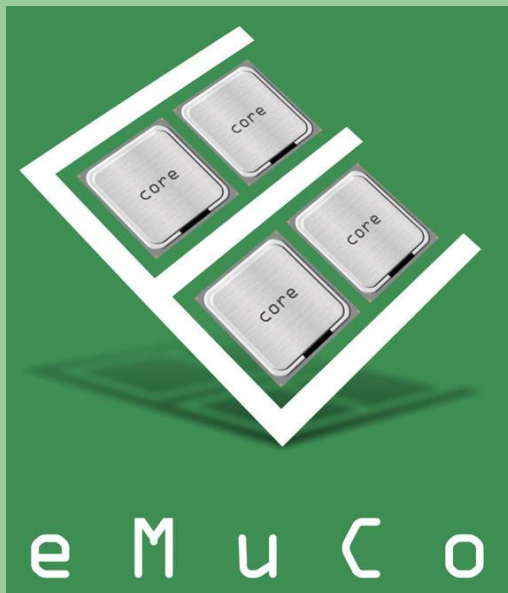


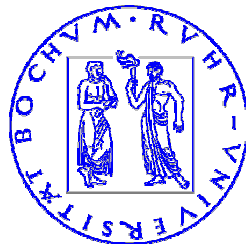
# Embedded Multicore Processing for Mobile Communication Systems



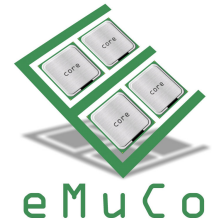
**Maria Elizabeth Gonzalez**  
**Ruhr-University Bochum**

**eMuCo**

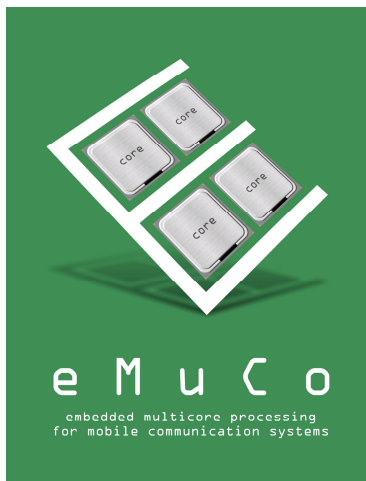
**Trends for Future Smart  
Phones**



# eMuCo Overview



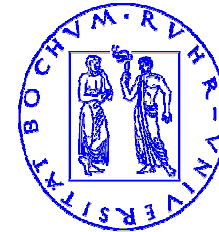
**At A Glance: eMuCo**  
*Embedded Multi-Core Processing for  
Mobile Communication Systems*  
Collaborative Project with 8 partners:  
3 industry, 1 SME, 4 academic



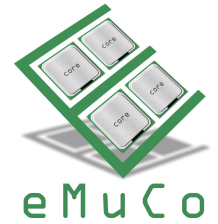
**Project Coordinator**  
*Attila Bilgic*  
*Ruhr Universität*  
*Bochum*

[www.emuco.eu](http://www.emuco.eu)

**Duration:** 24 months  
*February 2008 – January 2010*  
**Total Cost:** € 4.582.829  
**EC Contribution:** € 2.900.000

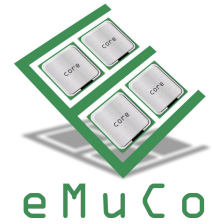


# Why multi-cores in Mobile Phones?

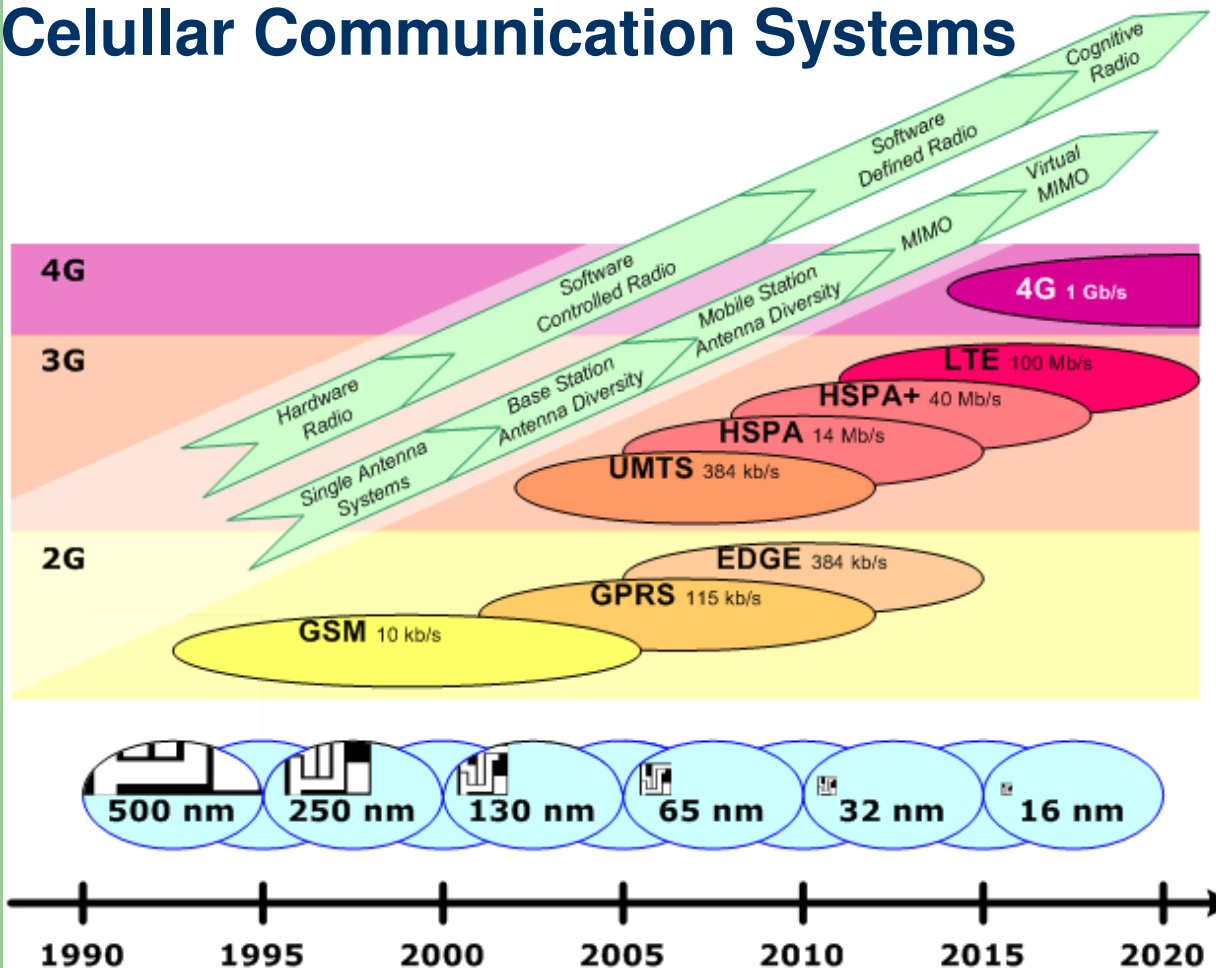


- Computational complexity

# Why multi-cores in Mobile Phones?

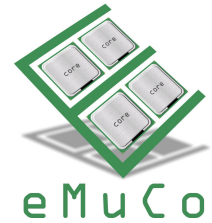


## Celular Communication Systems

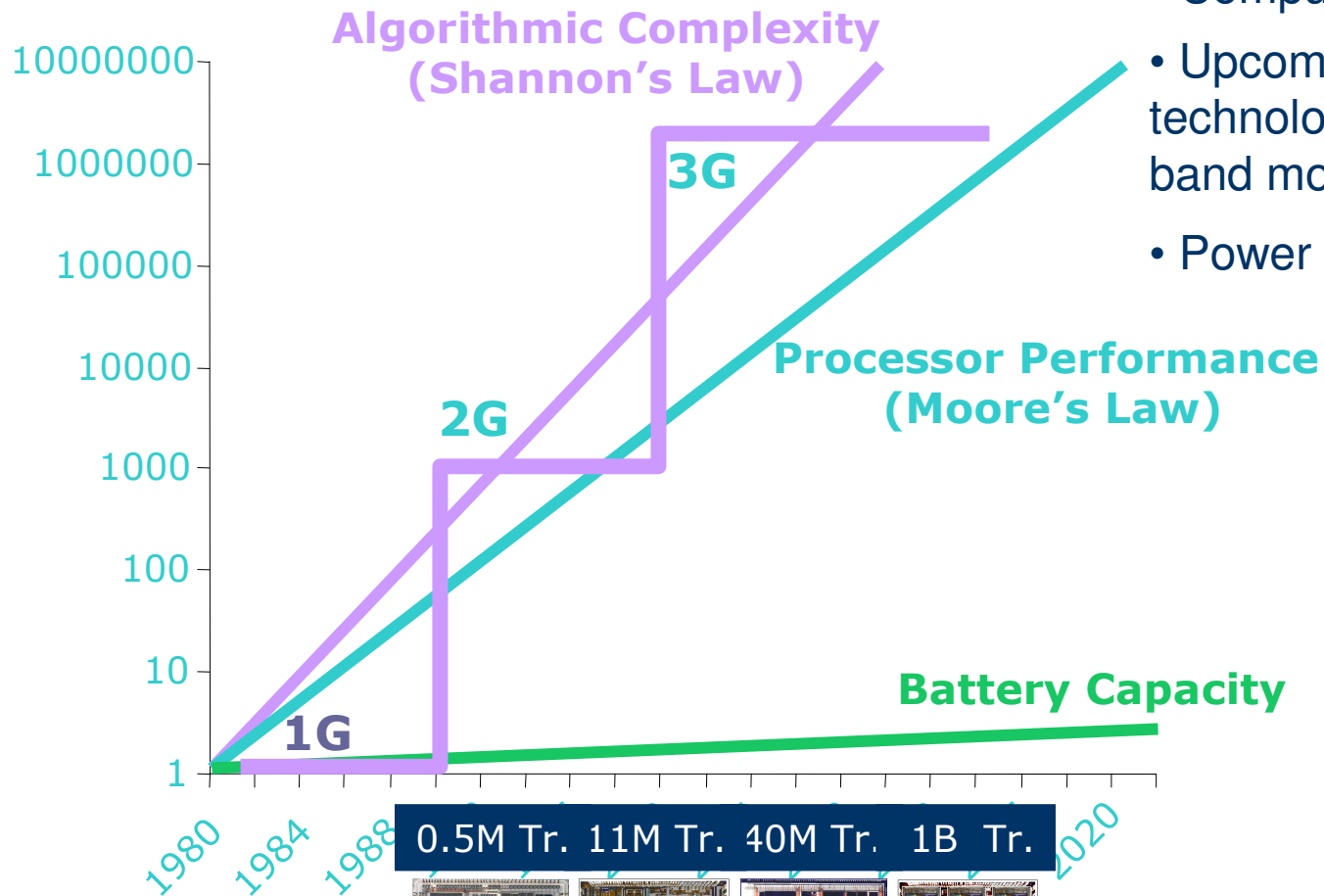


- Computational complexity
- Upcoming radio access technologies providing broadband mobile data access

# Why multi-cores in Mobile Phones?

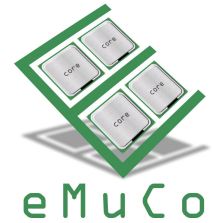


## The Algorithmic Driving Force

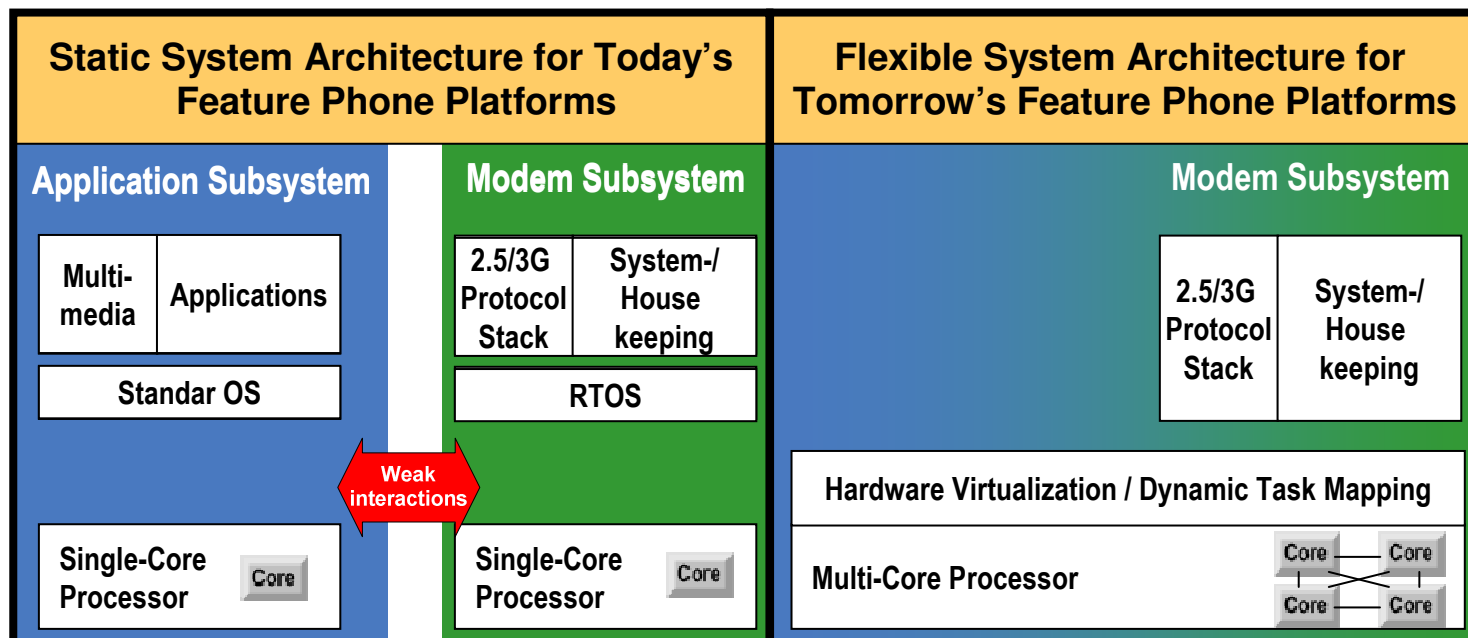


- Computational complexity
- Upcoming radio access technologies providing broadband mobile data access
- Power Consumption

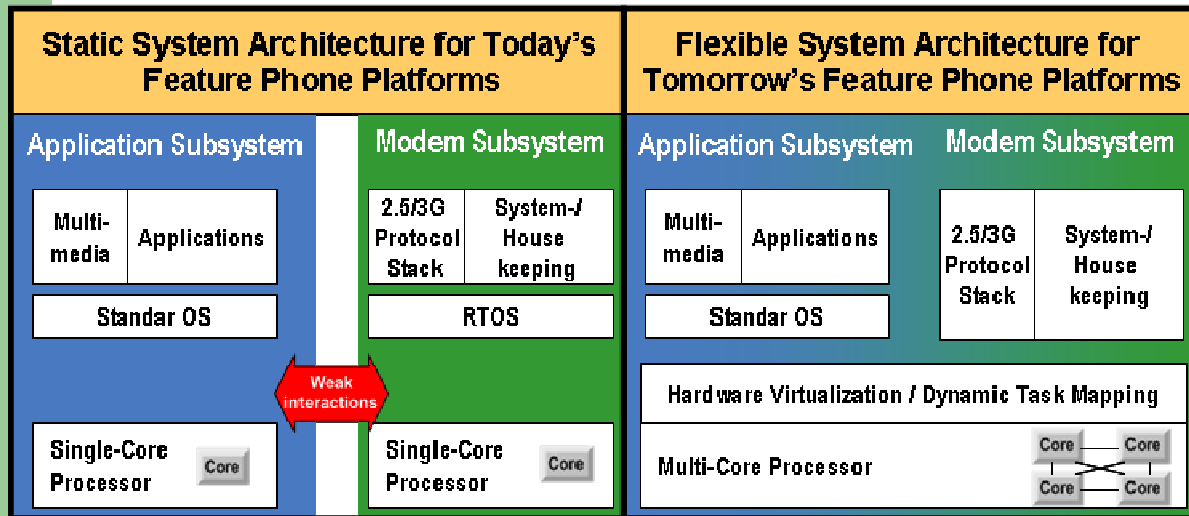
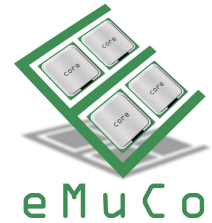
# Why multi-cores in Mobile Phones?



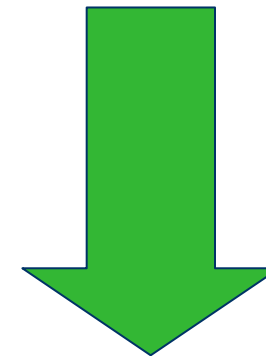
- Computational complexity
- Upcoming radio access technologies providing broadband mobile data access
- Power Consumption
- Flexibility and Scalability



# Why multi-cores in Mobile Phones?

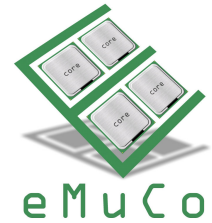


- Computational complexity
- Power Consumption
- Upcoming radio access technologies providing broadband mobile data access
- Flexibility and Scalability

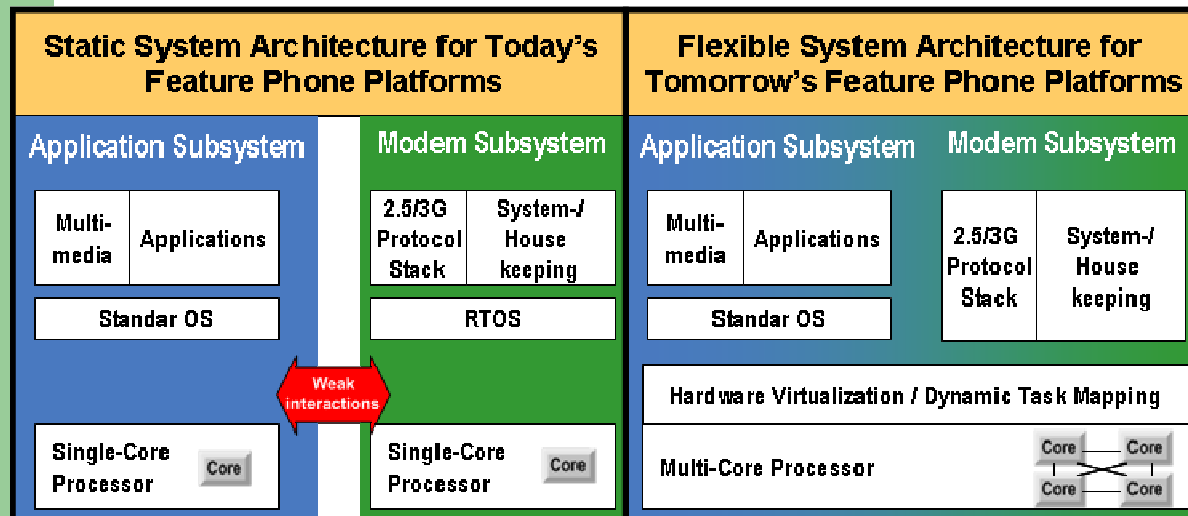


***With the recent advances in wireless networks and the exponential growth in the usage of multimedia applications, multi-core platforms point to be the solution of feature-rich phones to deliver the performance comparable to today's computer system.***

# Software Challenges



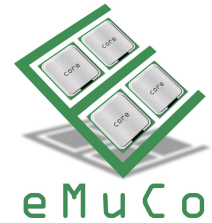
***Adding software to a mobile phone to permit to exploit the enormous performance gain provided by multi-cores as can be seen in today's PCs creates several challenges.***



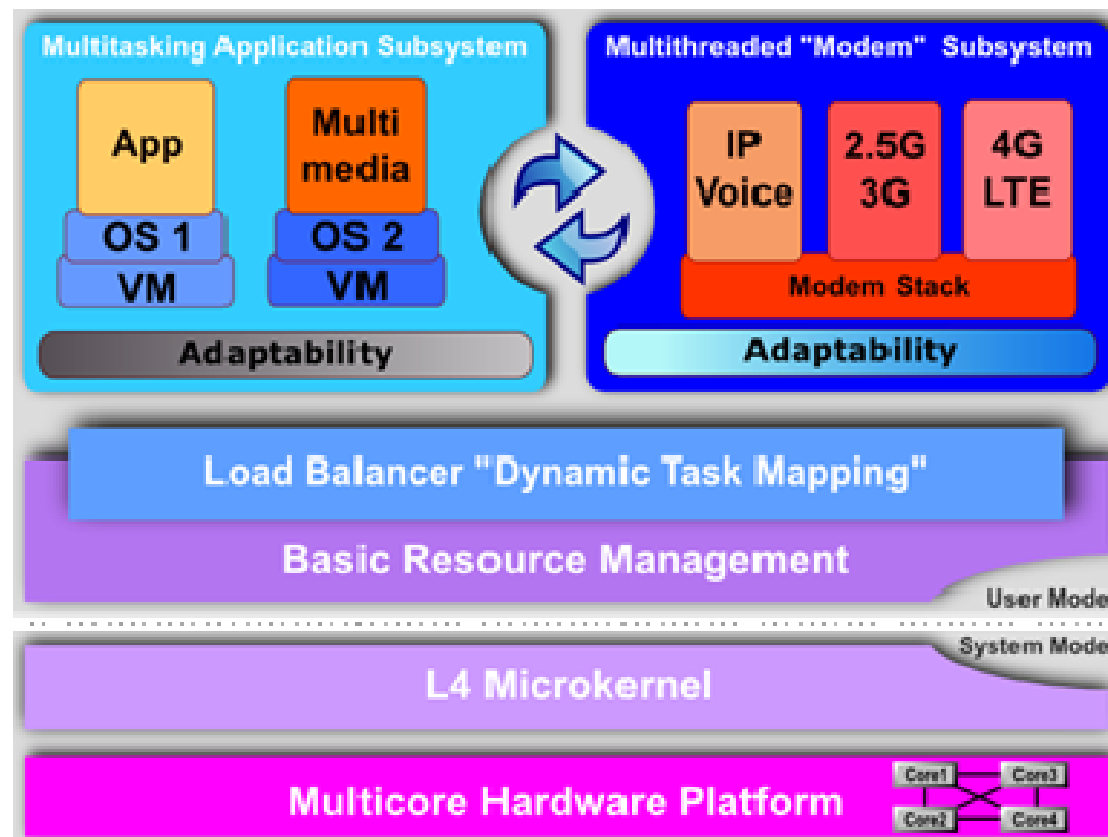
- Seamless and secure integration of diverse software environments
- Concurrent and parallel execution of applications and control signals
- Multiple cores will only provide more speed when used with multi-threaded software
- User experience



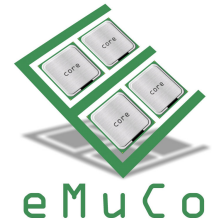
# eMuCo Solution



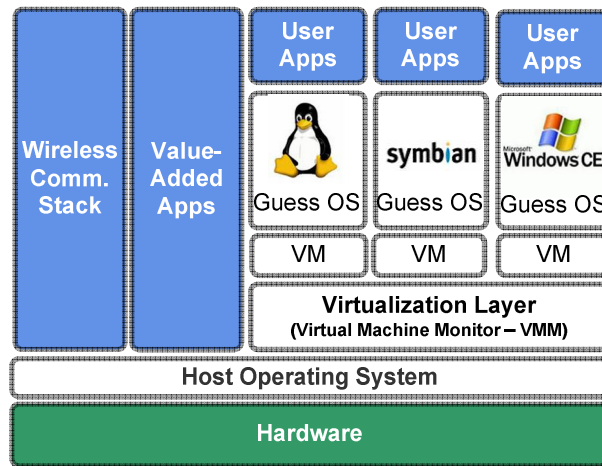
***eMuCo (Embedded Muticore Processing for Mobile Communication system) is a commercially viable solution to Embedded Muticore Processing for Mobile Communication system.***



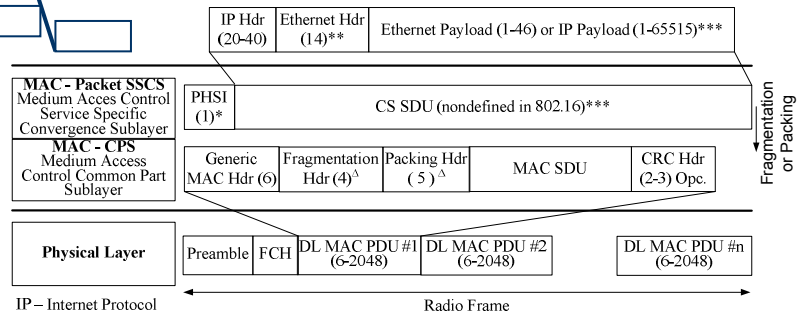
# Why Virtualization



## Use Case:

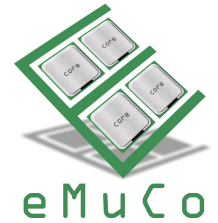


- Complexity Becomes Limiting Factor
  - Time to Market
  - Reliability
- Isolation
  - Security
  - Robustness (Fault containment)
- Real-Time Workloads alongside legacy
- Flexible Resource Usage (Multi-cores)

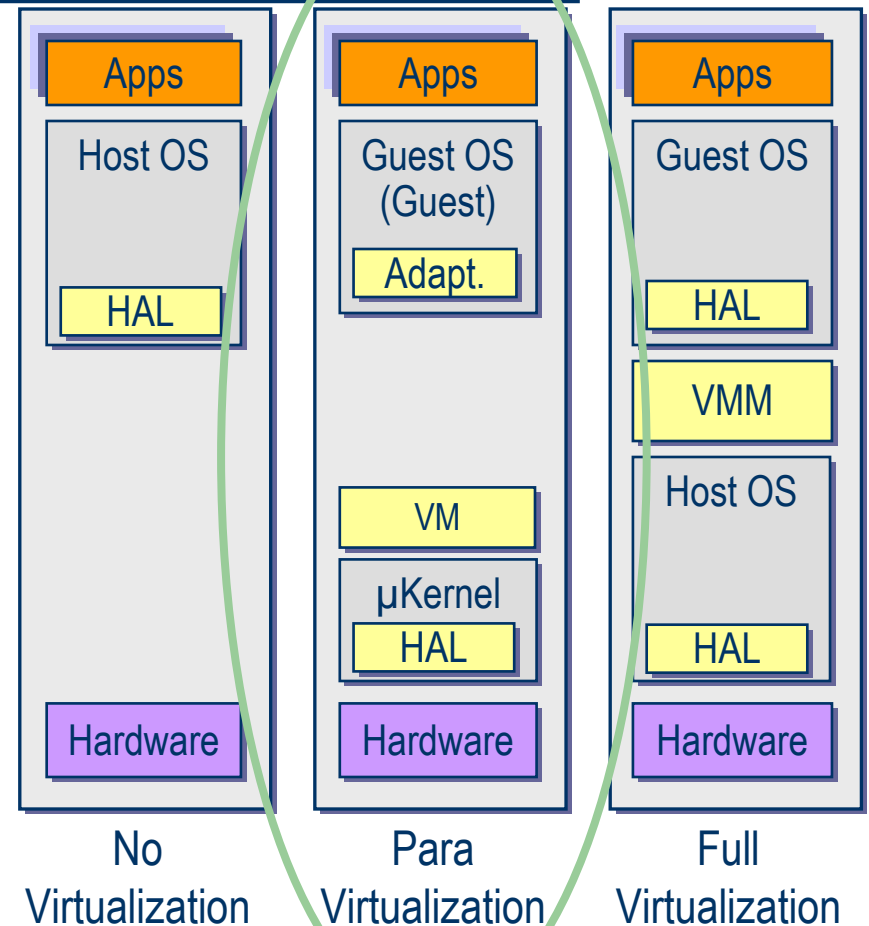


IP - Internet Protocol  
 SDU - Service Data Unit  
 PHSI - Payload Header Suppression Index  
 FCH - Frame Control Header  
 \* When the header suppression is activated, the IP, Ethernet und UDP header are suppressed  
 \*\* When 802.1Q VLAN is used, 4 bytes are added to the Ethernet header  
 \*\*\* Depend on upperlayers. The standard 802.16 does not have restrictions in this field  
 Δ Extended MAC headers used when the MAC SDU is fragmented or packed

# Virtualization – Concepts

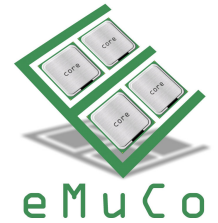


- No virtualization
  - Adaptation to HW needs to be built into Host OS
- Para Virtualization
  - Split OS into platform dependent and independent part
  - Requires adaptation of Guest OS
  - Low performance penalty
- Full Virtualization
  - Virtual Machines (VM) virtualizes complete HW environment
  - Performance penalty



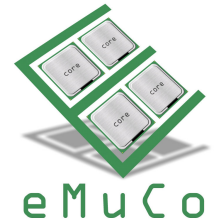
**Best for mobile devices**

# Advantages of $\mu$ Kernel



- Modularity
- Flexibility
- Extensibility
- Better footprint management
- Easier development, unit testing, maintenance and portability

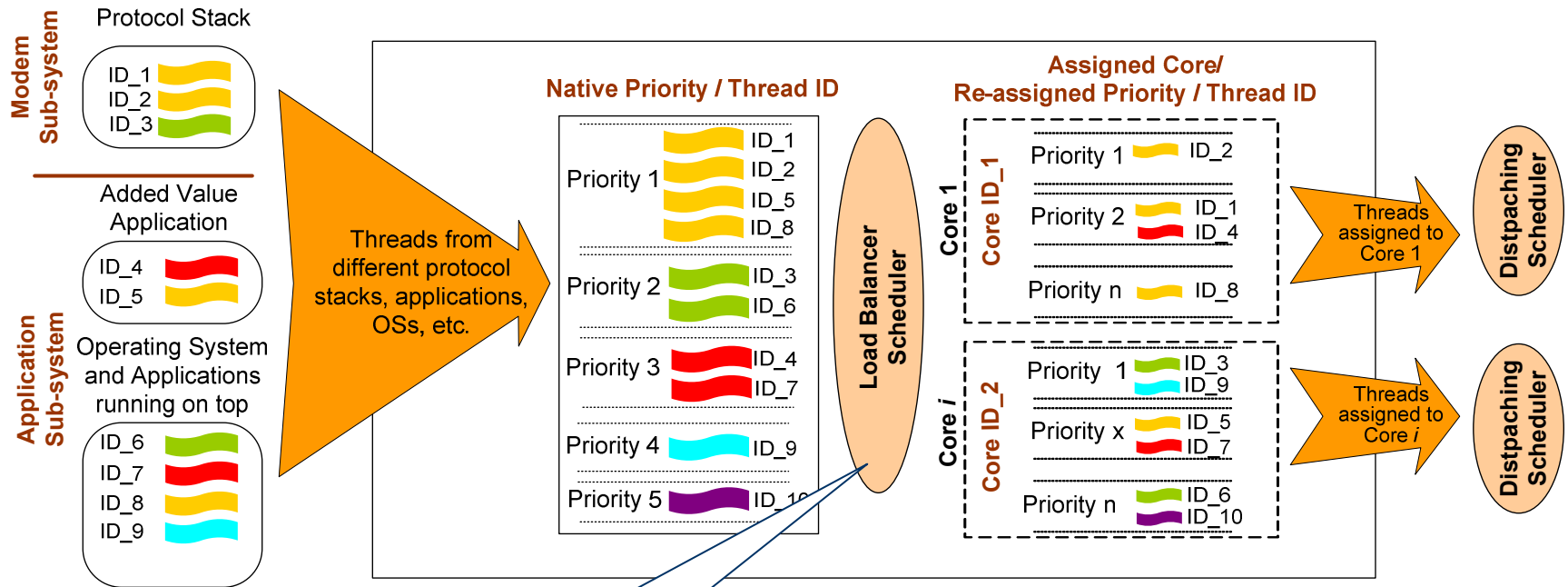
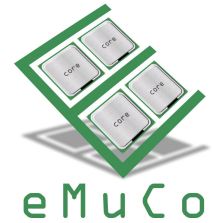
# Multiplexing CPU through the VMs?



**Virtualization and time slice  
is not enough  
in the times of multicore mobile embedded  
systems!**

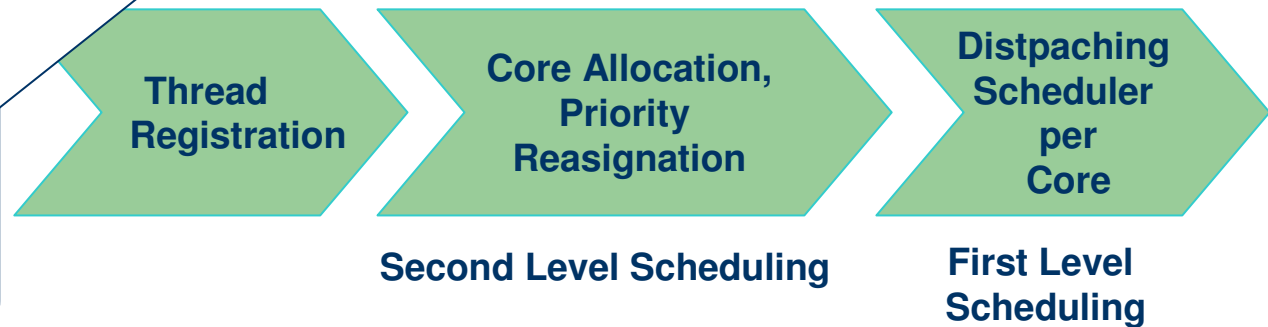
**Load Balancing becomes and Issue!**

# Functionality view of the Load Balancer

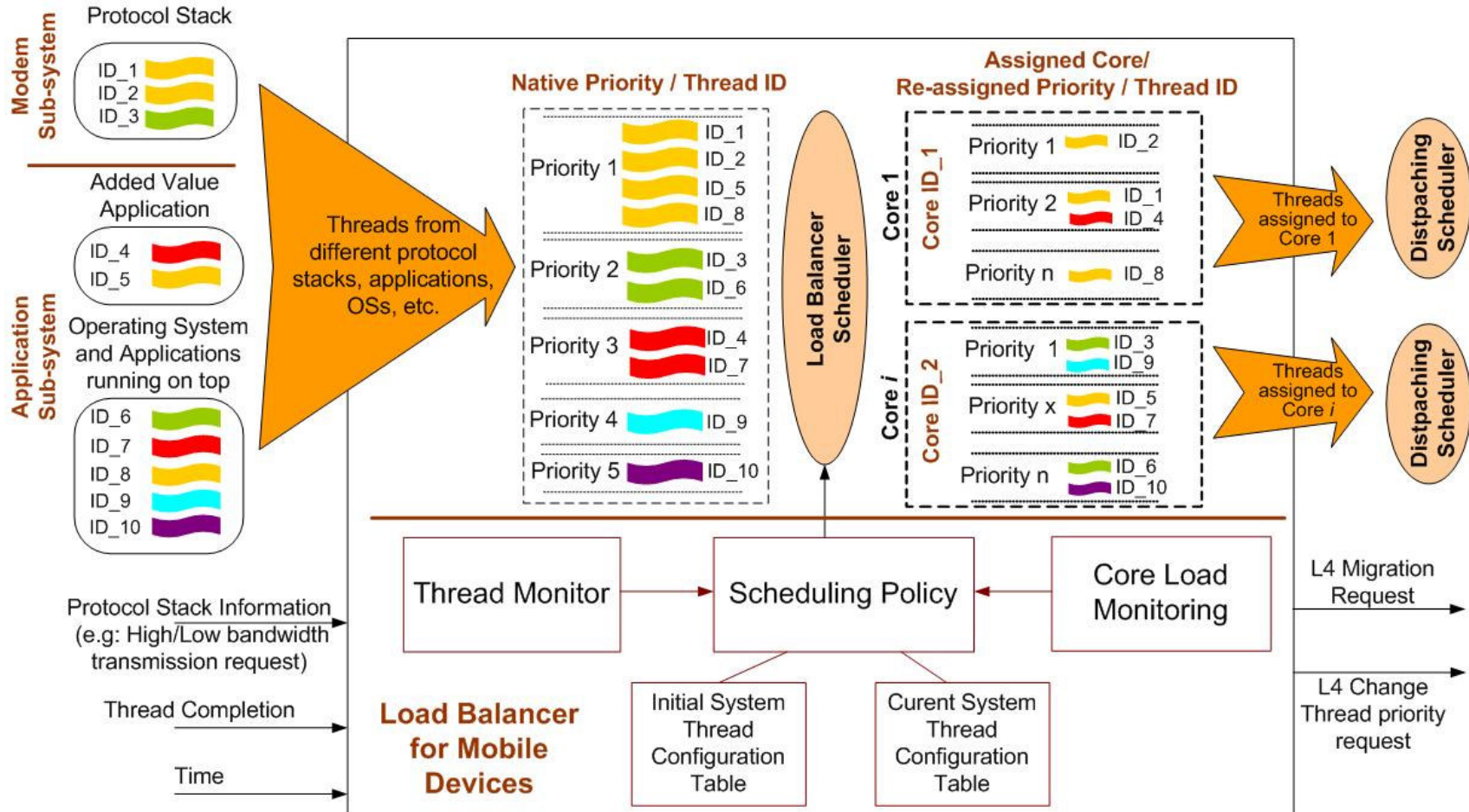
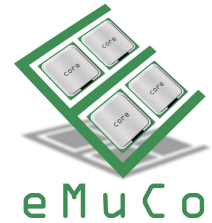


## Decision based on:

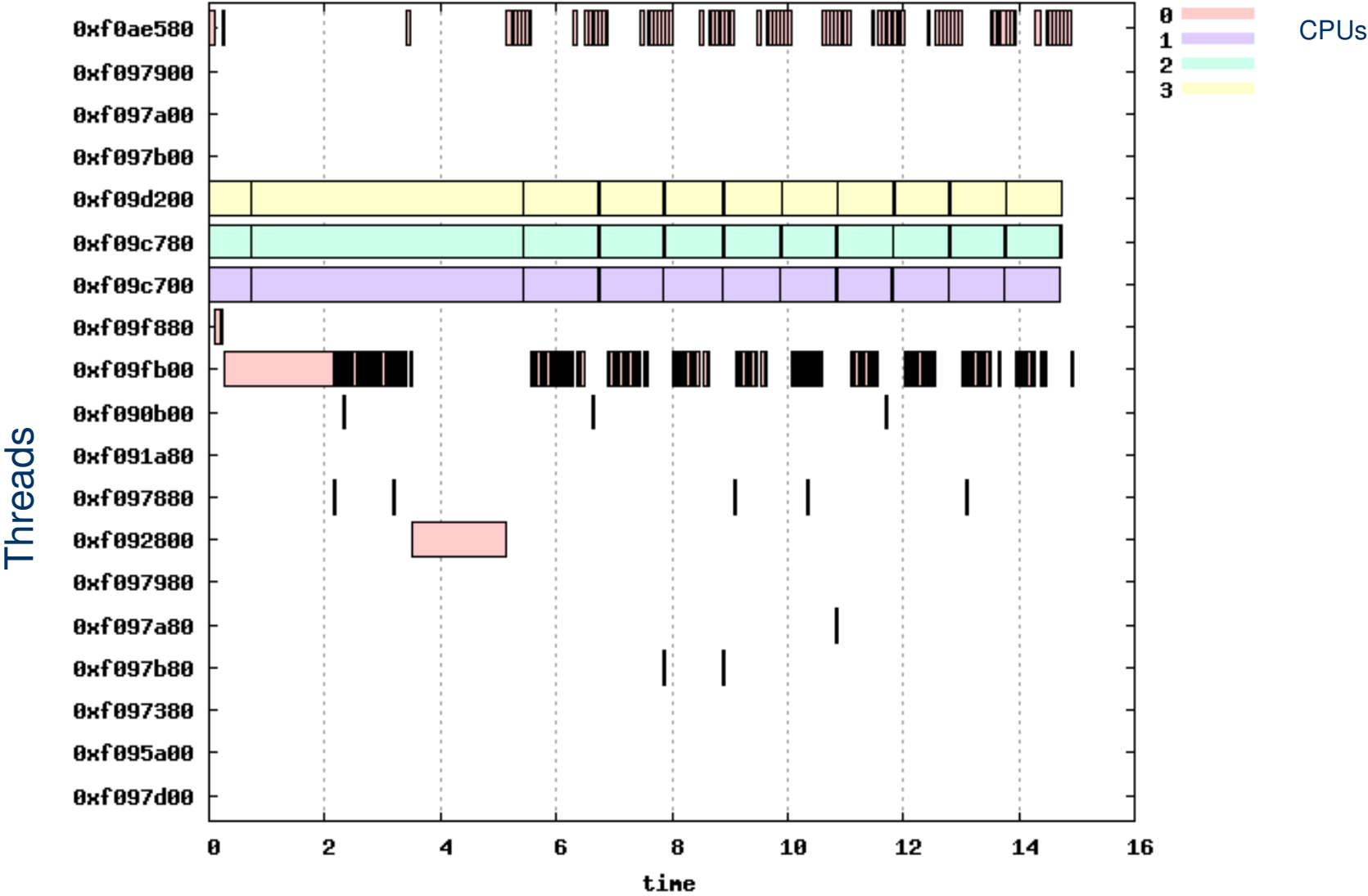
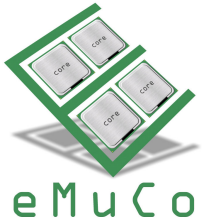
- Capacity limit of the unit processing;
- Capacity limit of the communication Channel
- Profiling information of the processing stages
- Approximate knowledge of the processing demand of the expected Workload.



# Top-Level Conceptual Load Balancer architecture

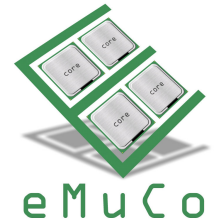


# Context Switch Monitor





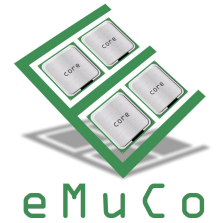
# Expected Impact



The project will support Europe to gain:

- Sustained leadership in mobile communication
- Market leadership for embedded multi-core systems
- Leadership in software development tools for embedded multi-core systems
- Open source platform components for european embedded systems

# Thank you

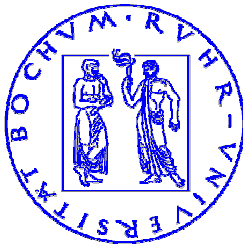


[www.emuco.eu](http://www.emuco.eu)

**Maria Elizabeth Gonzalez**

**[Elizabeth.gonzalez@is.ruhr-uni-bochum.de](mailto:Elizabeth.gonzalez@is.ruhr-uni-bochum.de)**

Project Coordination:



Prof. Dr. Ing. Attila Bilgic  
E-mail: [attila.bilgic@is.rub.de](mailto:attila.bilgic@is.rub.de)  
Ruhr-Universität Bochum  
Institute for Integrated Systems  
Universitätsstrasse 150  
D-44780 Bochum  
GERMANY

ICT-eMuCo is a European project supported under the Seventh Framework Programme (FP7) for research and technological development

