FLAVIA - #257263
FLexible Architecture for Virtualizable future wireless Internet Access

(FP7 call 5, obj1.1)

FLAVIA: Project Overview

R&D towards the Future Wireless Internet

- **Paradigm shift:** From *pre-designed link services* to *programmable link processors*
- **Key concepts:**
  - Explore possible flexibility and programmability level in future wireless technologies
  - Shift as much as possible development and customization from hardware to software

Consortium

Expected Benefits

- **New architecture design for Future Wireless devices (LTE/WiMAX/WLAN)**
  - Enable implementation of emerging standards on the same hardware platform
  - Reduce wireless products development, customization and optimization costs
- **Proof-of-concept validation through WLAN and WiMAX prototyping**
- **Contribution of designed solutions to relevant standardization fora**
  - Potential targets: IEEE 802.11, IEEE 802.16 and 3GPP

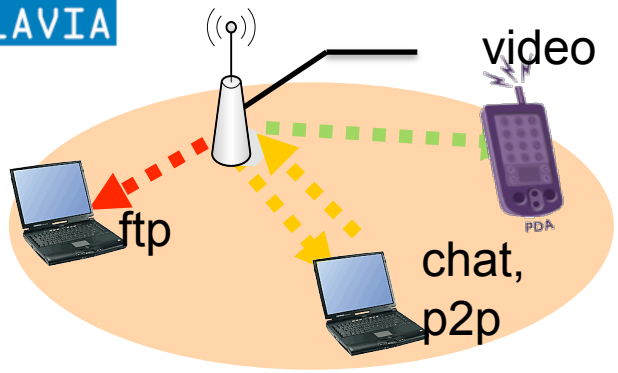
Why FLAVIA?

- Trend towards performance **is** important but wireless is not “just” performance….: FLAVIA focus: flexibility and openness
- Some examples of (in)flexibility…
  - **QoS over 802.11**
    - **6 years work for a standard!**
  - **Adaptive video over wireless**
    - **When 802.11aa will finalize?**
  - **Tailored resource management**
    - **Large customization costs**
  - **Emerging scenarios (mesh, overlapping, cooperative)**
    - **Slow deployment (proprietary-based)**
    - **Long standardization paths**
    - **no hope for “niche” needs**

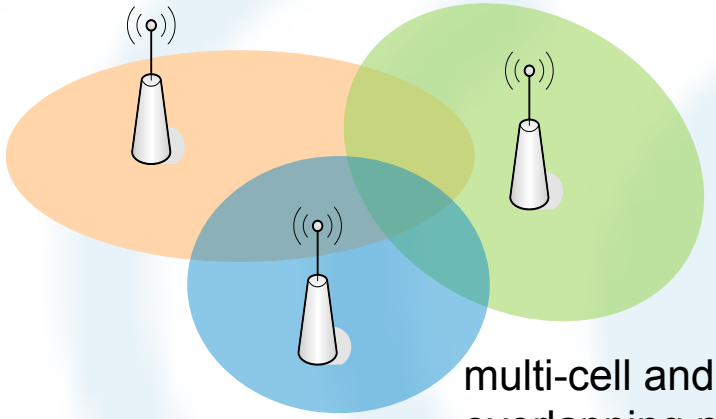
Why FLAVIA?

- Layer 2 interface: clean and well thought
  - retained throughout OSI→Internet stack
  - In wired networks…. But…
- Wireless: the failure of L2 SAP abstraction
  - An evolution “blocker” for wireless?
  - Why so much cross-layering, otherwise?
- Inside the wireless link layer stack
  - multiple users, interference management, distributed control, scheduling, etc
  - very complex features, all below the L2 SAP

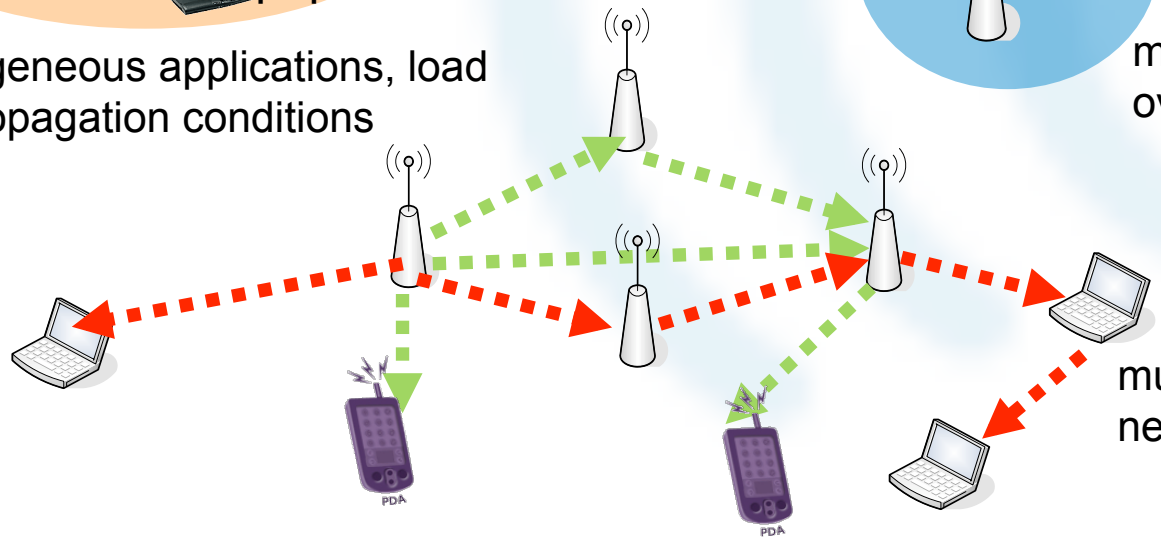
Contention-Based Network Scenarios



heterogeneous applications, load and propagation conditions



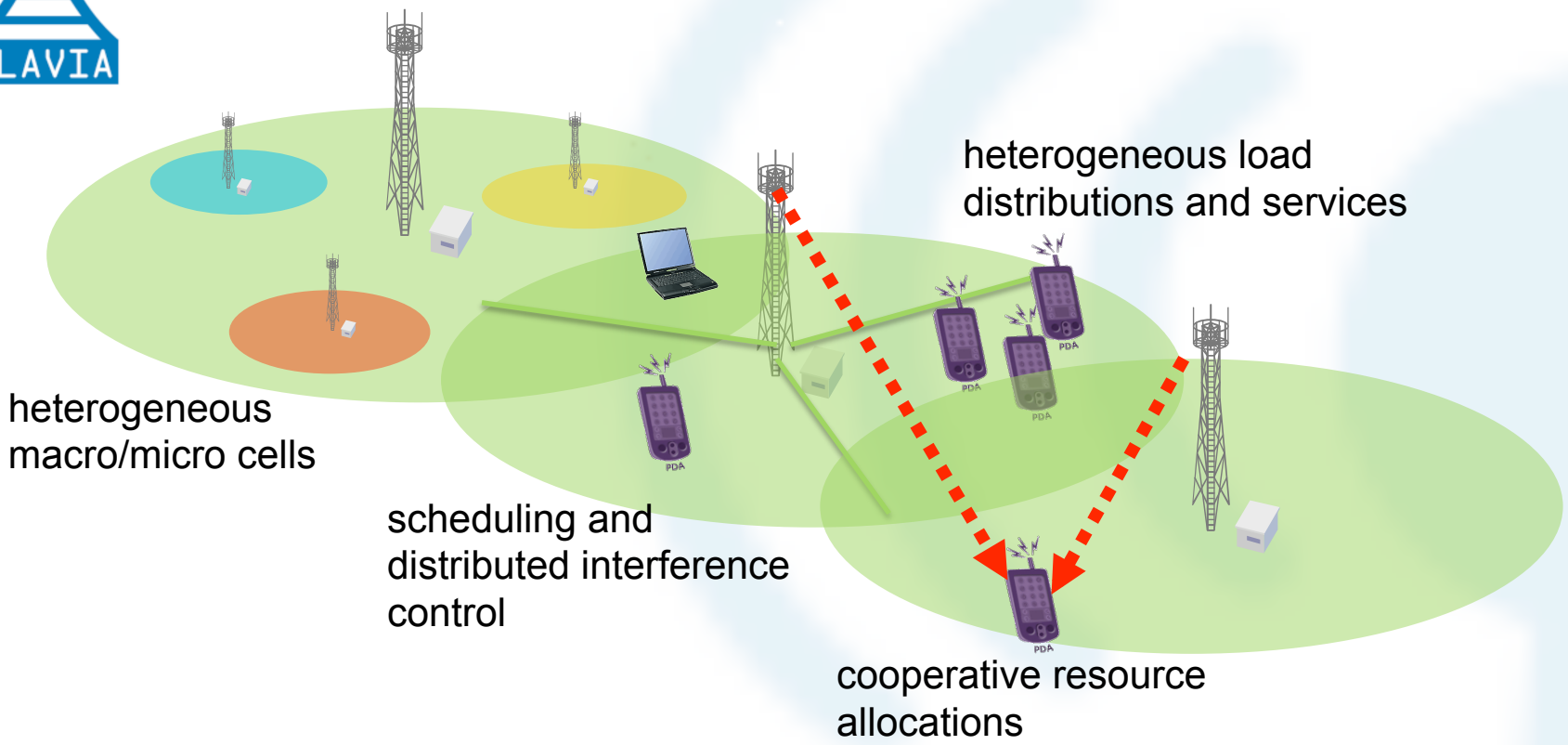
multi-cell and overlapping networks



multi-service mesh network

May a one-for-all solution adapt to different (evolving) networking and service contexts?

Scheduled-based Network Scenarios



May a one-for-all solution adapt to different (evolving) networking and service contexts?

FLAVIA vision

- Lower the L2 interface and “open” the MAC SAP blackbox
  - Expose key tuning knobs to higher layers
  - Benefit from hierarchies and relevant interfaces
- Wireless “processors”
  - Wireless cards and devices as “processors” that can execute wireless access coordination “modules”

Don’t confuse FLAVIA programmability vision with “full” card reprogrammability!
- Too costly; Too complex; yields fragmentation

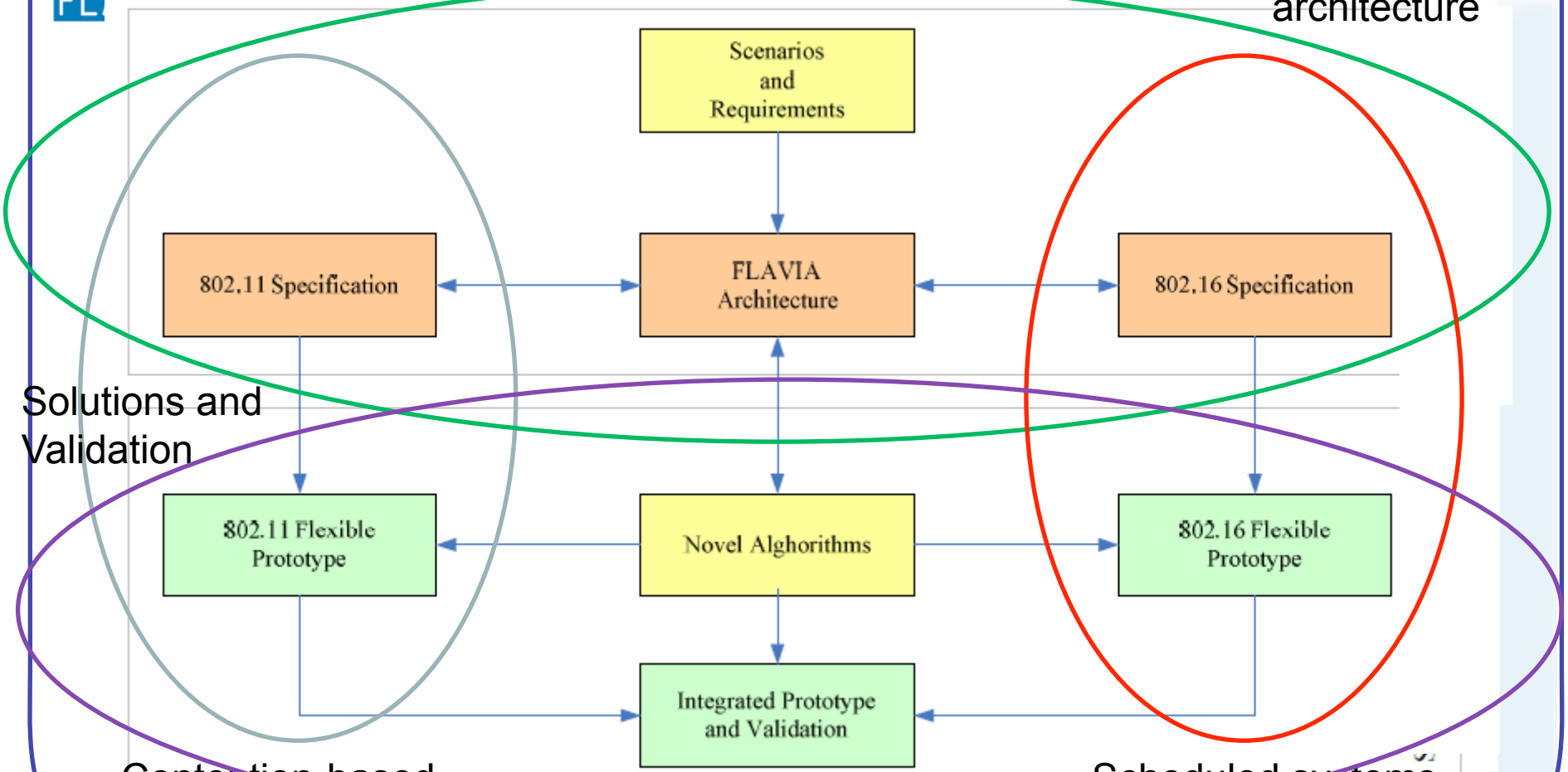
How to accomplish such vision
(at a glance, details and sub-goals in DoW)

- Objective 1: architecture
  - *we just said that an important problem of wireless today is the failure of the traditional OSI/ Internet layered architecture*
- Objective 2: two prototypes
  - *Leveraging existing standards: contention-based (leveraging 802.11) and scheduled based (leveraging 802.16, but keeping in mind LTE)*
- Objective 3: advanced algorithms using the new architecture and primitives
  - *Research direction devised to both prove, with concrete case studies, that our architectural design and identification of primitives works, as well as challenge it by providing feedbacks.*
- Objective 4: two trials
  - *@ Alvarion and @ TID*
- Objective 5: standardization and dissemination
  - *Invest project resources in standard committees for fostering our new vision*

FLAVIA Technical Approach

FLAVIA Workflow

Components and architecture



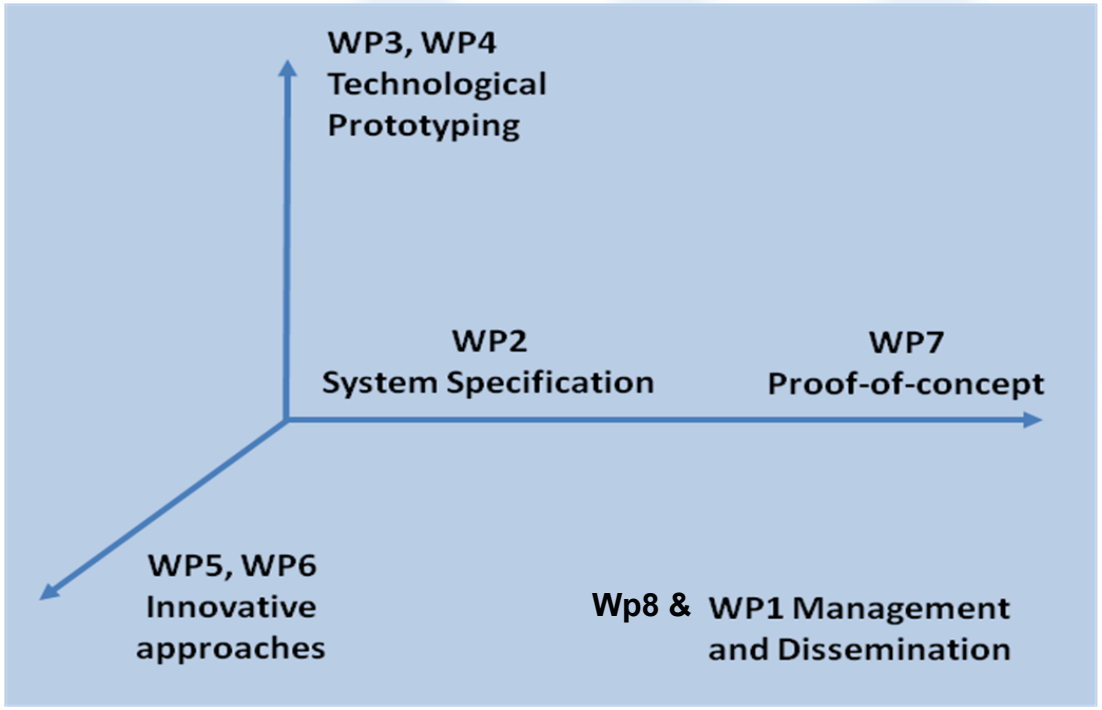
Solutions and Validation

Contention-based systems

Scheduled systems

WP Organization

Technological Dimension



System Dimension

Scientific Dimension

FLAVIA Activities and WPs

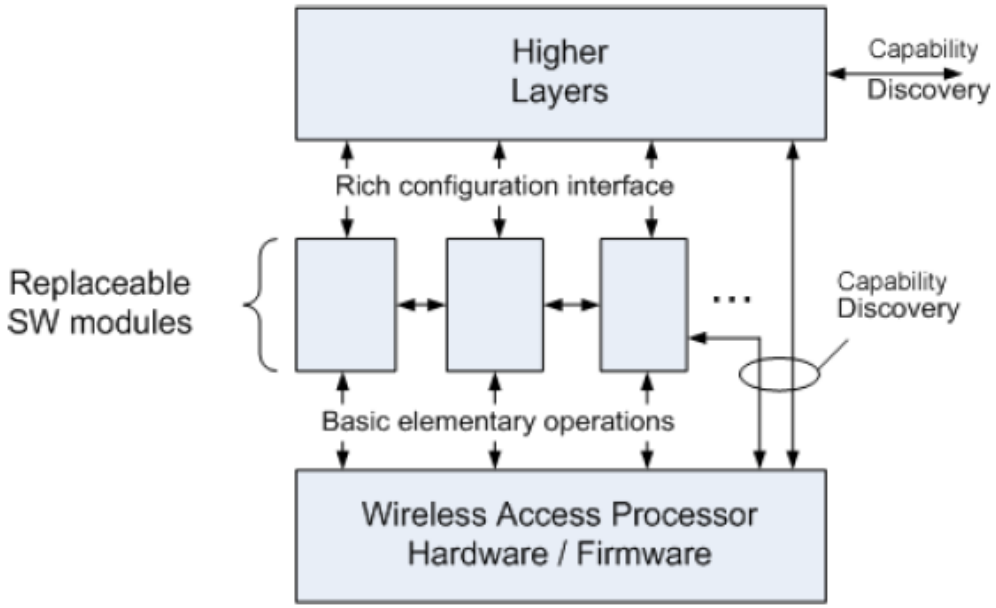
WP1 & WP8: Project Management and Dissemination

- **WP1: Management**
- **WP8: Dissemination, Standardization, Exploitation**
  - Promote standardization of FLAVIA specific achievements and push the overall FLAVIA modular and programmable vision
  - LTE assessment

WP2: Architecture and Requirements

-**Core primitives and modules**
  -Access timing, rate selection, scheduling
-**Control plan modules**
  -Interoperability and capability negotiation
-**Technology dependent architecture**
  -High-level block-based description

-**Use cases** for MAC flexibility exploitation

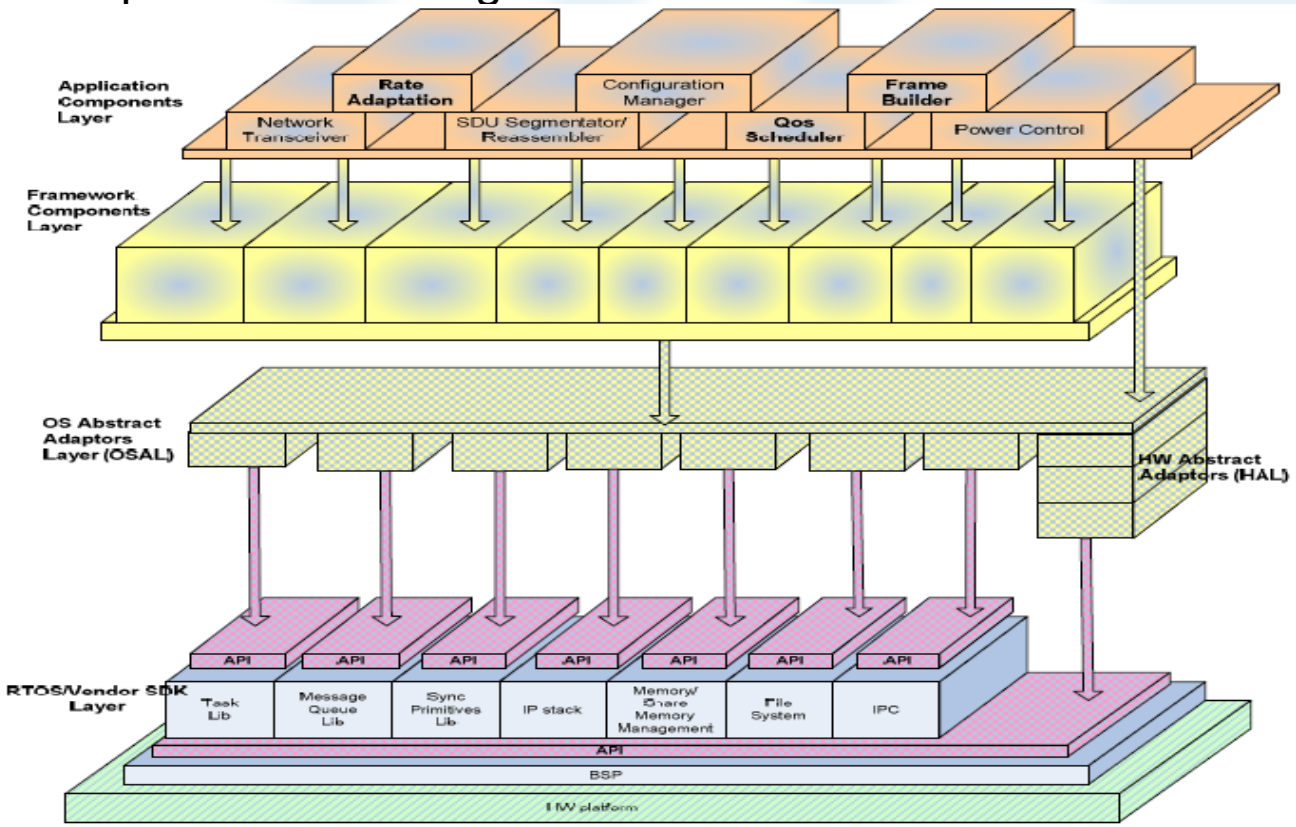


WP3: Specification and Prototyping of 802.16 modules & interfaces

-**Flexible** to different hardware platforms
-**Scalable** to different infrastructures like pico, femto cells and relay stations
-**Open** to algorithm updates and changes

Basic Components

Hardware-Level Interface

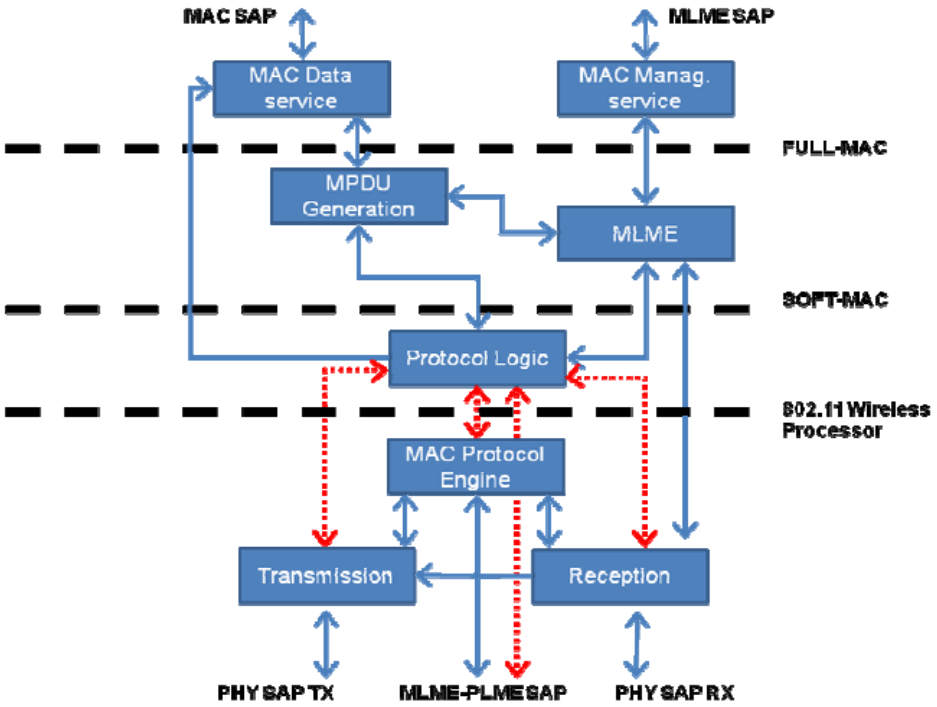


WP4: Specification and Prototyping of 802.12 modules & interfaces

-**Driver level and firmware level** interface
-Prototyping of **modules** for custom header formats, queuing policiies, prioritization schemes, doze state control, channel switching policies..
-**Virtualization** for concurrent channel access operations

Basic Components

Hardware-Level Interface



WP5: Innovative approaches for scheduled systems

-Evaluation and extension of **standard enhancements**
-Solutions for **inter-cell novel scheduling schemes**
    -Joint scheduling and power allocations
    -Programmable optimization goals
    -Abstract solutions unaffected by the scale of the system, nor by the multiplexing technology, only slighlty by the technology (LTE, 802.16
-Solutions **for inter-cell novel scheduling schemes**
    -Resource allocations in multi-scale environment, with low-cost small-coverge base stations
    -Self-configuration, frequency planning, sychronization

WP6: Innovative approaches for contention-based systems

-Evaluation and extension of **standard enhancements**
  -features enabling performance improvements (for video streaming and reliable multicast)
  -flexibility risks on selfish node behaviors
-Solutions for **enhanced and flexible PHY**
  -Dealing with new spectrum usage rules, OFDM/MIMO, cognitive radios, etc.
  -Solutions for simultaneous use of multiple channels with per-channel access means
  -Compatibility problems and coexistence of heterogeneous solutions
-Solutions for **multi-hop multi-channel communication**
  -Network wide coordination among the nodes
  -Phy-aware and congestion-aware networking solutions
  -Local state estimation methods
  -Signalling mechanisms

WP7: Integration, Validation and Trial

Two trials: stack customizations and interoperability of multi-channel multi-technology nodes

-**Services for validating the FLAVIA architecture**
support of H.264 SVC (real-time application) over FLAVIA prototype
support of multiple access point connections for aggregating backhaul bandwidth
-**Stack customization trial**
several indoor and outdoor 802.16 base stations with advanced scheduling capabilitieis
-**Network-wide access trial**
cooperative resource allocations
coexistence with multi-stack or multi-technology prototypes

Project Phases