Cognitive radio and Cooperative strategies for POWER saving in multi-standard wireless devices

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C2POWER at a Glance

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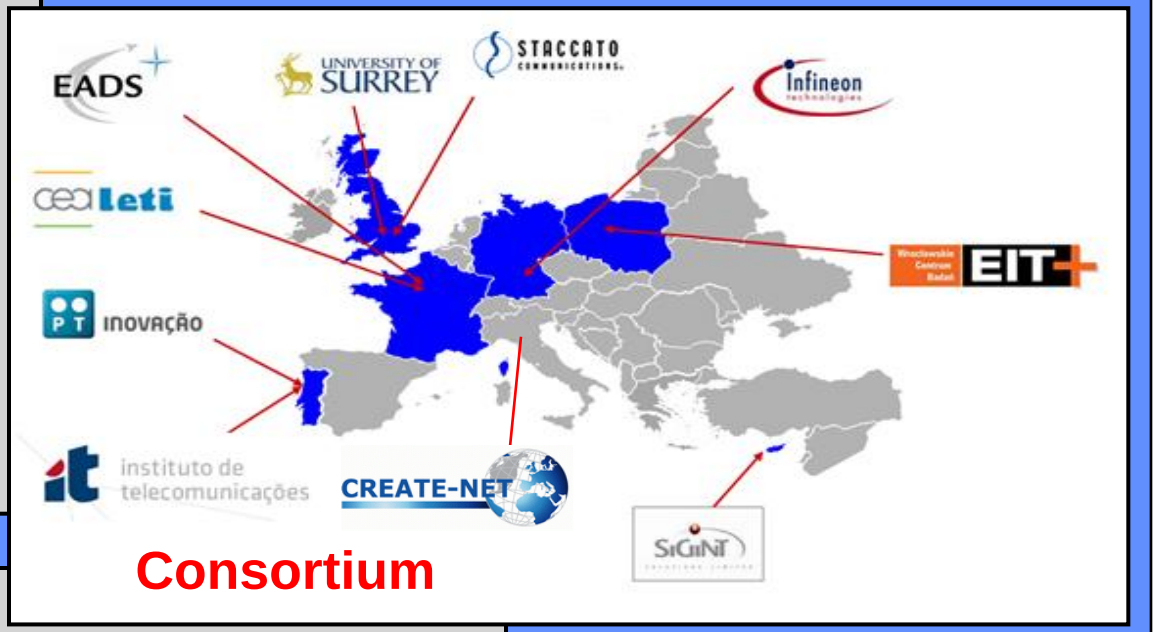


Consortium

Duration: Jan. 2010-Dec. 2012
Funding scheme: STREP
Total Cost: €5,14m
EC Contribution: €3,45m
Contract Number: INFSO-ICT-248577

Why go GREEN?

- Global warming is now unprecedented
  - Rise in temperatures of global average air and oceans
  - Widespread melting of snow and ice
  - Rising of global average sea levels
- The global warming debate shifted
  - From: Whether man-made climate change is occurring
  - To: What atmospheric levels of Greenhouse Gases (GHG) is acceptable
- A clear need for reducing CO_2 or GHG emissions

Ref: SMART 2020 report
Ref: Green Touch

Why go Green?

Currently, 3 % of the world-wide energy is consumed by the ICT infrastructure

- Contributing ~ 2 % of the world- wide CO2 emissions
- comparable to the world-wide CO2 emissions by airplanes or ¼ of the world-wide CO2 emissions by cars

The transmitted data volume increases approximately by a factor of 10 every 5 years

Why go Green?

ICT: 10% of electrical energy in industrialized nations

- 900 Bill.. kWh / year = Central and South Americas

Power consumption of ICT is currently rising at 16-20% / year

- Doubling every 4-5 years

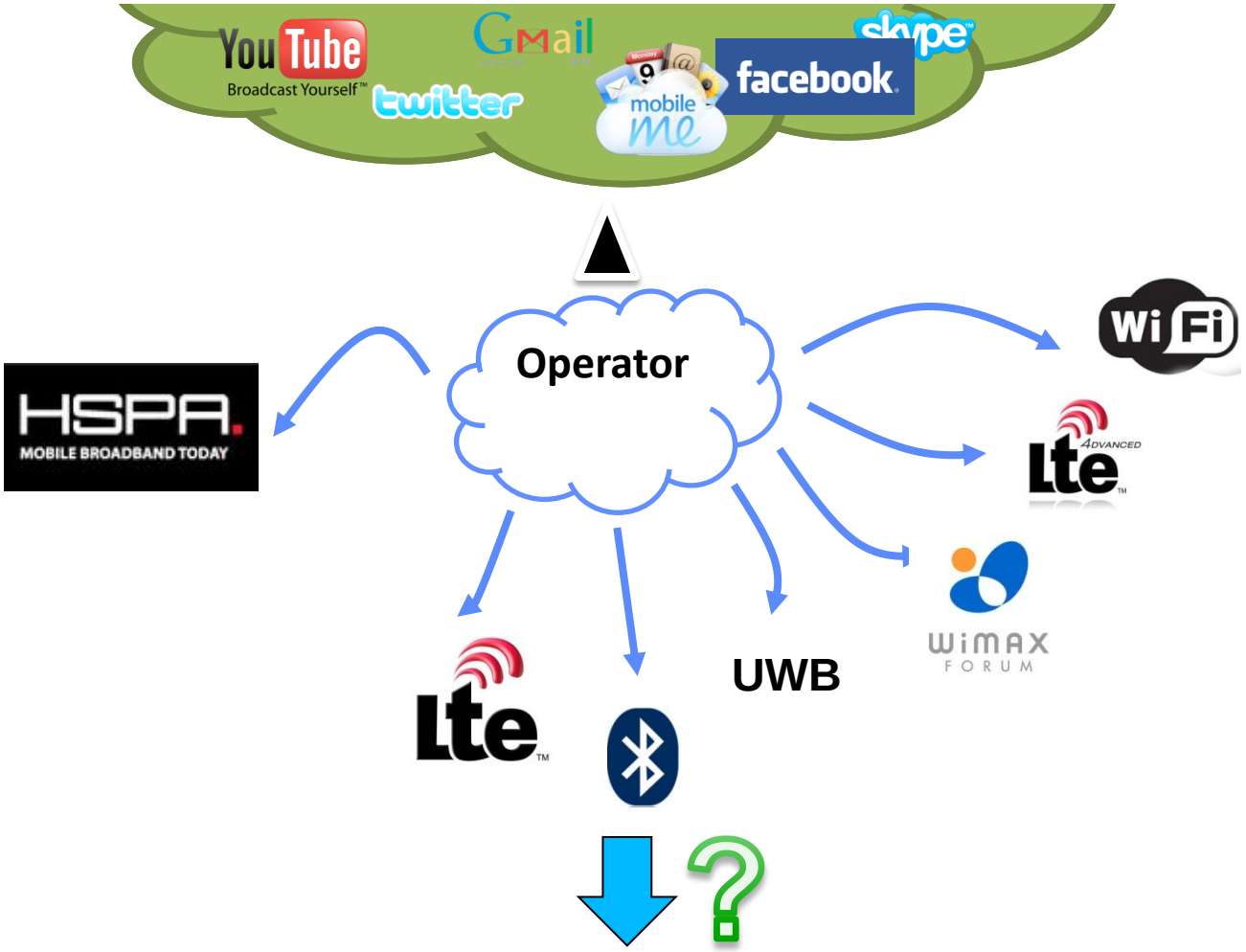
Wireless communications can be used extensively to save energy in other industrial sectors

e.g. Smart grids...

EE Mobile networks

So far, mobile networks standards and design rules have ignored EE

- Cellular networks have been optimized in terms of spectral efficiency, **Max** capacity, not really in terms of Energy Efficiency!
- Efficiency metrics
  - Spectral efficieny b/s/Hz
  - Energy efficiency J/b
- With mobile networks becomming ever so power hungry, there is a need for huge efficiency improvement !
  - Opex increase
  - Battery lifetime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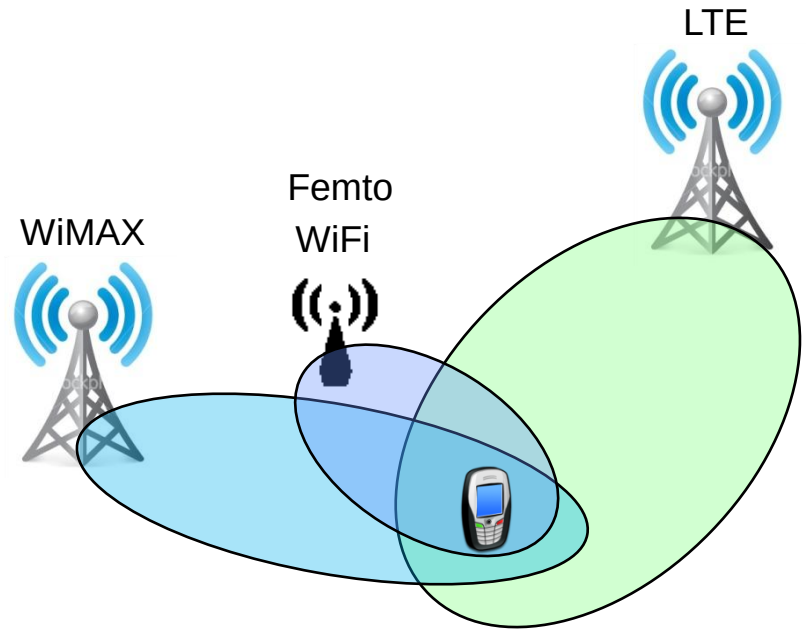
WiMAX
FORUM
Lte
UWB

Energy Situation



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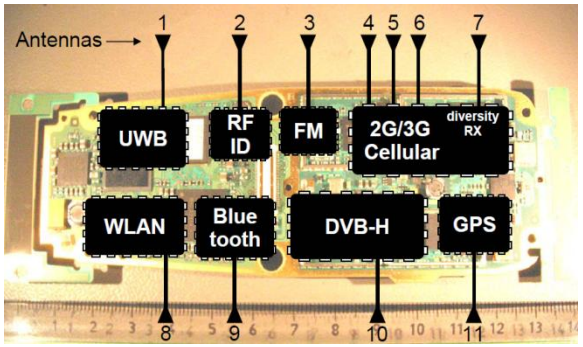


Increase in energy consumption

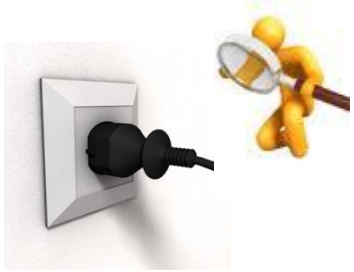
Requirements

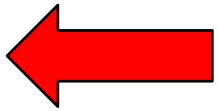
- Demand for higher data rates
- Data rate performance of high mobility speeds
- High signaling overhead
- Need for better multimedia support
- High capital and operational costs

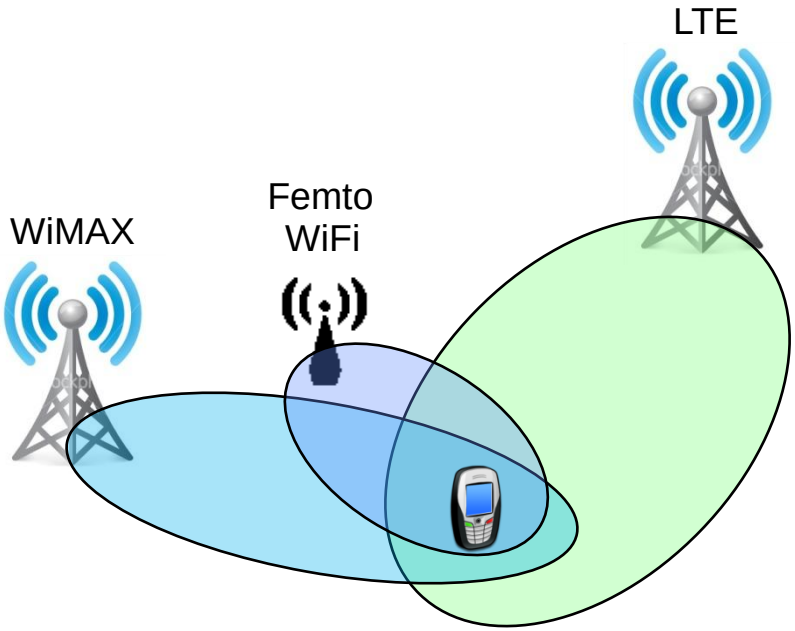
Energy Trap

There is a continuously growing gap between the energy requirements of emerging radio systems and what can be achieved by

- Battery technology evolution
- Scaling and circuit design progress
- System level architecture progress
- Thermal and cooling techniques







C2POWER Solutions

- Short-range cooperation among mobile terminals
- Cognitive vertical handovers
- Context Awareness
- Energy-efficient Reconfigurable Radio Transceivers
- Business models

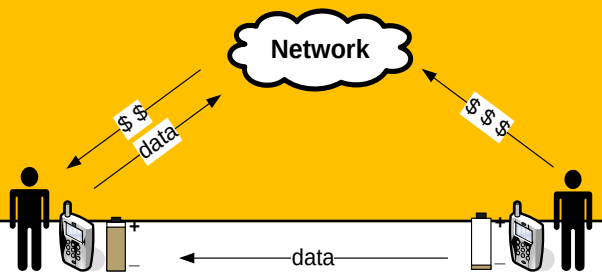
C2POWER Goals

Technical

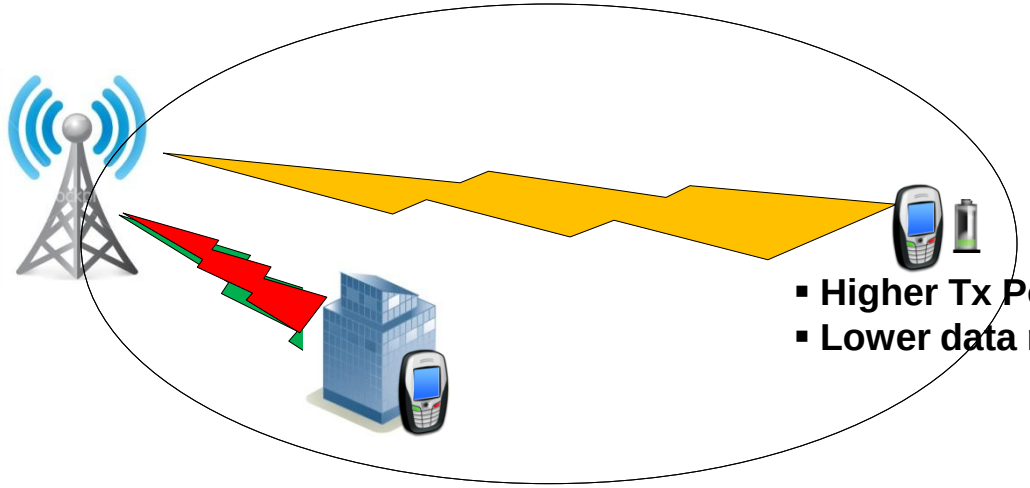
- Investigate how context information can be used by cooperative strategies to achieve power efficiency at the wireless interface of mobile devices.
- Investigate and demonstrate the potential of cooperative techniques based on advanced short range communications for the goal of power/battery lifetime saving of mobile wireless devices.
- Investigate and demonstrate minimum energy consumption handover procedures and policies between heterogeneous technologies and associated tradeoffs in realistic scenarios.
- Investigate, design and demonstrate energy efficient reconfigurable multi-standard transceivers able to switch from one standard to another according to a power saving strategy.

Business

- Investigate methods and incentives to encourage cooperation and develop attractive business models for the network/service provider (Stimulate and motivate cooperative networking among users and between heterogeneous networks , e.g. financial incentives / bio-inspired reputation mechanisms).

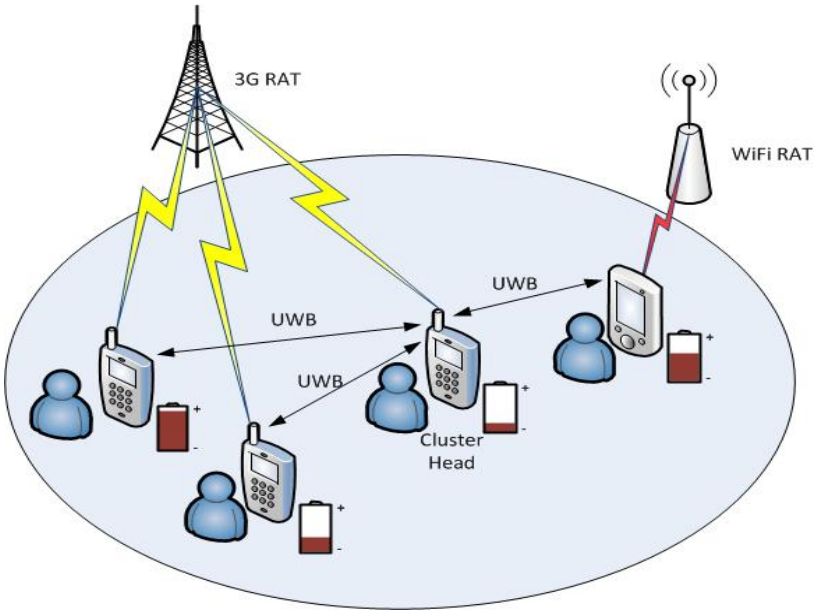


Short range Cooperation

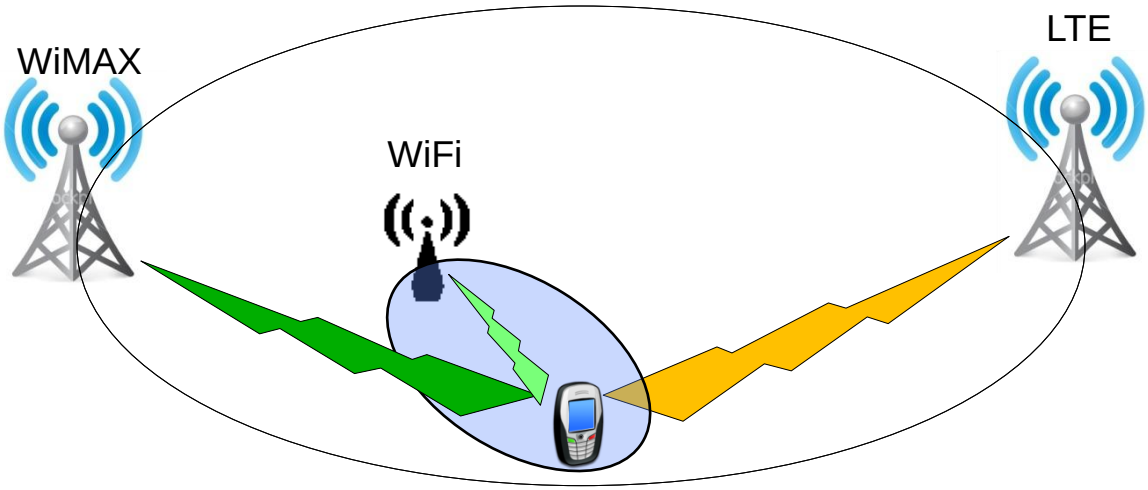


- Higher Tx Power
- Lower data rate

→ Increase energy consumption

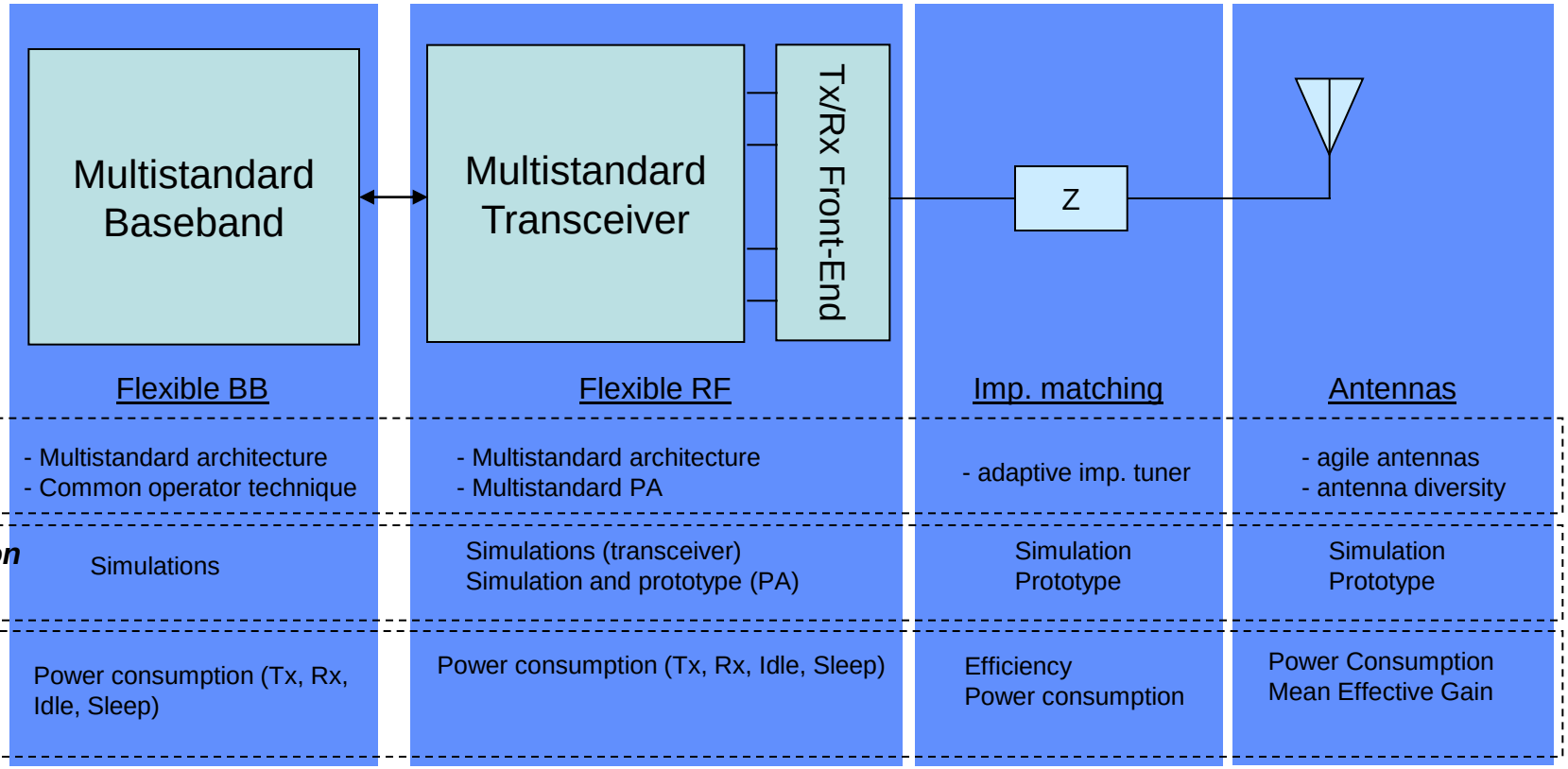


Cognitive Handover



Choose the most energy efficient available RAT

Reconfigurable Radio Transceivers



SR Cooperation

- Take advantage of good channel conditions of short links and lower energy requirements

Smart VHO

- Take advantage of availability of heterogeneous RATs in the vicinity

Two use cases

- Same technology
  - WiFi for both
- Heterogeneous SR and LR
  - WiMedia (UWB) and WiFi

Two use cases

- Heterogeneous RATs
  - WiMAX and WiFi
- Same Technolgoy
  - Macro and Femto cells

Interface type	Power consumption in TX mode [mW]	Power consumption in RX mode [mW]	Power consumption in Sleep mode [mW]
WiMedia	350	400	0.25
WiFi 802.11g	1900	1340	75
WiMAX	1500	1500	5

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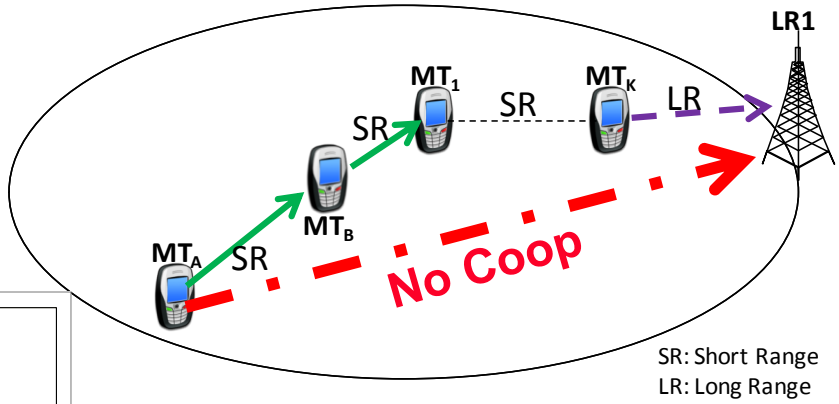
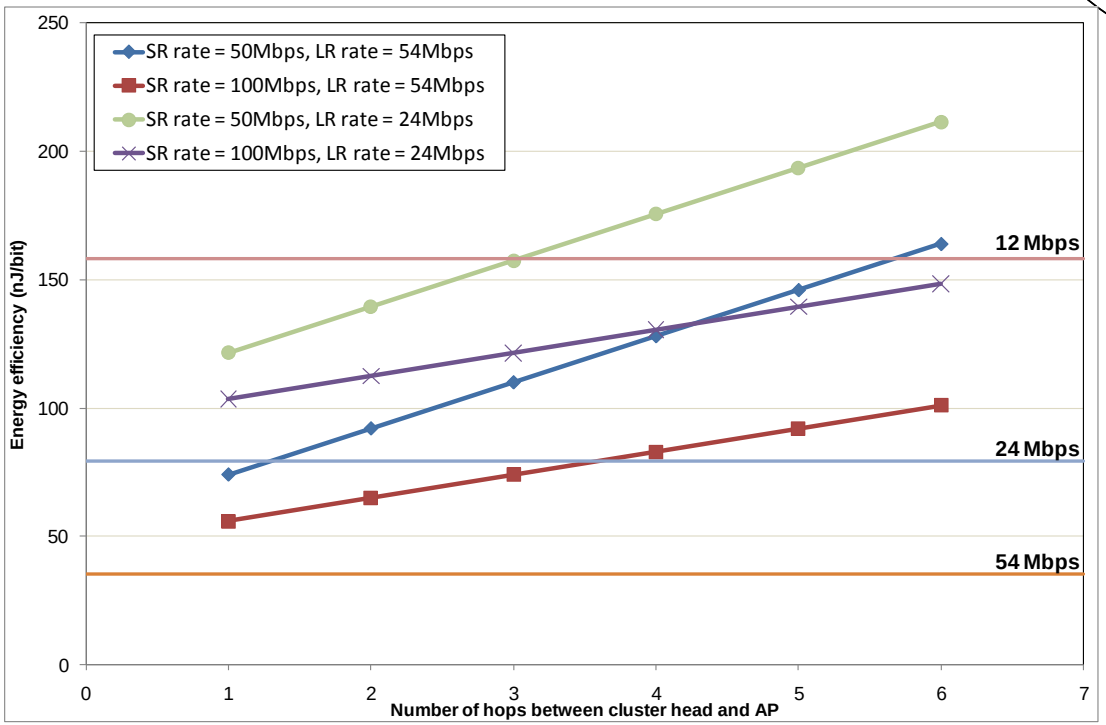
- Short range Cooperation



WiMedia - WiFi



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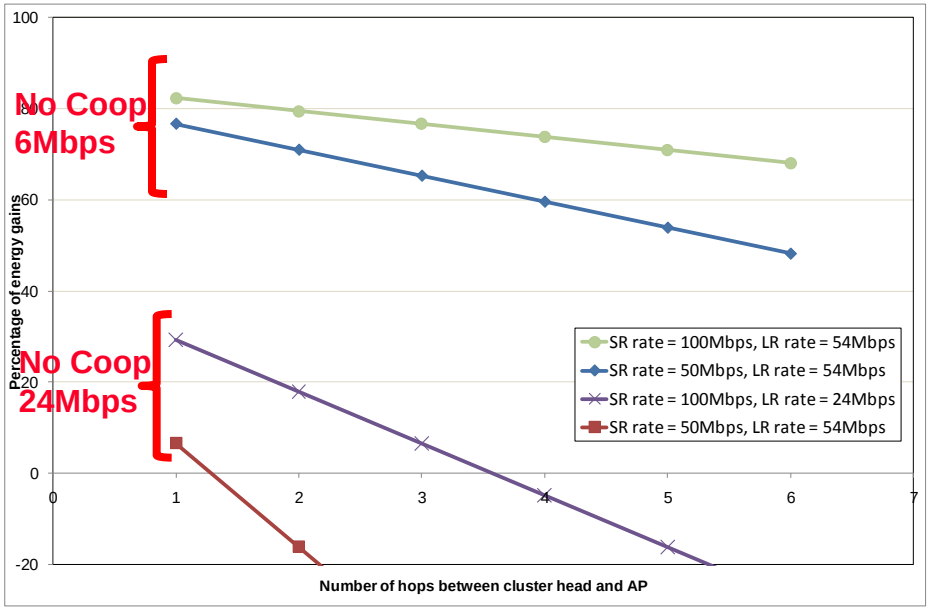
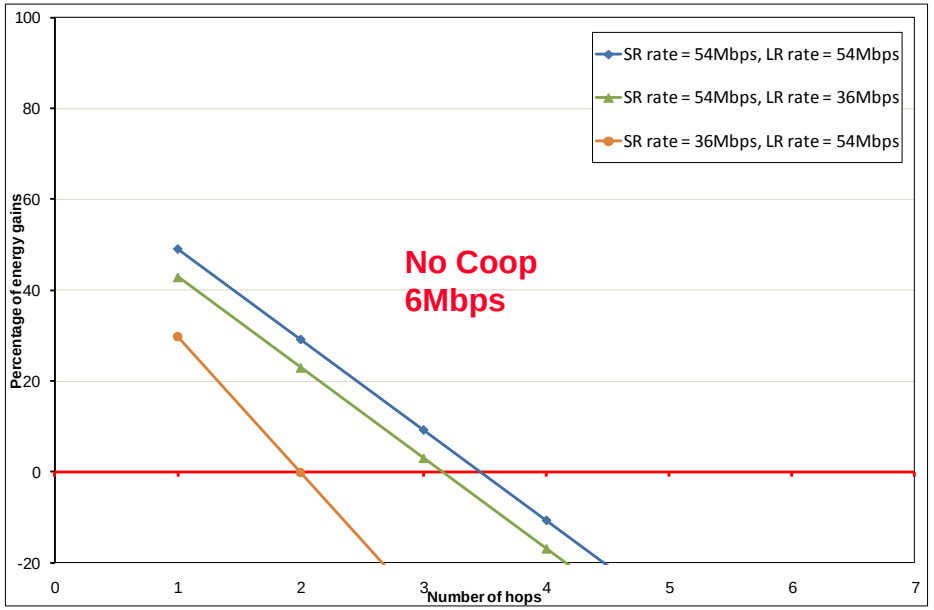


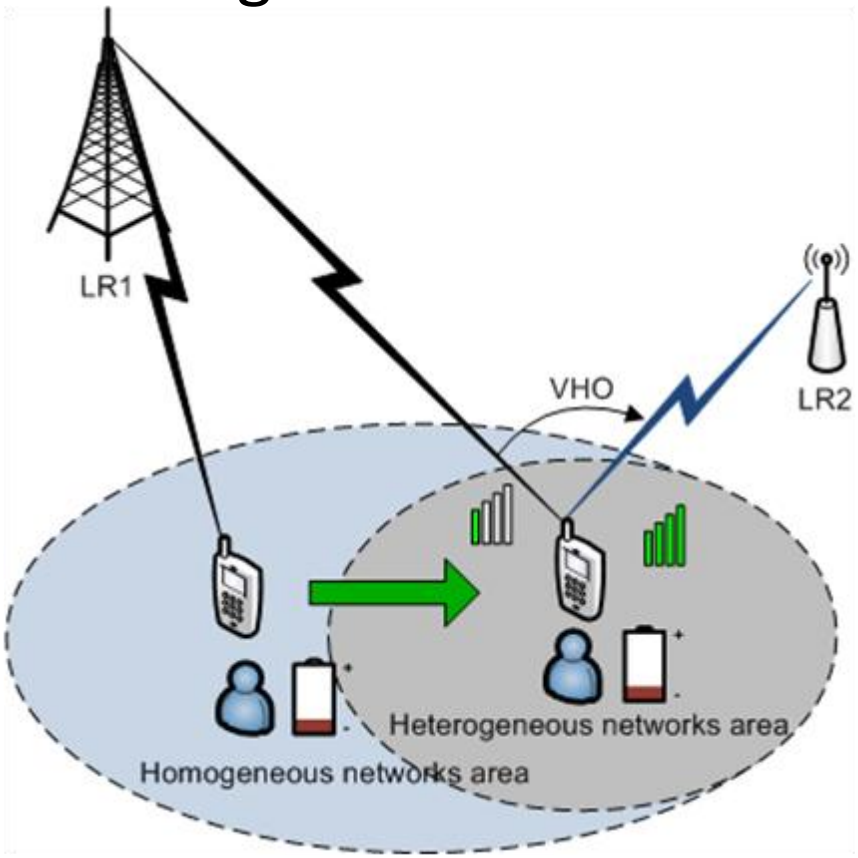


WiMedia - WiFi

WiFi - WiFi

C2POWER targets 50% energy savings using SR cooperation

- Cognitive Vertical Handover



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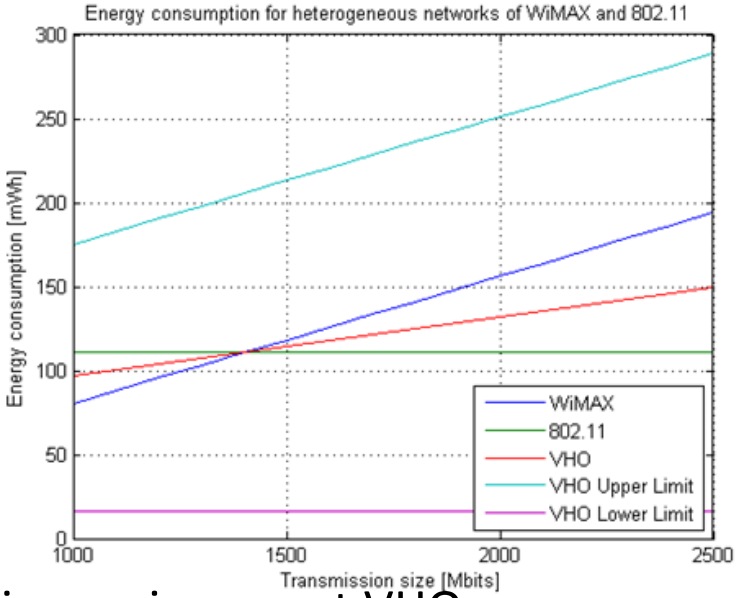
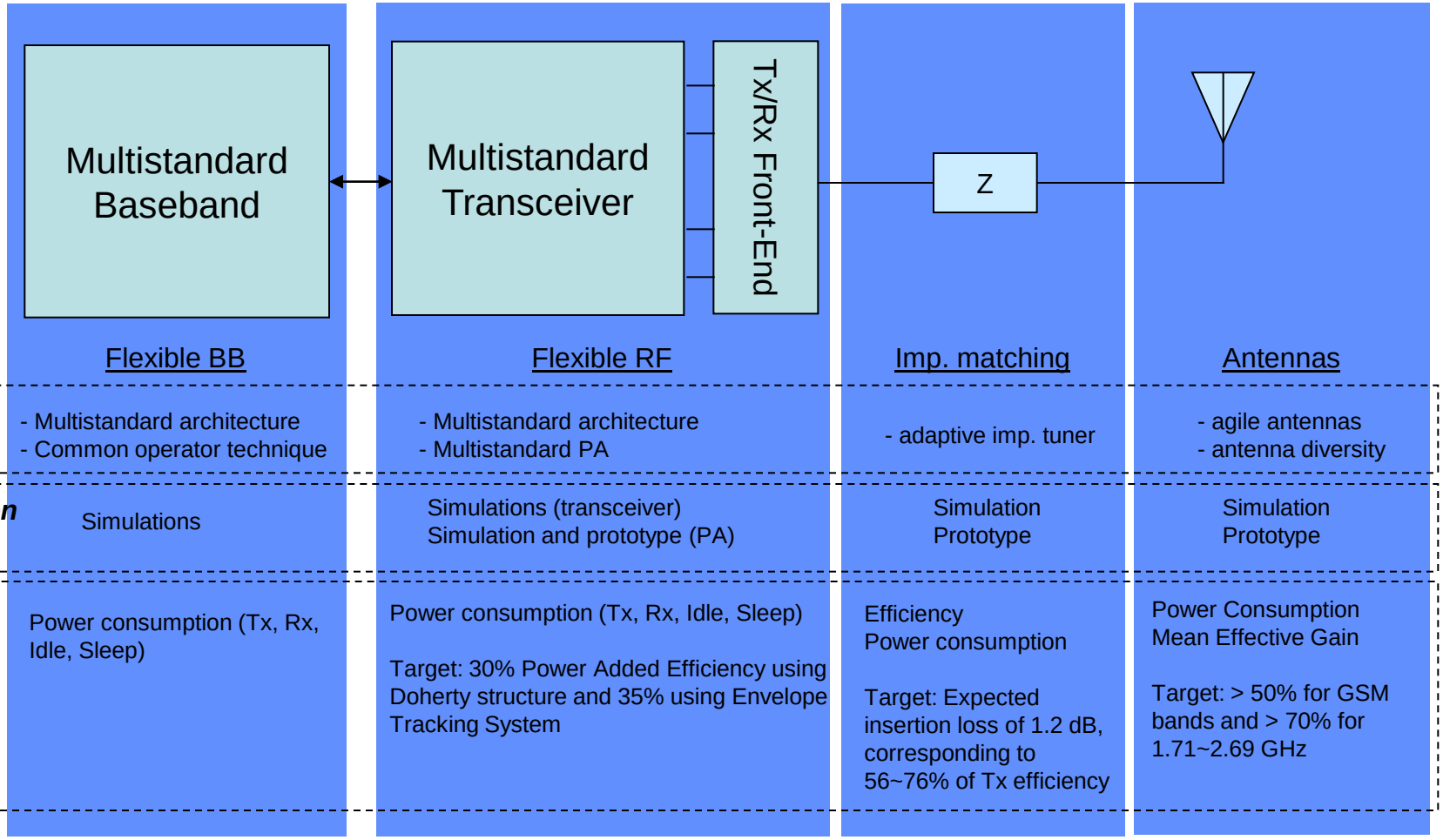


C2POWER targets 15 ~ 20% energy savings using smart VHOs

- Reconfigurable radio transceivers



Required Supporting algorithms

- Context awareness

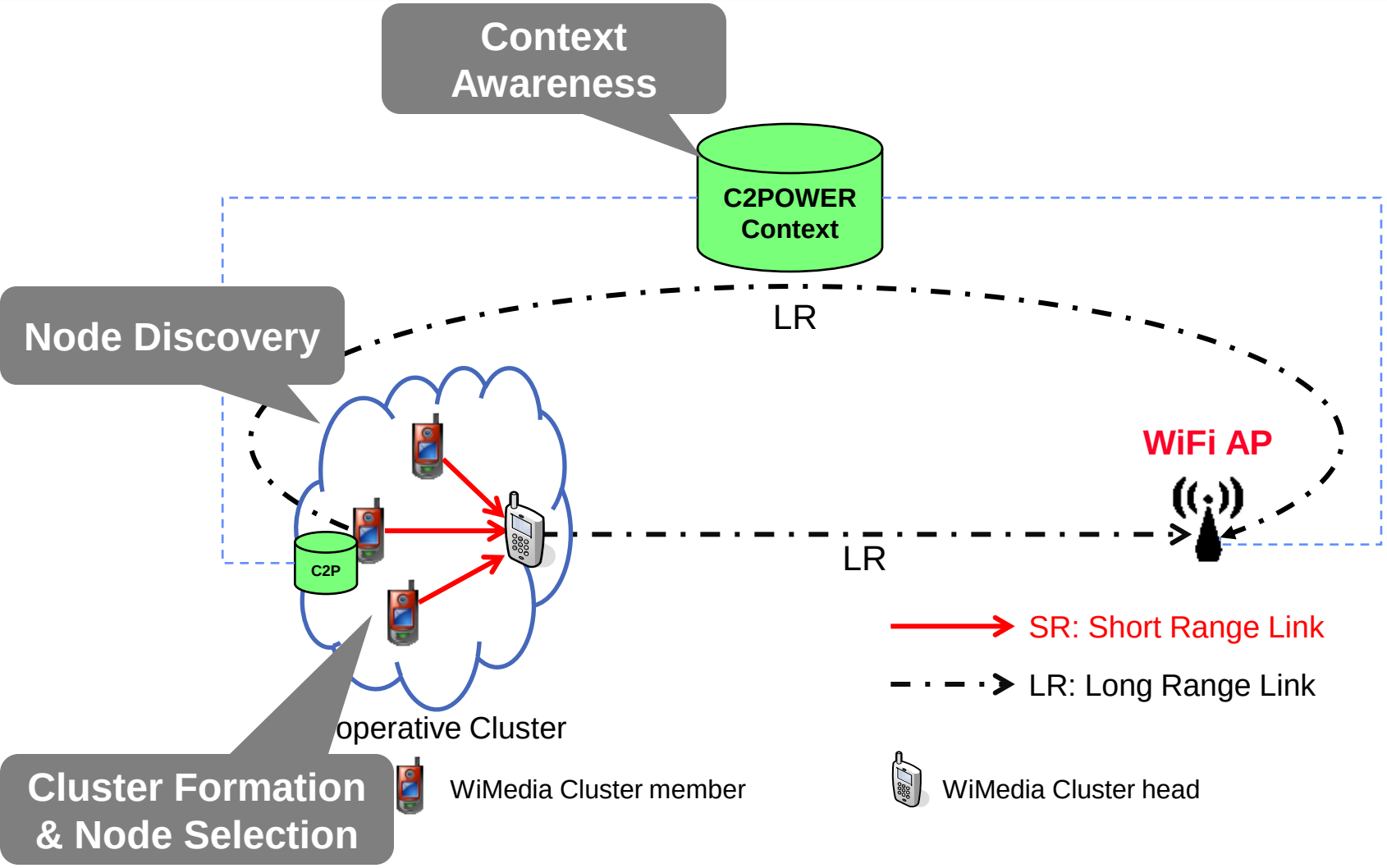
Short range cooperation:

- Energy efficient node discovery
- Cluster formation
- Node selection
- Routing
- Cooperative relaying

Cognitive vertical handover

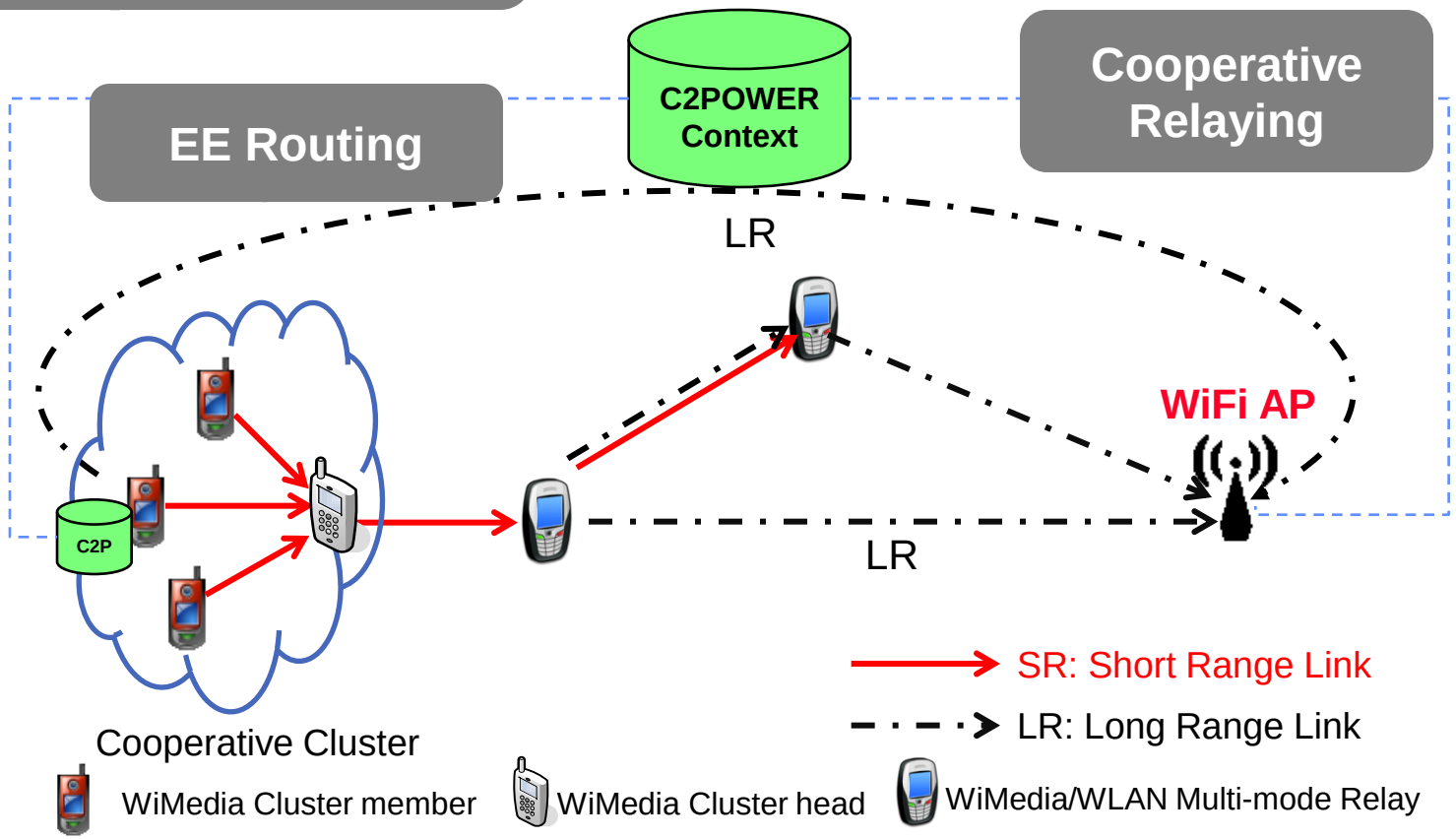
- Energy efficient network discovery
- Smart Vertical Handover decision

Short range Cooperation 1



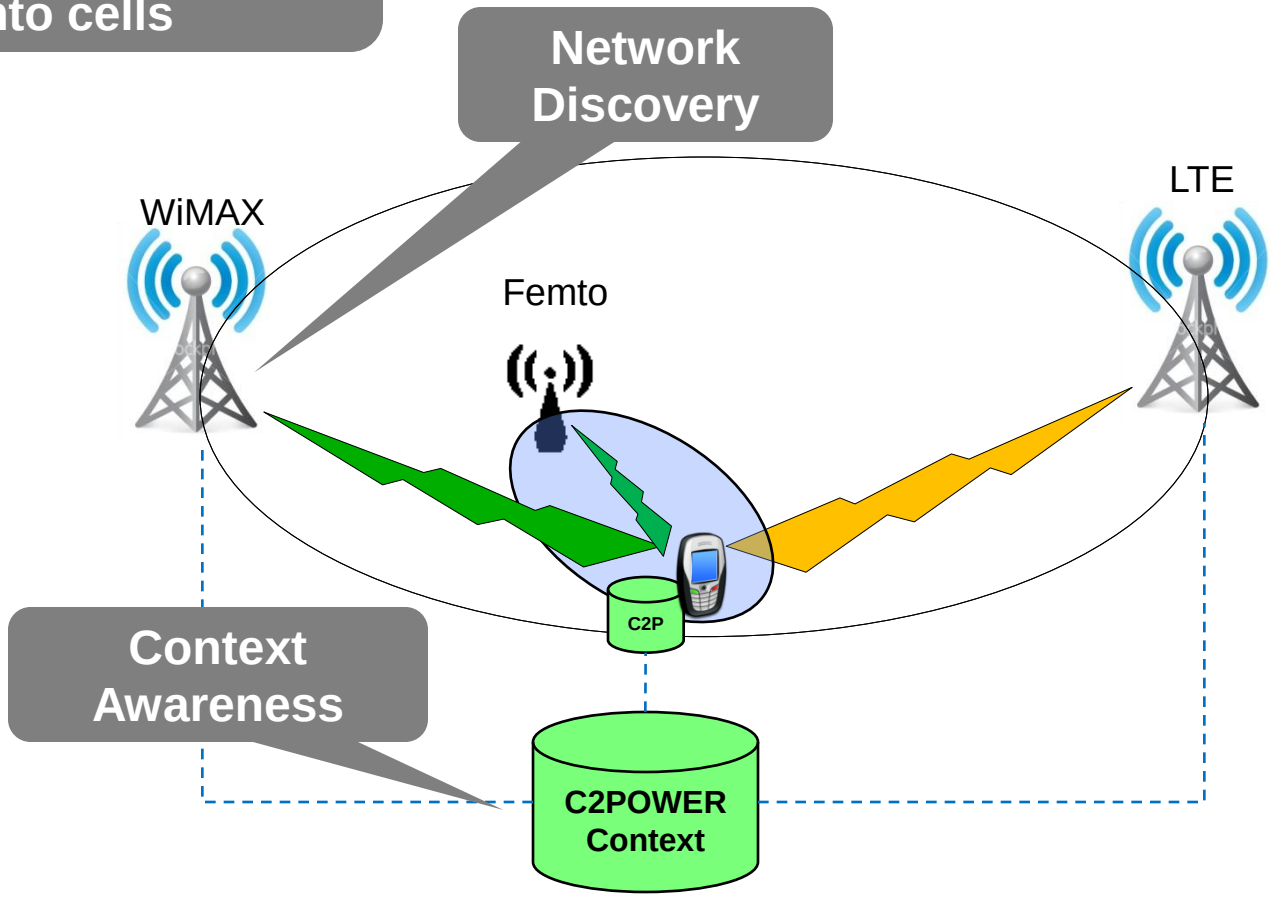
Short range Cooperation II

- Node discovery (using Context)
- Cluster formation
- Node Selection



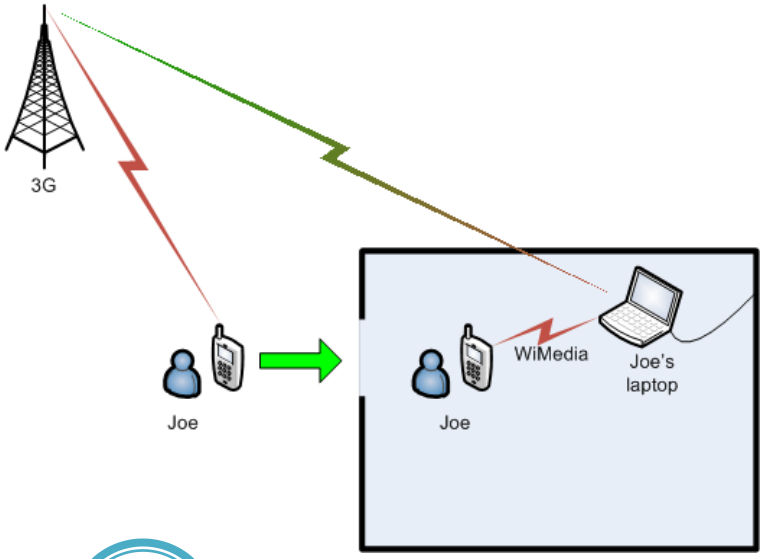
Cognitive Handover

- EE VHO Algorithms
- HO between Macro and Femto cells

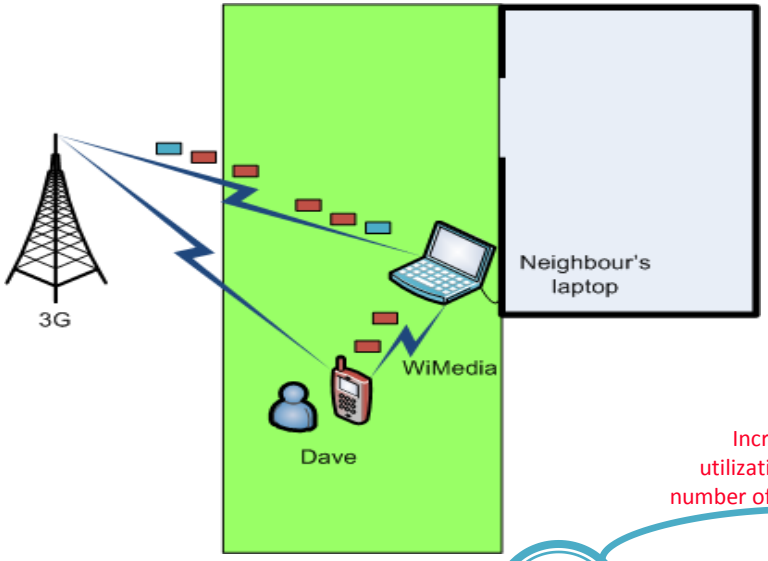


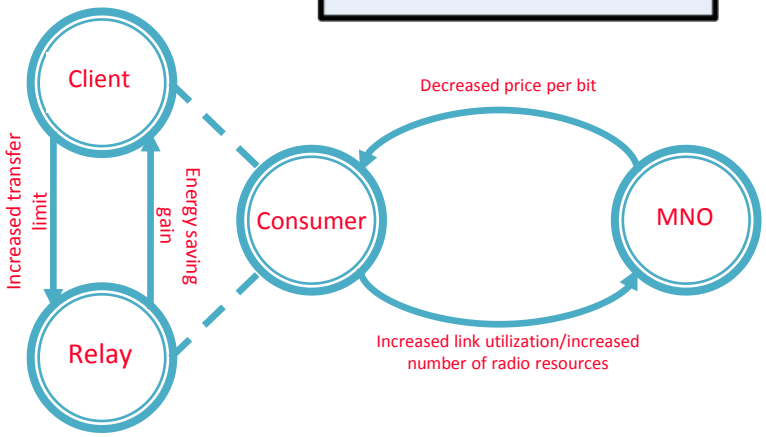
Business Models

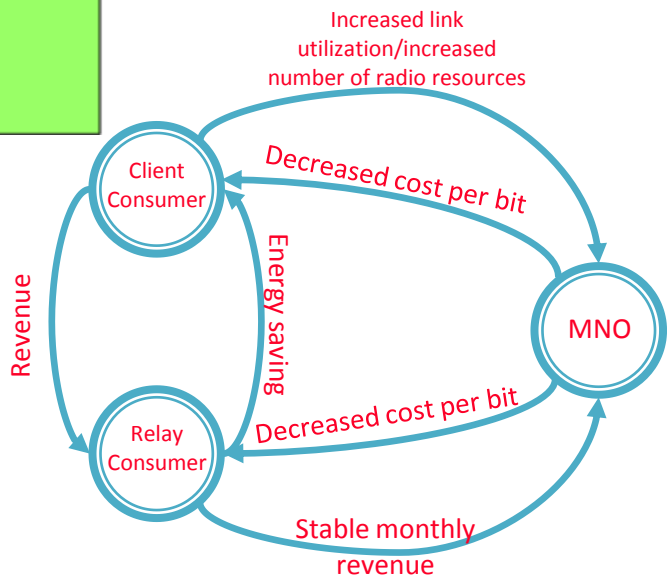
Home short-range tethering access



Short-range tethering hot spot







Conclusion

The envisage energy trap of 4G handsets

Reduce human exposure to handset radiations

- C2POWER investigates:
  - Context awareness
  - Cooperation
  - Energy Efficient Handover
  - Energy efficient Reconfigurable Radio Transceivers
  - Business models for incentives

- Target: 50 % reduction in Energy reduction
  - in multi-standard MTs

Thank You