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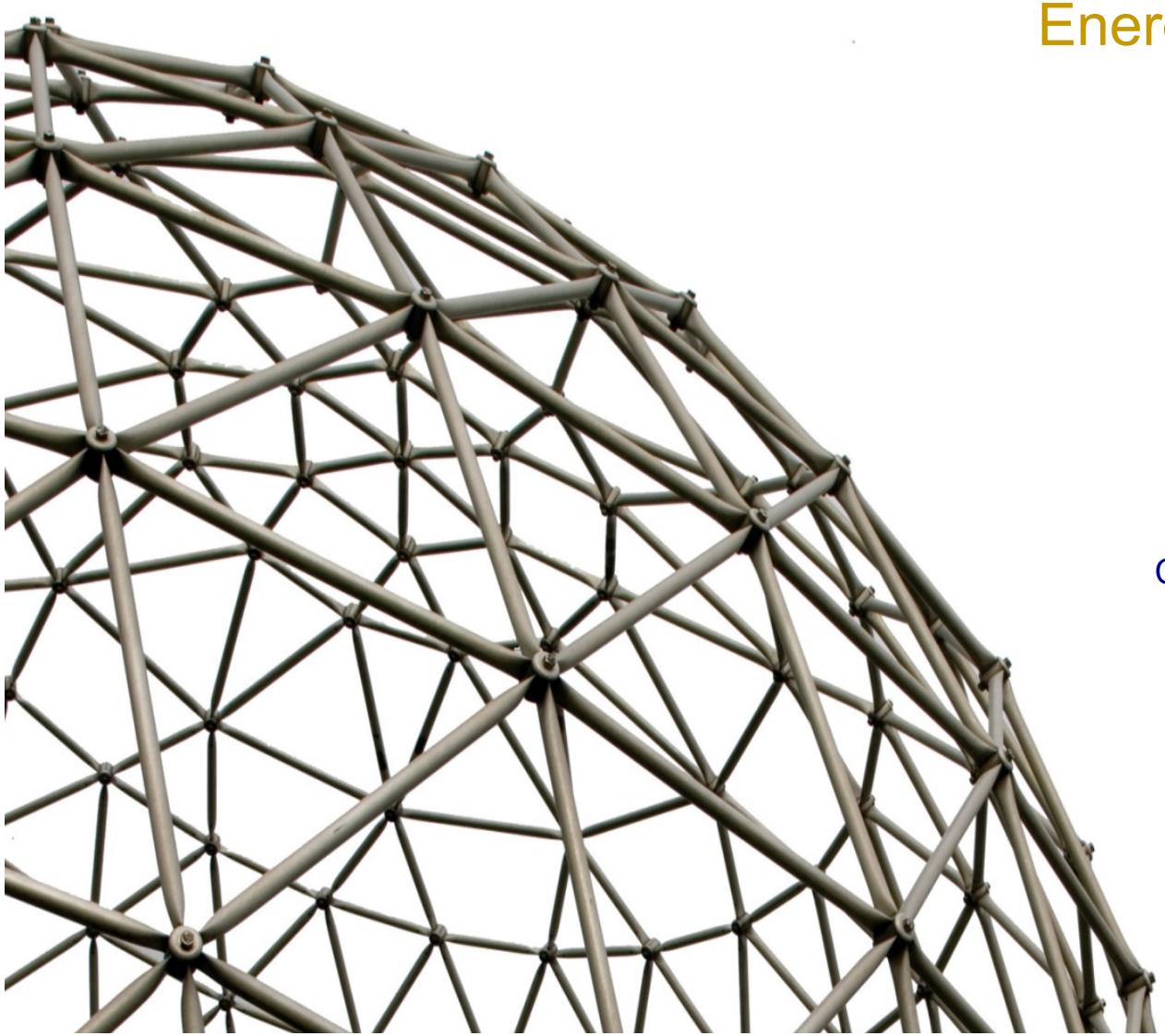

Energy Efficient Protocols

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networks over the years

mainly evolution

fixed-mobile conversion mainly built on “tight coupling”

loads on emphasis on overcoming heterogeneity

focus on bandwidth and delay, capacity and throughput, much less on energy efficiency

areas

software defined networking

self-management

energy awareness

content awareness

self-management

autonomics

modelling

information processing and learning

autonomics

autonomics (control-loops) in future networks

autonomic features in the instances and parts of networks (core and capillary)

- information and knowledge provision and processing

interactions and competition

- game theory may be a solution, but…

modelling

operational properties and modelling of the autonomic networks

- operational conditions will influence/impact the networks

modelling tools

- interrelations of control loops
- modelling of the knowledge plane

information processing and learning

information processing (cognition) in autonomic networks

computational algorithms

- information filtering/data mining pattern recognition

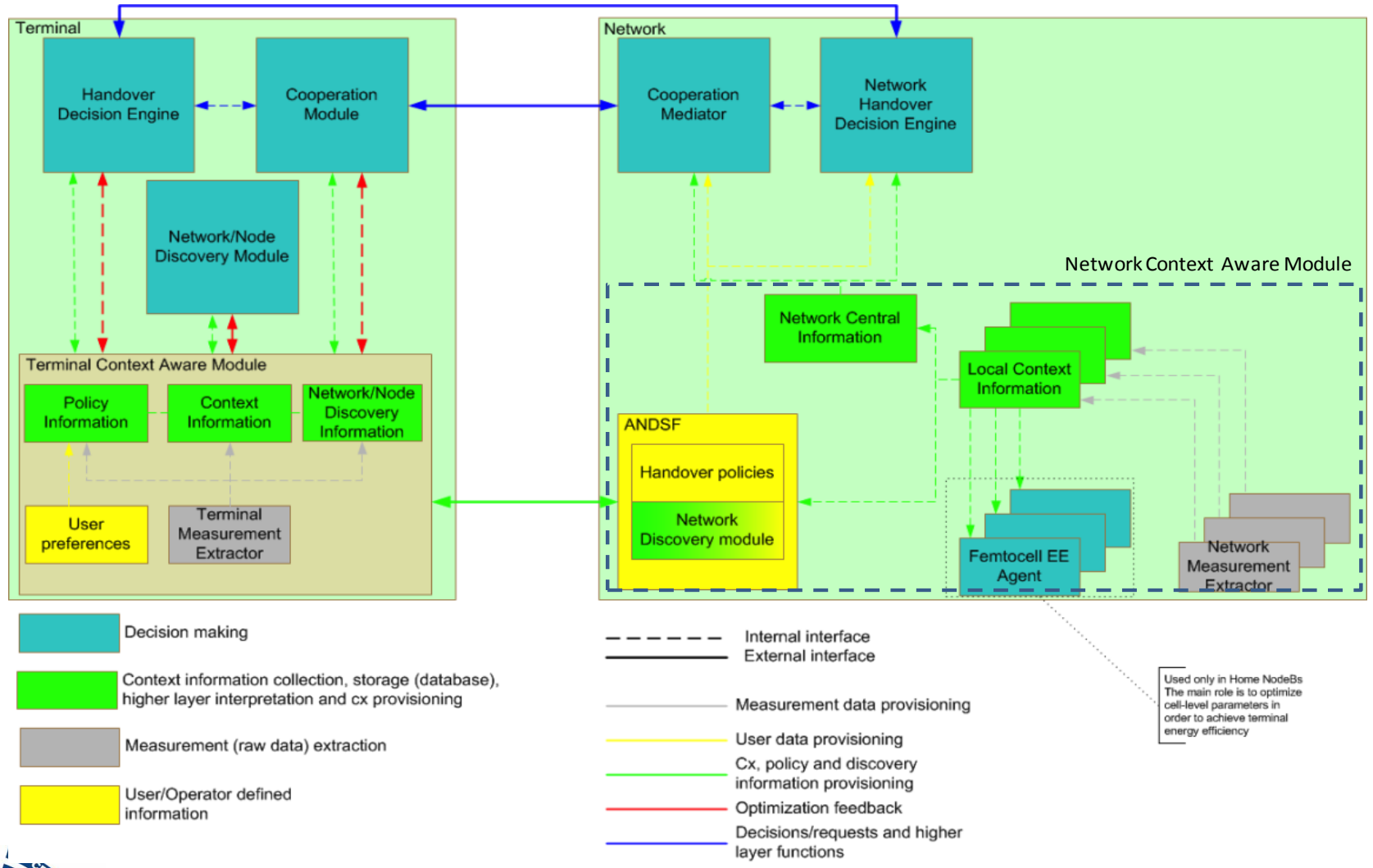
intelligence

- level of “intelligence”

decision-making and processing of information in the knowledge plane

- “range based” look-up, control networks, machine learning, ...

C2POWER - it is about context...



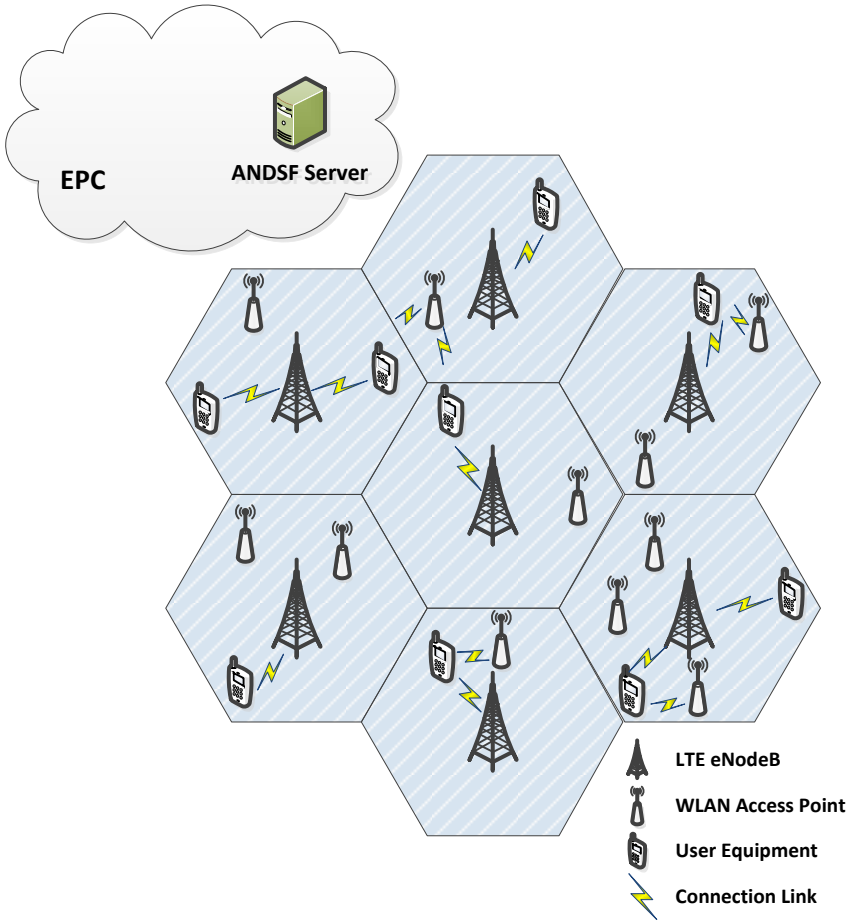
Objectives

Design, implementation and validation of energy efficient network discovery mechanisms

Design, implementation and validation of energy efficient neighbour (node) discovery mechanisms

Implementation of mobile terminal-context and network-context units for integration in WP7

Network Discovery



Network Discovery Algorithm

Large geographic area covered by LTE cells and randomly distributed WLAN APs.

UEs perform eNodeB selection and inter-eNodeB handovers based on RSS information.

Also perform network scanning to detect available APs.

When an available AP is discovered, vertical handover to the WLAN for traffic offloading and energy-saving.

ANDSF used as a database to record the network context .

UE estimates its current location using mature localization techniques.

Network Discovery

Algorithm Outline

New UE context parameter

- query distance: d_q

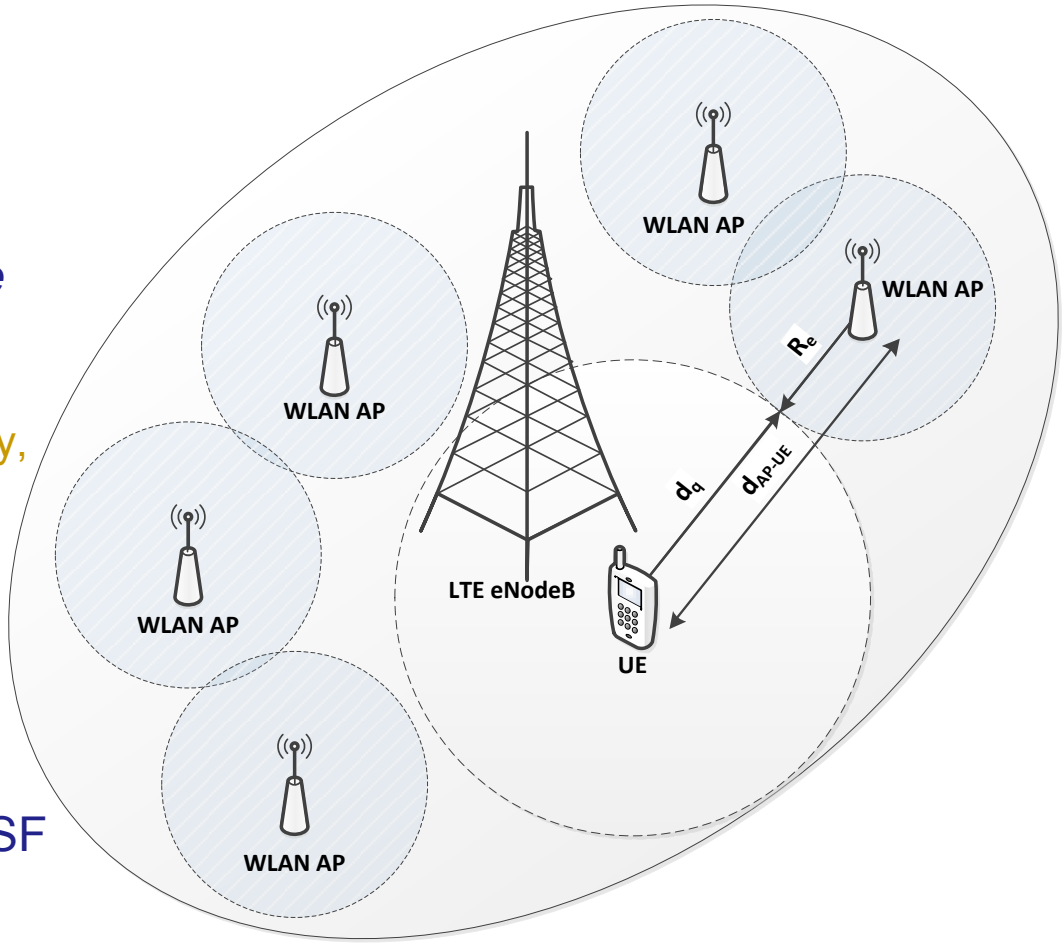
Distance between the UE and the closest WLAN AP discovered in the previous ANDSF query

- When the UE has travelled more than d_q since the last ANDSF query, it will send a new one

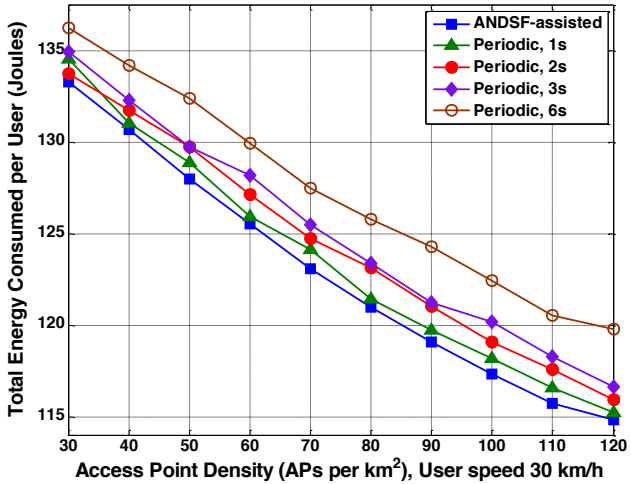
ANDSF will respond with a list of available networks in the UE coverage

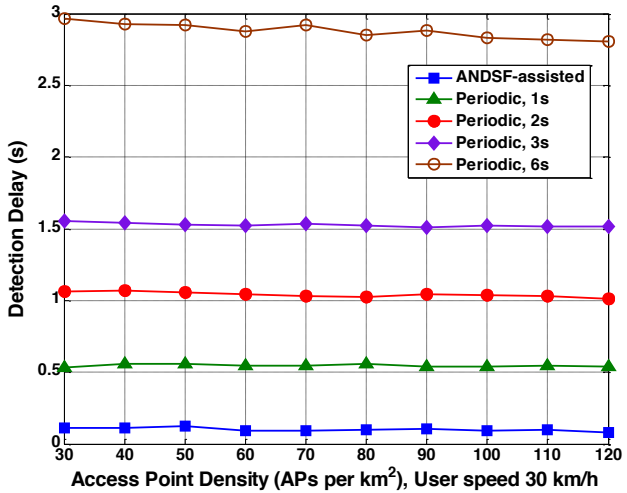
UE will use this to perform network scanning and VHO

If no WLAN AP is accessible, ANDSF will set new d_q

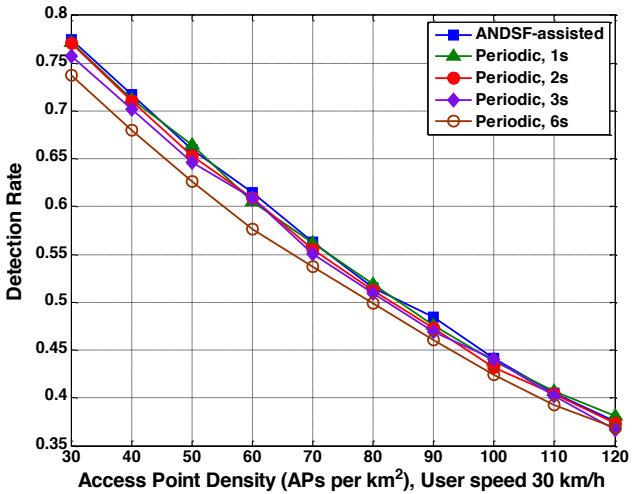


Simulation Results

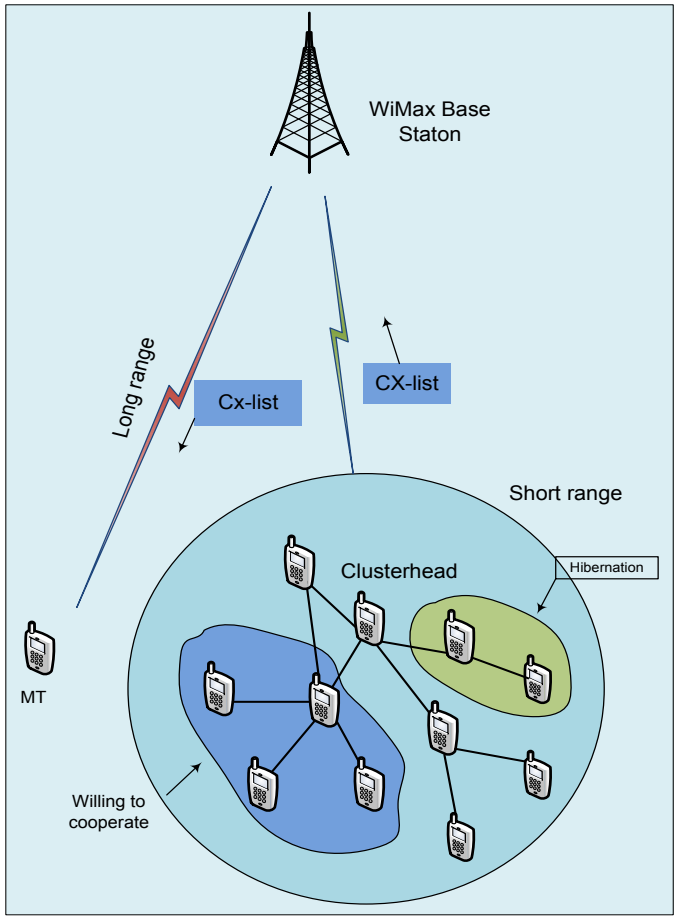


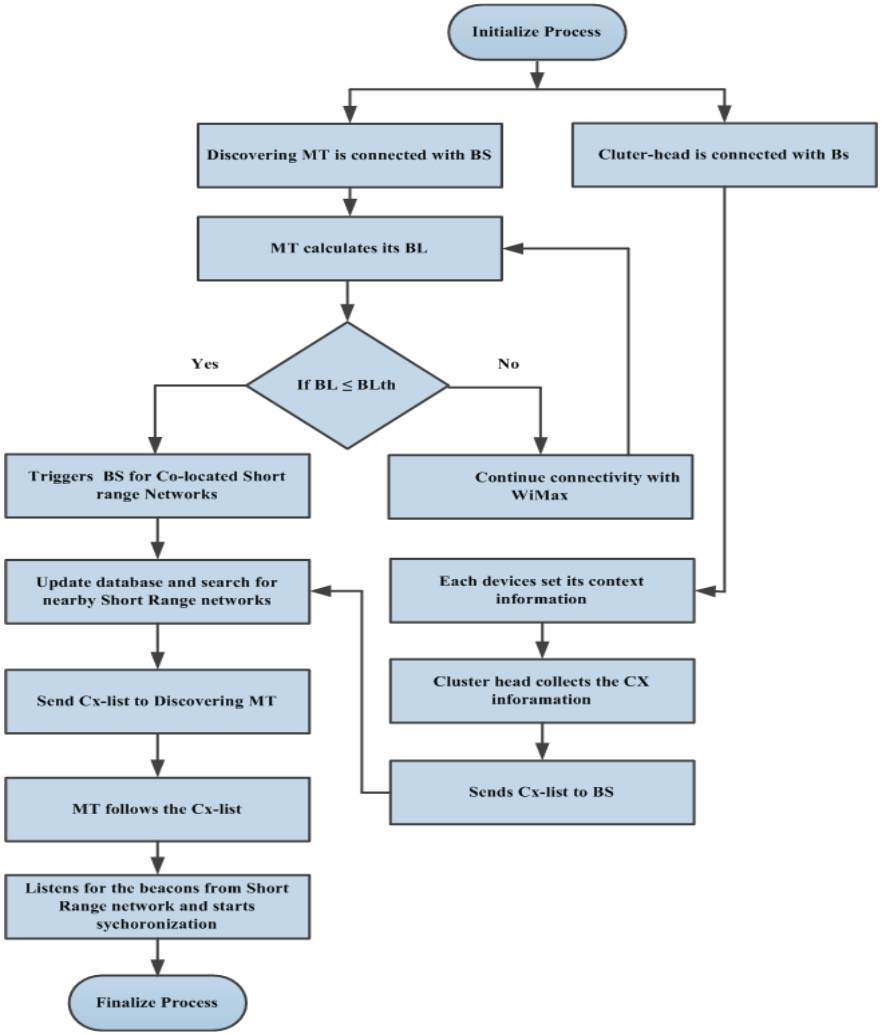


Parameter	Value
Maximum LTE power in the uplink	250 mW
LTE cell radius	1 km
Path loss model in the LTE network	$PL = 128.1 + 37.6 \cdot \log d$, d in km
LTE uplink power control	Open loop with fractional path-loss compensation
Maximum WLAN power in the uplink	100 mW
WLAN cell radius	50 m
Energy consumption per WLAN scan	11 mW
Operational power	100 mW
Mobility model	Random Walk Model
Number of LTE cells	7
Number of users	500
Simulation time	500 s



Context based Node Discovery



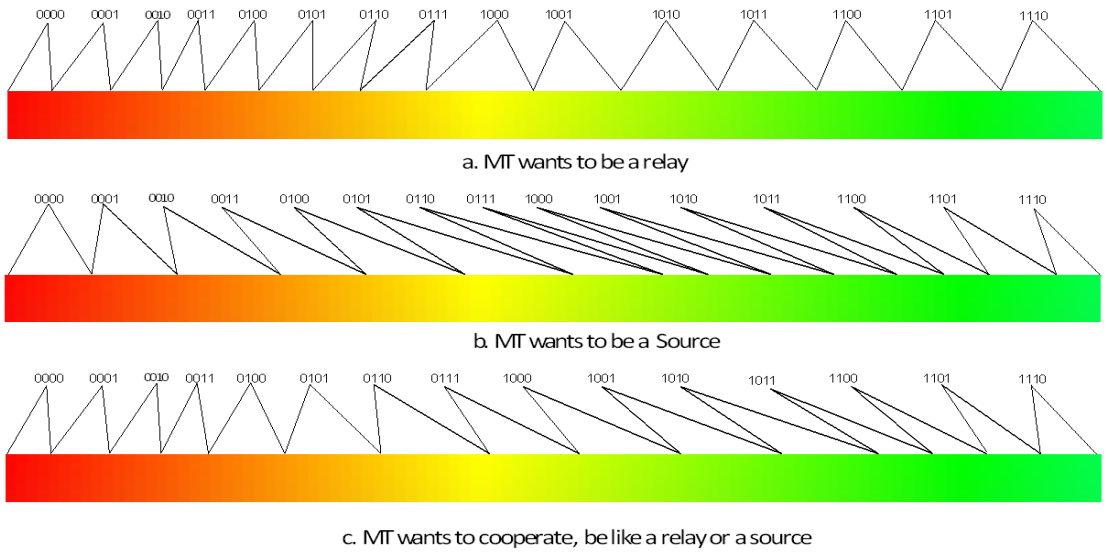


Representation of Willingness in Beacon

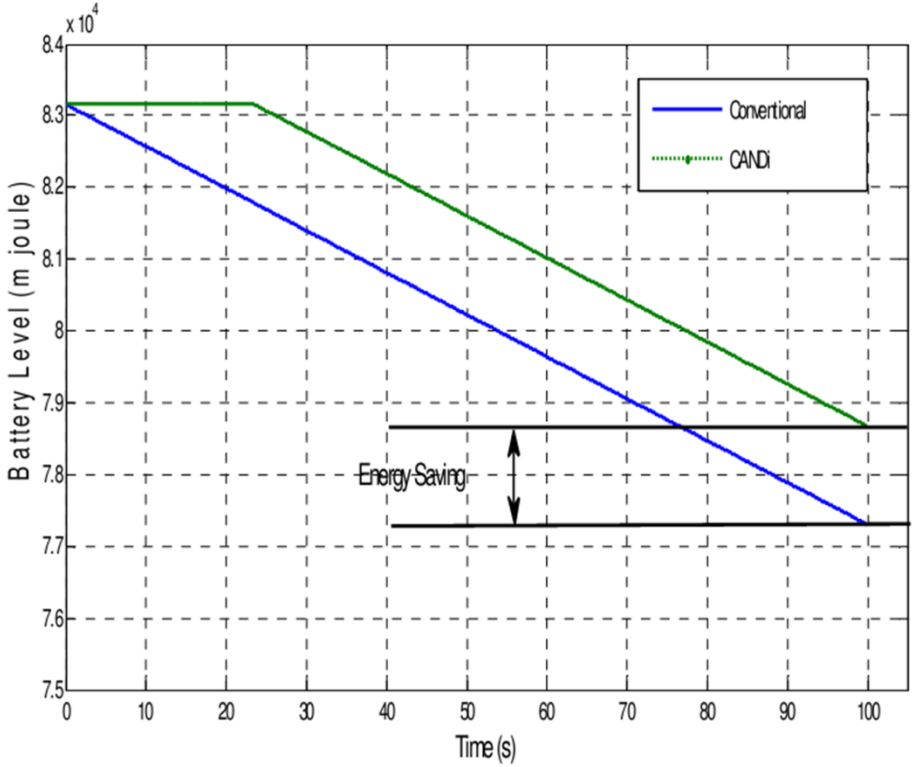
Each MT uses 2 bits to represent its willingness to cooperate:

- 00 → not willing to cooperate.
- 01 → willing to cooperate and to be relayed.
- 10 → willing to relay.
- 11 → willing to cooperate both as relay and relayed.

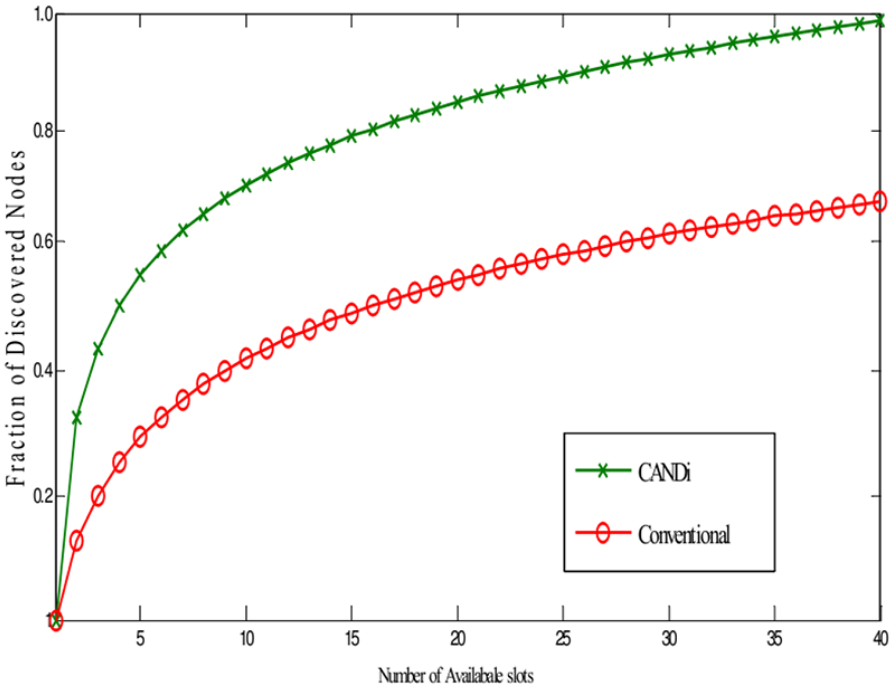
Each MT uses 4 bits to represent its battery:



Simulation Results

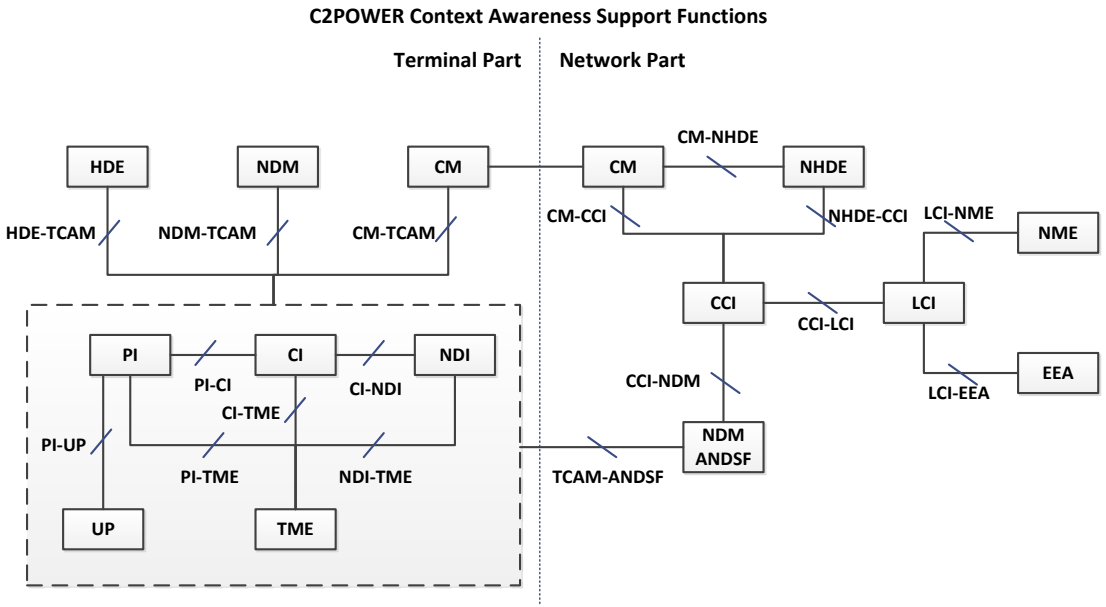


The C2POWER nodes achieve energy saving



The C2POWER nodes discover a higher number of nodes by utilizing context

Interactions between the C2POWER modules



The specification of each interface includes:

information on the general principles

specification objectives

capabilities

description of functions

a Message Sequence Chart (MSC) that describes the interface protocol structure.

Trends | content and context

service demands/types and networks

demographics

technologies

Demographics: Service Mix

	Description
Summary	87% of mobile users subscribe to 3G services
Voice	Fixed voice usage progressively moves to mobile, and the convenience and increasing affordability of mobile causes an increase in voice usage Voice usage increases from 150 minutes per user per month in 2007 to 358 minutes per user per month 30% of mobile voice traffic arises from indoor usage
VoIP	10% of total voice traffic is carried by VoIP
Mobile TV	40% of 3G users watch personalised (unicast) TV and video clips, consuming an average of 150 minutes per user per month Three mobile TV broadcast channels are launched in 2008, and this increases to eight channels 35% of mobile TV consumption is indoors
Internet access	Wireless Internet access attracts some fixed users (for example, students and single-person households) as well as mobile users 13% of 3G subscribers take up Internet access and consume an average of 1GB per user per month 90% of Internet traffic is consumed indoors
Other data services	Mobile messaging and mobile email are very popular services, but they consume relatively little network capacity 41% of 3G users download games, ringtones and other content, at an average of 8 downloads per user per month 25% of 3G users download music and other audio content, at an average of 15 downloads per user per month 19% of 3G users browse small-screen Internet sites, for an average of 41 minutes per month

Source: www.analysysmason.com

Conclusions

Objectives of energy efficiency - what do you want to achieve?

Protocols will need to react to context.

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Thank you!

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