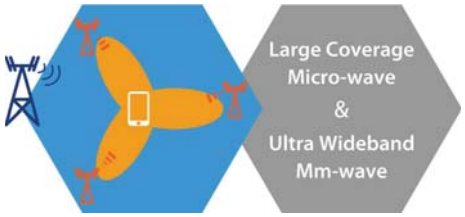

Multi-RAT Link Adaptation Techniques for Green Convergent Networks

Isabelle Siaud & Anne-Marie Ulmer-Moll

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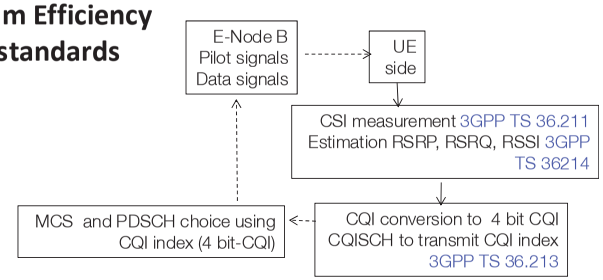
International Workshop on Cloud Cooperated Heterogeneous Networks

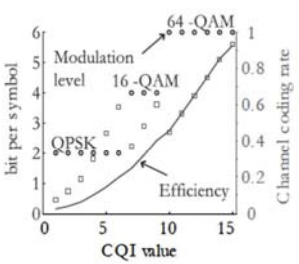
Link Adaptation Techniques (LAT): background

LAT based on Spectrum Efficiency criterion [1]+3GPP standards

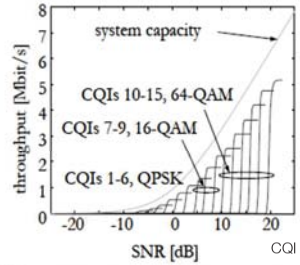
TABLE 1

Channel Quality (downlink pilot E_s/N_o in dB)	4-bit CQI word
−16.25	0000
−14.75	0001
−13.25	0010
−11.75	0011
−10.25	0100
−8.75	0101
−7.25	0110
−5.75	0111
−4.25	1000
−2.75	1001
−1.25	1010
0.25	1011
1.75	1100
3.25	1101
4.75	1110
6.25	1111





(a) Link Adaptation Parameters for each CQI

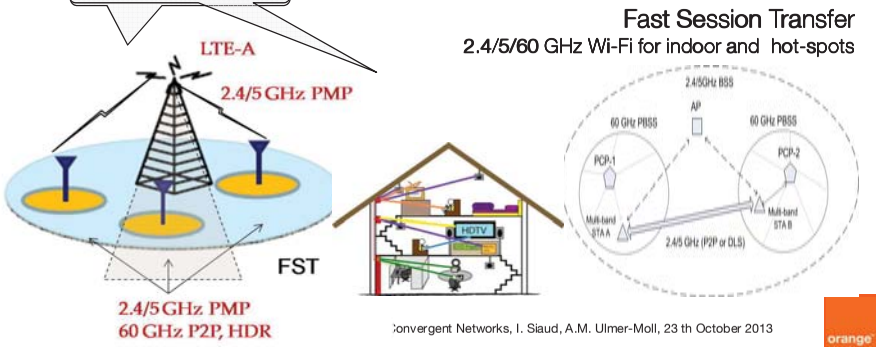


(b) Link Adaptation Effect on the Throughput of a 1.4 MHz Cell

CQI : Channel Quality Indicator

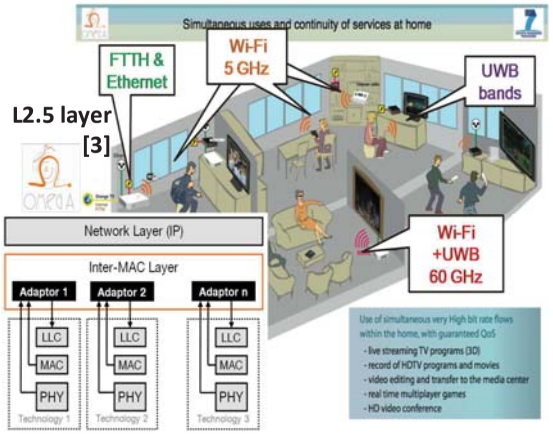
Flexible air interface and Multi-RAT HET NETS

- **Select the most appropriate Air Interface to transmit services into seamless connectivity upon multi-RAT use cases [2]**
  - Green radio criteria : radio coverage + QoS + power minimization
  - Low complexity implementation
  - ➢ FAI and Multi-RAT **Link Adaptation technique**

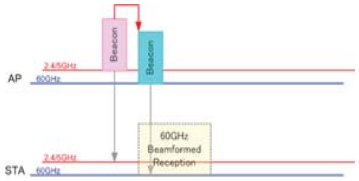


Flexible air interface and Multi-RAT HET NETS

- **FAI and Multi-RAT Link Adaptation technique**
  - Green radio criteria : radio coverage + QoS + power minimization
  - Low complexity implementation



FST mechanisms integrated in **LA for Wi-Fi [2][4]**
➔ Multi-band processing 2.4/5/60 GHz Wi-Fi standards



FST

Multi-technology Link Adaptation Techniques

- **Question :** is the RSSI , Pr, PER are the relevant CQI to perform **green LA and Multi-RAT Multipke Interface Management** ?

- **Our challenge** : define a generic CQI metric to perform **Link Adaptation (LA)** and **Multiple Interface Management (MIM) in mutli-RAT**

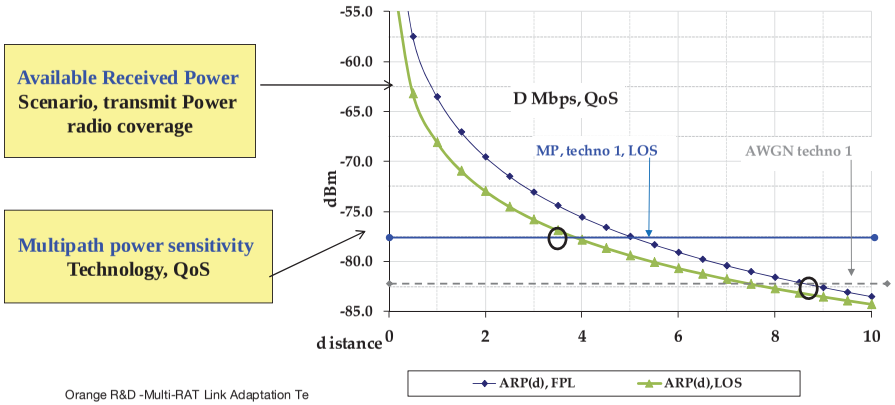
- **CQI Technical Requirements** :
  - A **generic CQI metri**c
  - **Independent AI** and **power level ranges**
  - Guarantying QoS and radio coverage
  - **Adaptive multi-technology power control**

Multi-technology Link Adaptation Techniques

- **Solution**
  - A dedicated **CQI Metric** using **Link Budget** assessments fit with **independent technologies** using **green radio optimization** (QoS, radio coverage and transmit power minimization)
  - **The Green Link Budget Metric {α,β} [4][2]**

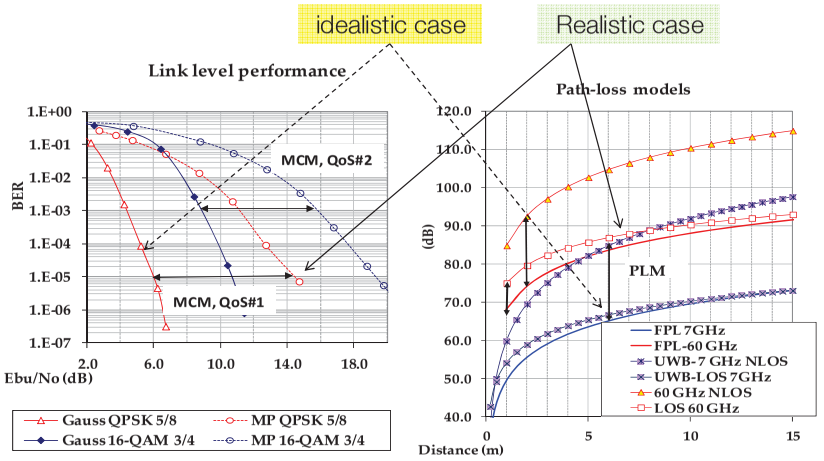
Available Received Power Scenario, transmit Power radio coverage

Multipath power sensitivity Technology, QoS



Multi-technology Link Adaptation Techniques

- **Solution : the Green Link Budget (GLB) CQI metric {α,β}**



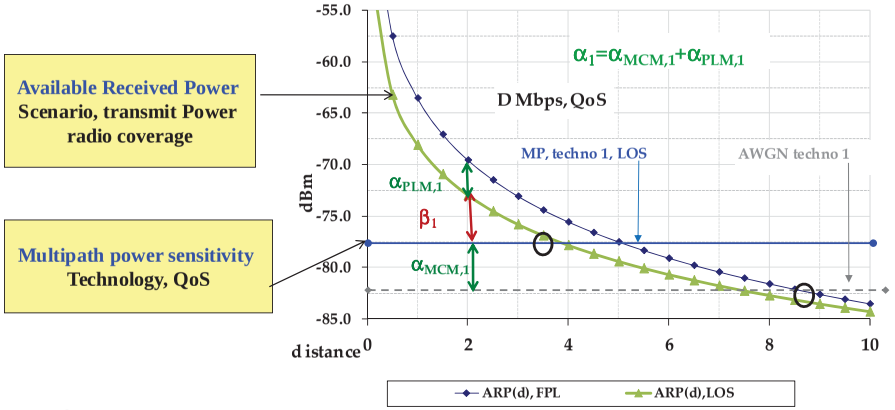
α-metric = MCM+PLM (dB)

Multi-technology Link Adaptation Techniques

- **Solution : the Green Link Budget (GLB) CQI metric {α,β}**

Available Received Power Scenario, transmit Power radio coverage

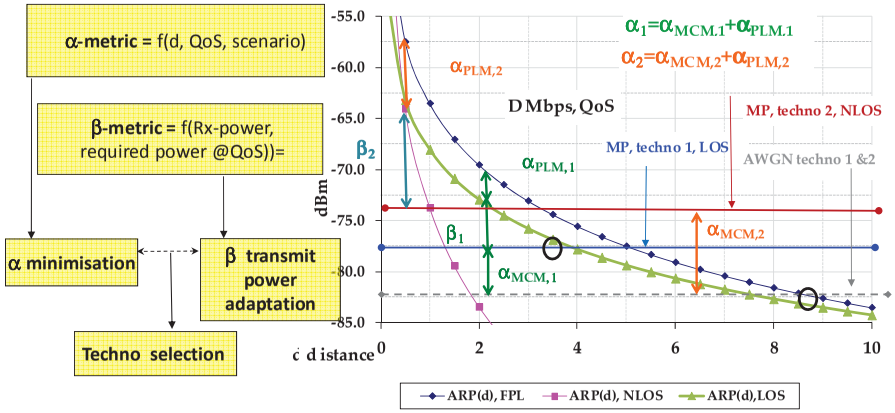
Multipath power sensitivity Technology, QoS



β-metric = ARP(d,fc)-S_M

Multi-technology Link Adaptation Techniques

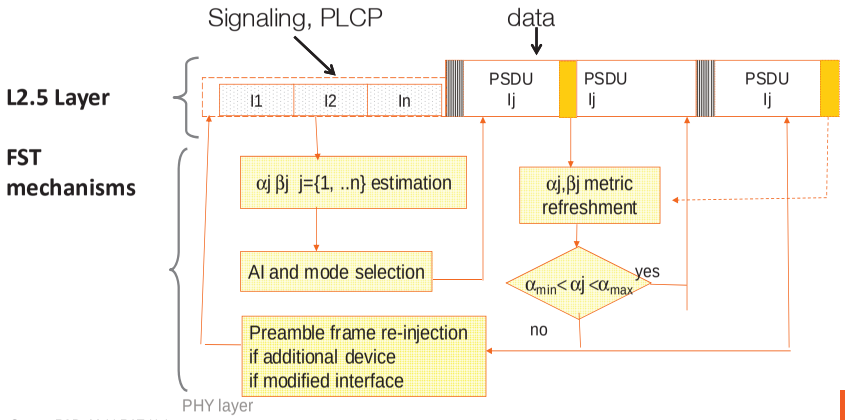
- **Solution : the Green Link Budget (GLB) CQI metric {α,β}**



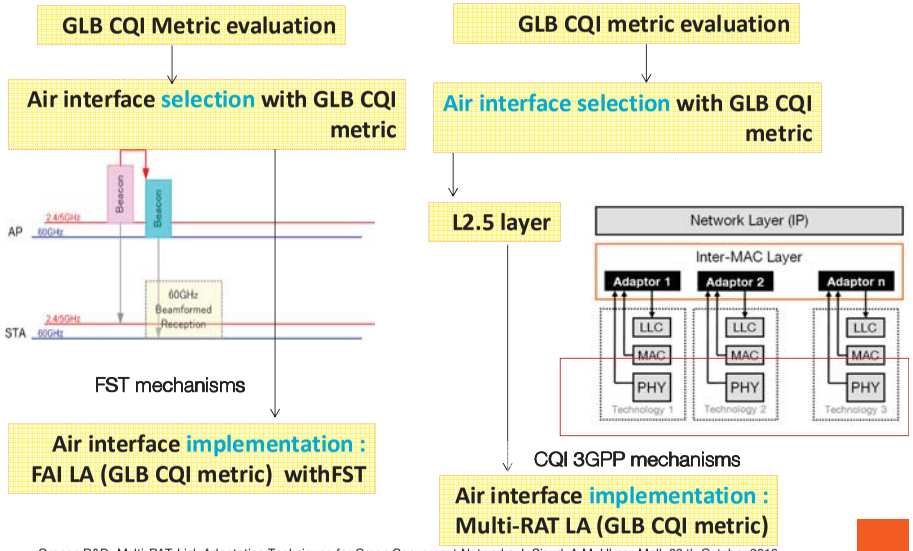
Multi-technology Link Adaptation Techniques

- **The {α,β} metric implementation**

1. Exploit signaling signals to extract input parameters of the {α,β} metric
2. Exploit data signals to refresh the {α,β} metric in dynamic environments.



Green Link Budget (GLB) CQI metric set-up



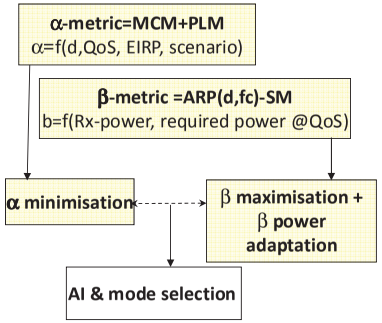
Indoor applications • Multi-RAT LA

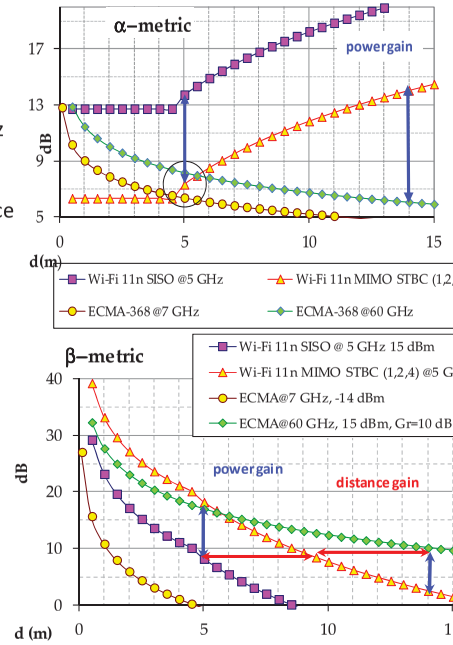
- SISO/MIMO
- bandwidth size versus MIMO antenna number
- WideBand versus UWB
- Power regulation impact

Data rate target : 80 Mbps	IEEE802.11n/ ac				ECMA-368
$MCS_{11n4.48}$	4	4	26	10	
Transmission mode	16QAM ¾ - Nss=1	16QAM ¾ - Nss=1			QPSK ½ TDS+FDS
	40 MHz	40 MHz	20 MHz	40 MHz	528 MHz
	SISO	MIMO STBC (1,2,4)	MIMO SDM (4,4,4)	MIMO SDM (2,2,4)	QPSK ½ TDS+FDS
Data rate (Mbps)	81	81	78	81	80
Efficient bandwidth(MHz)		35.9	19.5	35.9	507.37
SNR (dB)	21.5	16	27.5	20	1.5
NF + L0 (dB)	10+2.5	10+2.5	10+2.5	10+2.5	8 (6.6) +2.5
S (dBm) [AWGN]	-71.9	-71.9	-78.8	-82.05	-82.37
S_M (dBm) [MP]	-57.94	-64.94	-68.44	-57.44	-77.89
MCM (dB)	13.96	3.96	24.6	10.36	4.48

Indoor applications

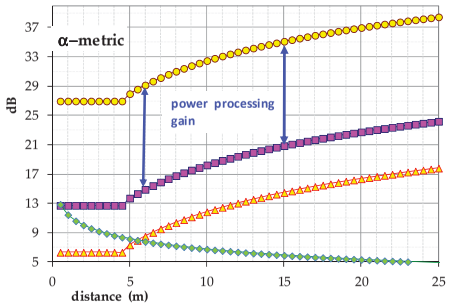
- IEEE802.11n
  MIM0 and SISO, 40 MHz, @ 5 GHz
  - ECMA-368 @ 7 Hhz and 60 GHz
  - 80 Mbps
  - 2 transitions as a function of the distance

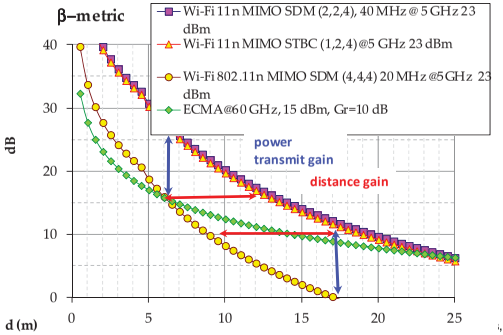




Indoor applications

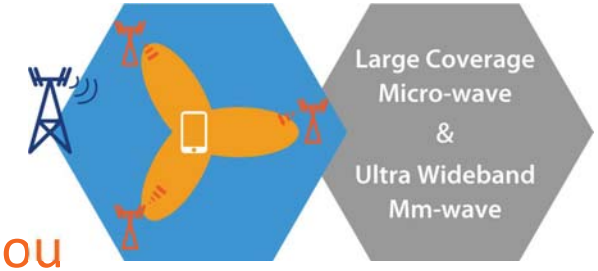
- MIMO size versus bandwith size
- UWB versus WB





Conclusions and perspectives

- The {α,β} CQI metric is a promising metric for multi-RAT Link Adaptation technique along Green Criteria :
  - Transmit power minimization in multi-RAT and multi-technology HET NETs
  - Perform adaptive control power
- Evaluate the {α,β} metric in outdoor Fast Session Transfer use cases [4]
- Evaluate the {α,β} metric in multi-RAT Wi-Fi/LTE use case
  - Multi-cast LTE
  - MIMO Wi-Fi configurations in outdoor environment
- Determine implementation schemes using signaling frame formats to extract input parameters of the {α,β} CQI metric



Thank you

Questions ?

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references

[1] M. Pelcat et al., *Physical Layer Multi-Core Prototyping*, 9, Lecture Notes in Electrical Engineering 171, DOI: 10.1007/978-1-4471-4210-2_2,, © Springer-Verlag London 2013

[2] I. Siaud, A.M. Ulmer-Moll, "Multi-RAT selection : from use cases to CQI metrics (part I)", Green Touch BCG and GTT projects, Stuttgart meeting, November 2013.

[3] ICT FP7 OMEGA project, Deliverable 2.7 "Radio Final Evaluation Report", March 2011.

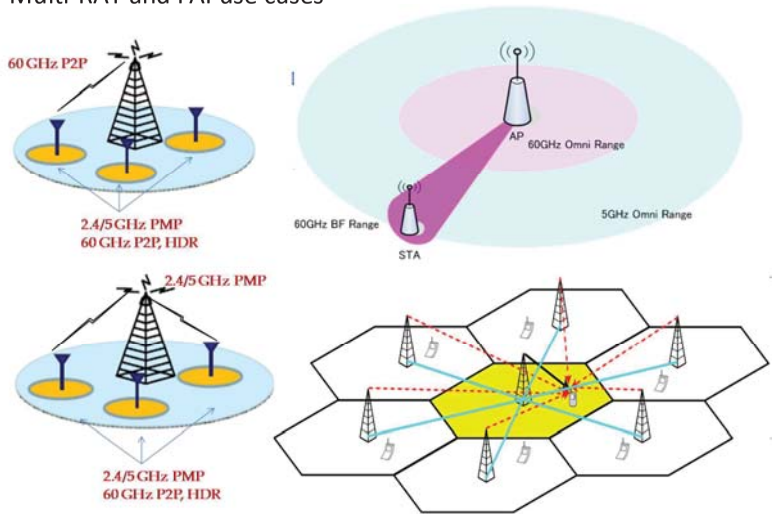
[4]A.M. Ulmer-Moll, I. Siaud, Orange Labs, "A green link budget CQI metric for multi-RAT HET-NETS", software demo, TIA'2012 , Dallas meeting, June 2012.

Complementary slides

Orange R&D -Multi-RAT Link Adaptation Techniques for Green Convergent Networks, I. Siaud, A.M. Ulmer-Moll, 23 th October 2013

Multi-RAT and Flexible Air Interface

- Multi-RAT and FAI use cases



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