analysis of 3G terminal emitted and received power during a real use

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context

- standards based on maximum maximorum concepts
  - Maximum Power
  - positioning distance
  - Phantoms
- public information on EMF
  - Real exposure
  - Multi media uses
  - Mean/average exposure
  - characterizing the main factors on the exposure
- mobile operators responsibility
  - Corporate social responsibility
  - Sustainable development
  - "Grenelle de l'environnement"
-

THE MOBILE PHONE SCARE PART I: THE EVIDENCE

The warnings we must listen to

Uncertainty persists among the scientific community. But, if there are dangers, children are at the highest risk, writes Clive Cookson

Any new technology introduced rapidly into the consumer market arouses safety fears – and these can be very hard to dispel. When the Victorians worried about the "force fields" associated with newfangled electric power, scientists could not provide absolute reassurance – and even today there are unresolved concerns about the health risks from power lines.

The introduction of mobile phones in the early 1980s was accompanied by allegations that the microwave radiation used to transmit conversations between base stations and handsets could cause brain damage – leading to memory loss and malignant tumours. After hundreds of studies around the world, the evidence remains inconclusive today.

So when Sir William Stewart, chairman of the UK's National Radiological Protection Board, issued an update last week on his landmark 2000 review of mobile phone safety, the conclusion was

Mobile et santé : toujours pas d'étude en France

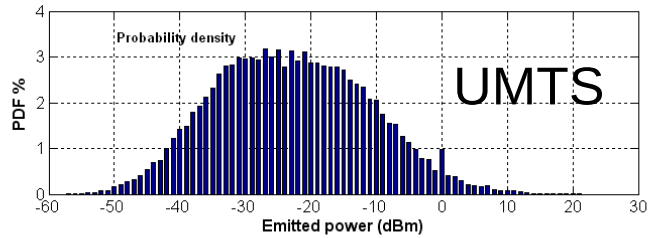
Les associations Agir pour l'environnement et Priartem ont adressé hier une lettre ouverte au ministère de la Santé pour dénoncer l'absence d'étude en France sur

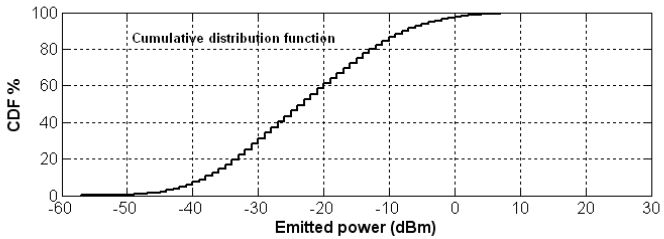
Une étude suédoise démontre notamment que le risque de tumeur à l'oreille est quatre fois plus important chez les personnes utilisant un portable depuis dix ans.

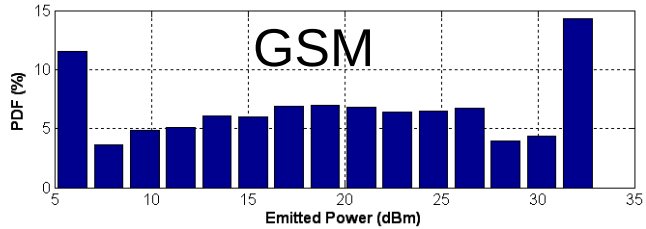
Par ailleurs, un éminent scientifique britannique, William Stewart, a dénoncé la semaine dernière à la une du *Times* le danger des portables pour les cerveaux des enfants. Une en-

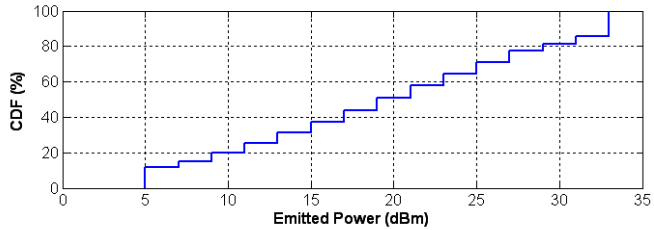
pour l'environnement affirme avoir déjà interpellé, en vain, le ministère de la Santé et la Direction générale de la santé. Aujourd'hui, les associations réclament des en-

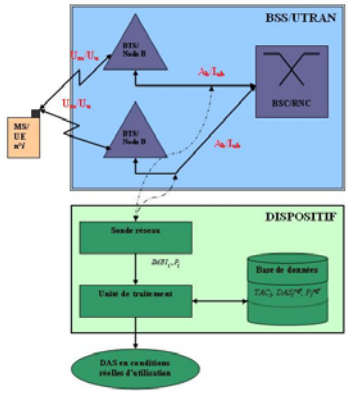
Previous work











	3G	2G	
Max	250mW	250 mW	
Mean	1mW	68 mW	de 10 à 20 dB
	~20 dB	3-6 dB	

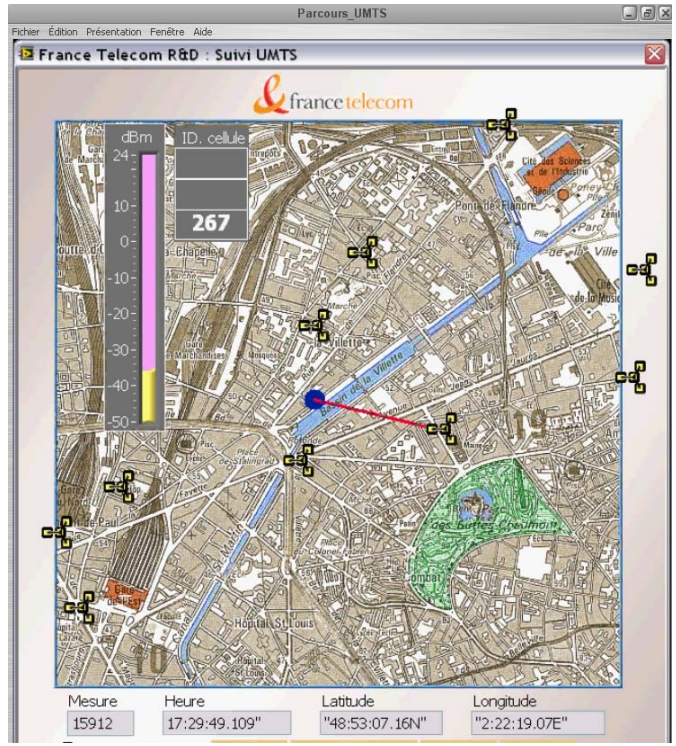
objectives

- investigate the emitted and received power of a 3G terminal during real uses
- in order to have a good knowledge of the real exposure due to this technology
  - Urban, rural, indoor
- What are the main factors influencing the real exposure ?
  - Service, Handset type, Network, Body influence ,in car
- Support epidemiological studies

Characterizing real exposure

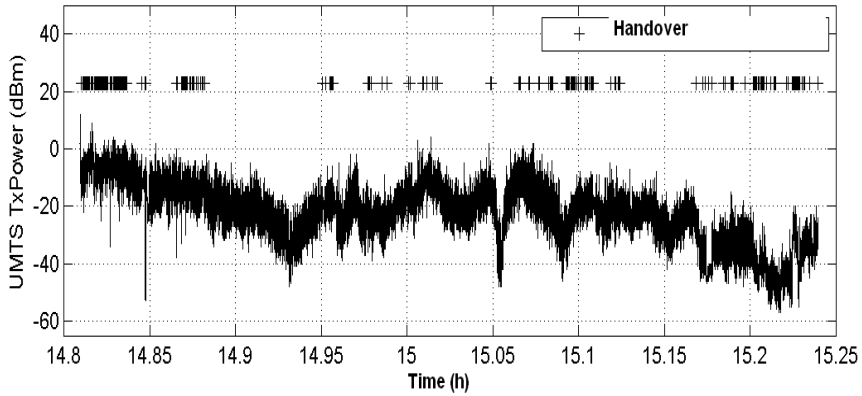
- Real SAR $\langle SAR \rangle = \langle P \rangle * SAR_{\max} / P_{\max}$
  - Statistical methods
  - Uncertainty consideration

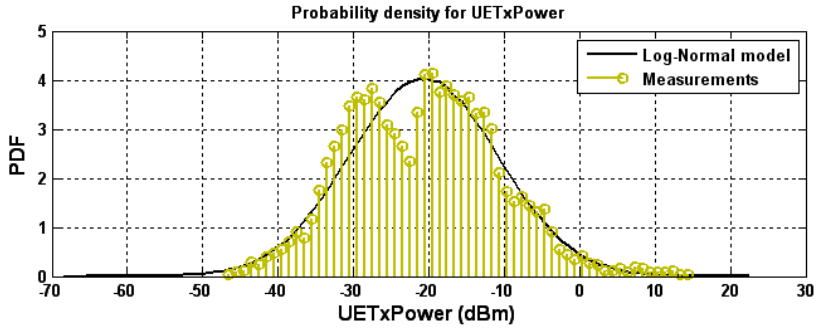
- Campaign of measurements in different configurations
  - Real time captures
  - Build models
  - Extract statistics (mean, median, max…etc)
  - Compare distributions

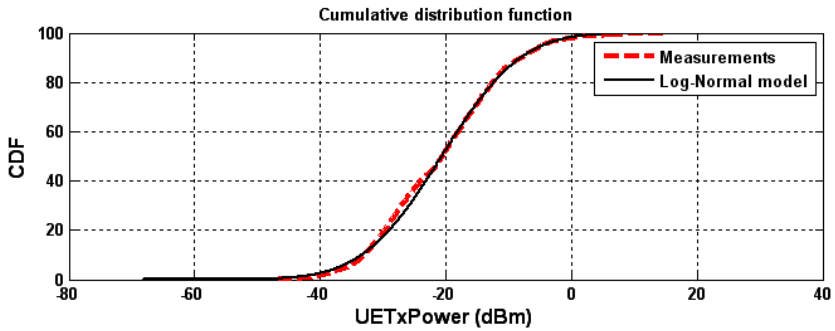


UMTS distribution model

- Real time captures
  - WCDMA avoid maximums
    - HO
    - Starting a call
- Log-normal model
  - Median << mean
  - Mean ~ max@90%
- Fast power control : 1500 per second
- Power adjustment : 1-2 dB

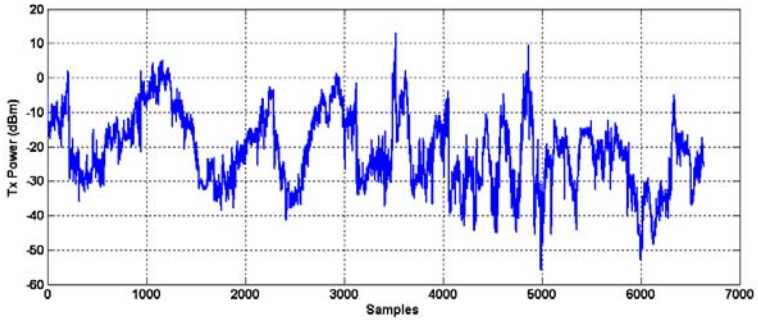


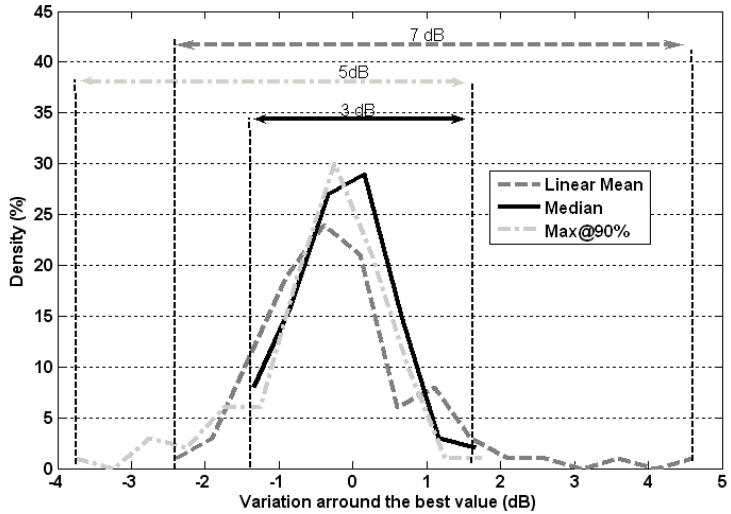




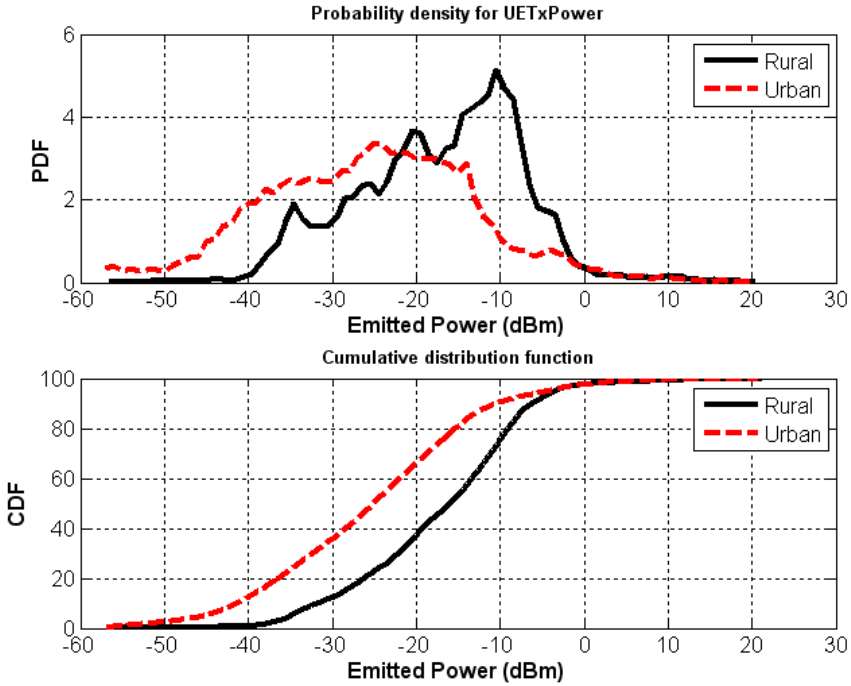
Uncertainty of statistical indicators

- Uncertainty assessment is a difficult task
  - Fading
  - Shadowing
  - sampling
- sampling rate
  - 3.5 dB on mean value
  - 2.5 dB on 90% quintile value
  - 1.5 dB on median value





Urban/Rural/Indoor – voice call



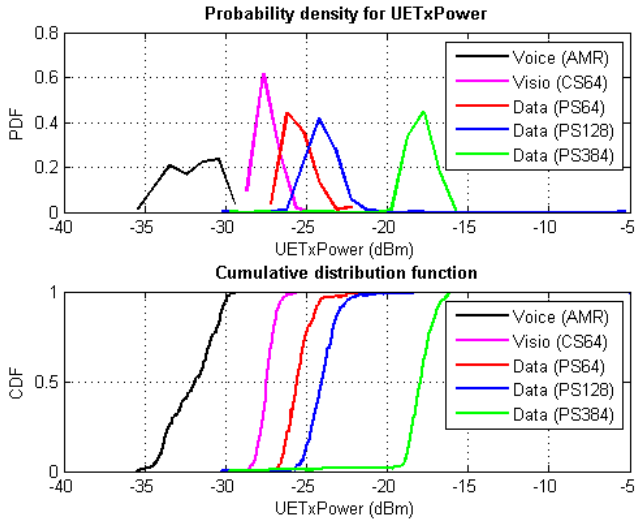
Real exposure

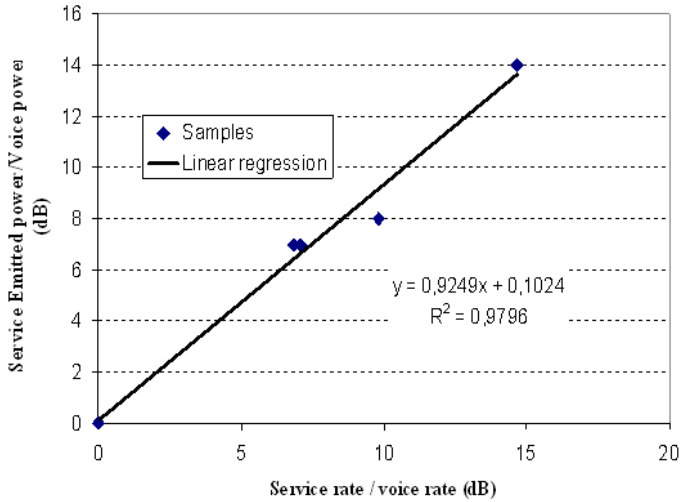
- Low power values
- Average ~ 1mW (hundreds of times under maximum possible values)
- 90% of samples < 4mW
- Low penetration capabilities for 2.1GHz carrier
- Highly spread shape in urban compared to rural

Indicator	**Outdoor Big city**	**Indoor City halls**	**Indoor Market center**	**Rural Small city**
Mean	0.2 mW	1.1 mW	5 mW	0.4 mW
Mean/max	**-30dB**	**-23 dB**	**-17 dB**	**-27 dB**
Median	0.003 mW	0.05 mW	0.001 mW	0.02 mW
max@90%	0.1 mW	2.3 mW	2 mW	0.24 mW
Standard deviation (Log values)	12 dB	13 dB	18 dB	10 dB
Indoor/outdoor	**+12 dB ±1.5 dB (median indicator)** **+7 dB ±3.5 dB (mean indicator)**			
Rural/Urban	**+3 dB ±3.5 dB (Mean indicator)**			

Service influence

	Voice AMR	Visio CS64	Data PS64	Data PS128	Data PS384
Throughput rate	12.5 kbps	64 kbps	60 kbps	120 kbps	364 kbps
Relative emitted power (Median)	0 dB	4 dB	6 dB	8 dB	14 dB

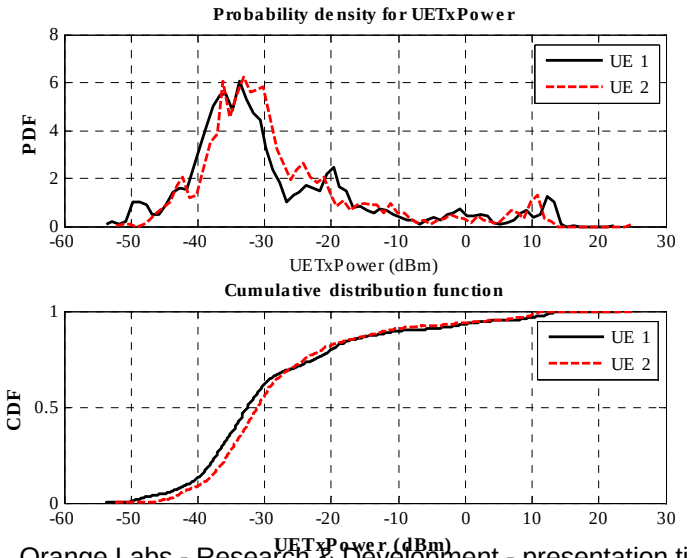




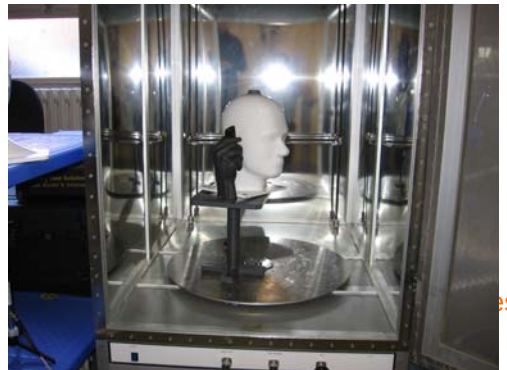
- New services are highly power consuming
- Energy per bit is constant
- What about new multi-channel techniques : MIMO

Mobile phone model

- Two different handsets
- Some handsets are adapted considering a head charge
- 90% of the power is absorbed by the head and the hand
- **Efficiency is compensated by the power control**

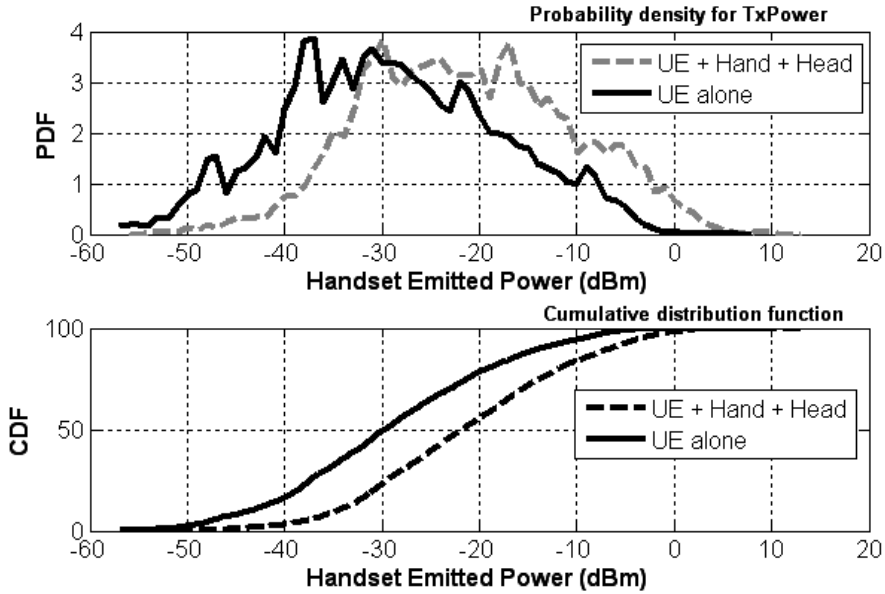


	UE1 (Samsung Z170)	UE2 (Samsung I600)
Handset alone		
Radiated power dBm	22.54 dBm	21.81
Maximum Power	24 dBm	24 dBm
Efficiency (%)	**71.5%**	**60.4 %**
Handset with hand and head		
Radiated power dBm	12.92 dBm	14 dBm
Efficiency (%)	**7.8%**	**10 %**
Body loss	9.6 dB	7.8 dB



Body loss

- Real use measurements
- Head and hand phantom filled with broadband liquid
- Real Body loss about 8 dB (±1.5dB)
  - In lab 9.6 dB

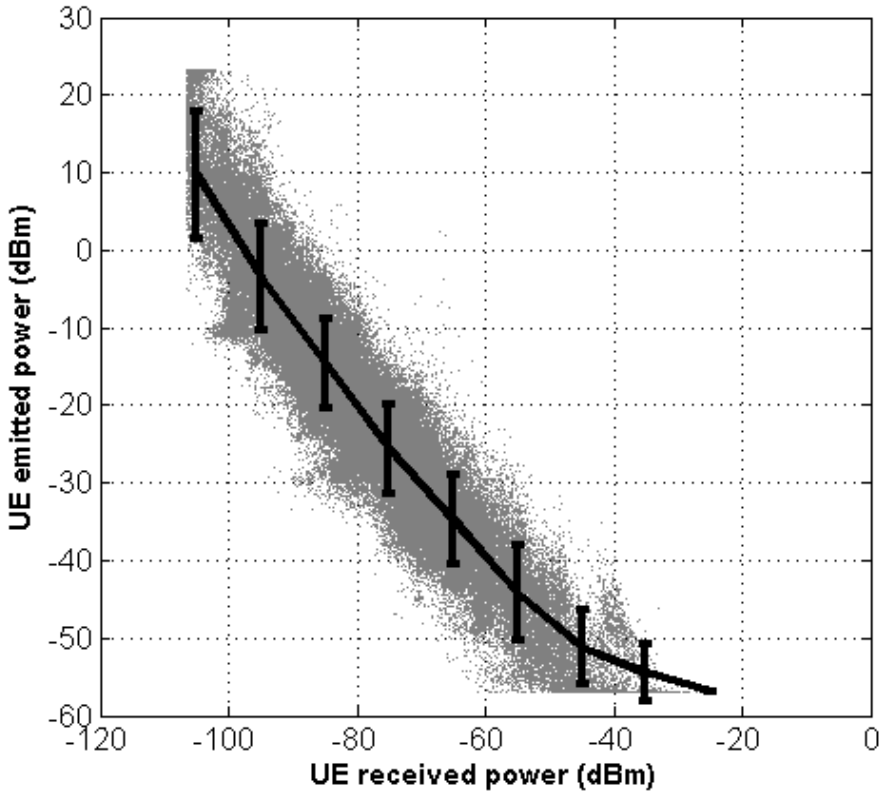


Main factors

Factor	*Influence*
Indoor /Outdoor	5-10 dB
Rural/ Urban	3 dB
Static/moving	1-2 dB
Body loss (in lab) **Body loss (insitu)**	9dB 8 dB
Body worn	4 dB
Handover	Weak effect
Service **Visio CS64 / Voice** **Data PS64 / Voice** **DataPS128 / Voice** **Data PS384 / Voice**	+4 dB +6 dB +9 dB +14 dB
Handset efficiency	No on radiated power*
Network planning	1 dB

Emitted power vs revceived power

- stronger is the reception, lower is the emission of the handset
- increase base station density !
  - Acceptability
  - Home
  - Femto cells
  - Pico cells



Multi-sources exposure

Base Station Type	Macrocell	Microcell	Picocell	Femtocell
Puissance	5 W – 40 W 1-3 secteurs	5 W	1 W	< 100 mW
Radius	kilomètres	~ 300 mètres	100s de mètres	10s de mètres
Nb d'utilisateurs simultané	qq centaines	100	10	Qqns (typiquement 4)
Couverture	Accès public outdoor et indoor	Accès public outdoor et indoor (extension de zone dense, stade, exposition centre …)	Accès public Ou accès privé Principalement indoor (entreprise, campus, aéroports, gares, …)	accès privé à la maison

conclusion

- overview of real power for 3G services
- on-site measurements collected during real stream
- many factors inducing variations of the power levels
- differences between 2G/3G technologies
  - fast power control and HO management avoid maximum power emissions .
  - rake receiver
- the average emitted power is strongly dependent on high power samples.
- combining different influencing factors is a heavy task
  - worst case situation
- monitoring systems
  - Geostatistics models
  - controlled uncertainty.
- smart devices
- new signal : ANR - Multipass