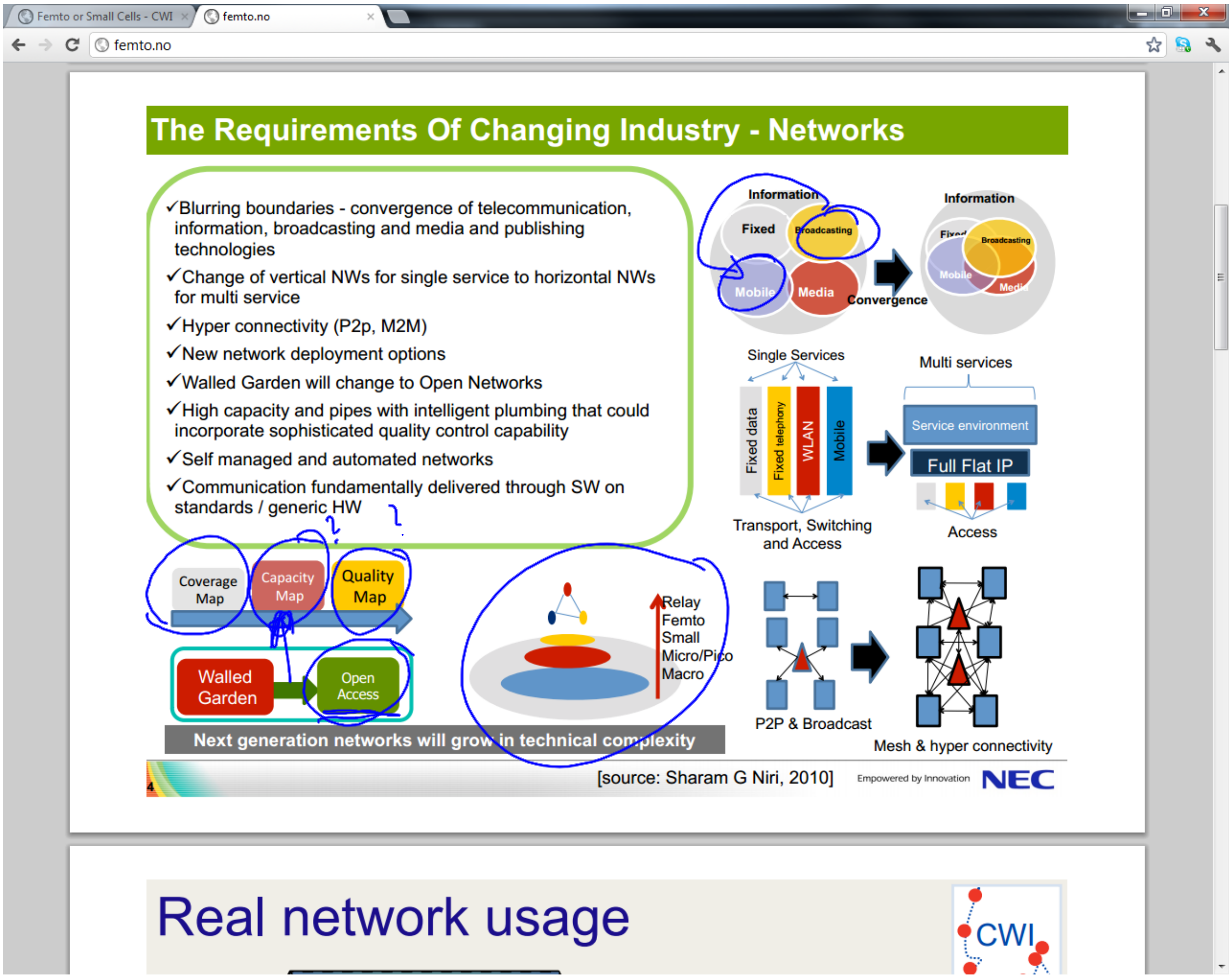
Capacity increase 800%

within next 4 years

"the user owns the network"

" " " " SIM



Femto or Small Cells - CWI
femto.no
femto.no
The Requirements Of Changing Industry - Networks
✓Blurring boundaries - convergence of telecommunication, information, broadcasting and media and publishing technologies
✓Change of vertical NWs for single service to horizontal NWs for multi service
✓Hyper connectivity (P2p, M2M)
✓New network deployment options
✓Walled Garden will change to Open Networks
✓High capacity and pipes with intelligent plumbing that could incorporate sophisticated quality control capability
✓Self managed and automated networks
✓Communication fundamentally delivered through SW on standards / generic HW
Information
Fixed
Broadcasting
Mobile
Media
Convergence
Information
Broadcasting
Mobile
Single Services
Fixed data
Fixed telephony
WLAN
Mobile
Transport, Switching and Access
Multi services
Service environment
Full Flat IP
Access
Coverage Map
Capacity Map
Quality Map
Walled Garden
Open Access
Relay
Femto
Small
Micro/Pico
Macro
P2P & Broadcast
Mesh & hyper connectivity
Next generation networks will grow in technical complexity
[source: Sharam G Niri, 2010]
Empowered by Innovation
NEC
Real network usage
CWI

increase of capacity — reuse of freq

↳ smaller cells

10x # cells

10x efficiency

10x bandwidth / spectrum

By 2020 ⇝ 1000x capacity

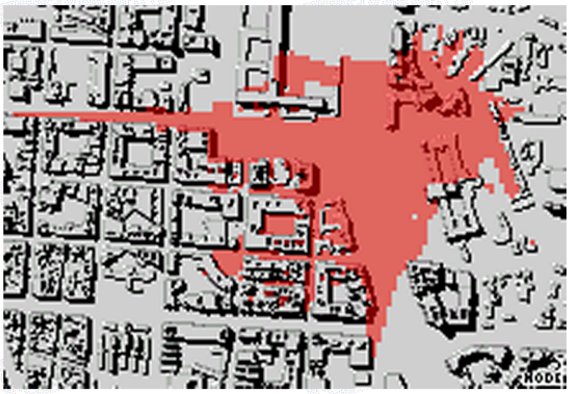
The results of the tests have shown a strong impact of the UTRA interface on the quality of service. For example, real time streaming of high quality music over UMTS requires very 'protected' channel, at least when the application is not applying any error resilience tools. A UMTS network design has to take into account capacity, QoS and coverage requirements. If you are interested in more information about application testing follow the link to the application testing executive summary.

Go back to beginning

The need for simulation

As mentioned above, compared to GSM, the W-CDMA technology for UMTS is considerably more complex. One of the fundamental characteristics of CDMA systems is that the coverage range is intrinsically linked to the capacity of the system - the more traffic being carried by a cell, the smaller the coverage area of the cell becomes. The GSM network capacity is limited by interference, first of all from adjacent cells. In UMTS each transmitted signal increases the noise level (N_0) of the overall system. As capacity is related to the signal over noise ratio, noise increase reduces capacity.
Since the traffic is constantly changing, depending upon the behaviour of the subscribers, the coverage range changes also. This phenomenon is know as *cell breathing* and it can be observed in the next image, which shows the service area of one base station with different traffic loads in the system.

Cell breathing



W-CDMA dominant

„LTE not that dominant"

This dynamic behaviour makes cell planning and network dimensioning a very complex process. Traditional static prediction methods are not appropriate and so simulation and statistical modelling techniques have to be used. However, the system is very complex, with so many interactions, that the simulation has to be broken into two parts:

- Link-level, considering the effects of the radio channel on individual bits transmitted in a single communication.
- System-level, considering a number of cells and mobiles, based on output parameters from individual link simulations produced at link-level.

The simulation approach has some advantages over other methods (e.g. hardware prototypes, analytical evaluations), such as lower costs, higher accuracy, and inherent flexibility. However to simulate a number of cells and mobiles in near-real time requires many hours of processing time to simulate just a few minutes of network activity mainly because of fast power control.

Learn more about link level simulation

ETSI selected W-CDMA and TD-CDMA as radio interfaces for the UMTS system. The main focus of the work performed in this task was to establish a link level simulator, which can analyse the radio propagation channel, taking into account UTRA's physical layer features. The link performance is a necessary input for system capacity and coverage evaluations that are definitely the most important aspects for a telecommunication operator.

A further output of the link level simulations is a set of error patterns to be used for the test of a selected application.
If you are interested in more information about link-level simulations follow the link to the link level simulations executive summary

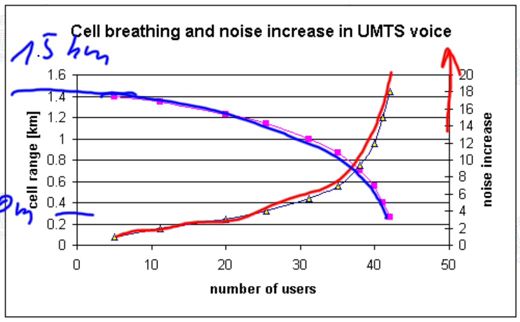
Learn more about system-level simulation

In UMTS capacity and coverage are interdependent and are functions of the radio environment. With an increasing number of users in the cell, the radius of the cell will decrease and the noise level, seen as interference, will increase (the attached figures gives an example for voice services in UMTS). Furthermore, both uplink and downlink radio performance have a large impact on system performance. QoS of the applications is also becoming a function of the location, the load of the network and the traffic mix. Multi-services and packet data transmission with packet dependent QoS parameters complicate the picture even more.

System-level simulations have the goal to model a 'complete' network with several base stations and an estimated traffic distribution with a mix of services, each one with different requirements in terms of error rates and delay. The values of E_b/N_o for each service that allows to accomplish with the maximum error rates are obtained by means of link level simulations. The main output of system level simulations is coverage, capacity and QoS in the simulated network.

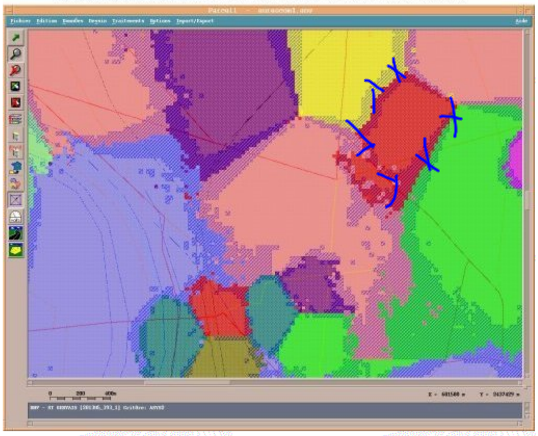
A system-level simulator is basically a software tool modelling the system and the environment. Any mobile network system simulator is composed of the following blocks: base station, mobile user equipment, propagation model, data collector, graphic interface manager and simulator manager.

There are two approach to design system-level simulators: the time based and the snapshot. Both approaches provide complementary cellular network results, but due to the complexity of time based system-level simulations, most of the simulators that are currently available use statistical methods, known as Monte Carlo simulation.



S/N ↓ ~ cell size ↓

CELL COVERAGE AND MACRODIVERSITY AREAS



The outcome of the system level simulator is the coverage area, as shown in the figure. Each cell is formed by one sector of the three sector antenna (this example). The shaded areas are the areas where coverage from two or more cells occure, the 'macrodiversity areas'. In UMTS terminals will have connections to both cells, to allow for fast and optimised handover at high data rates.

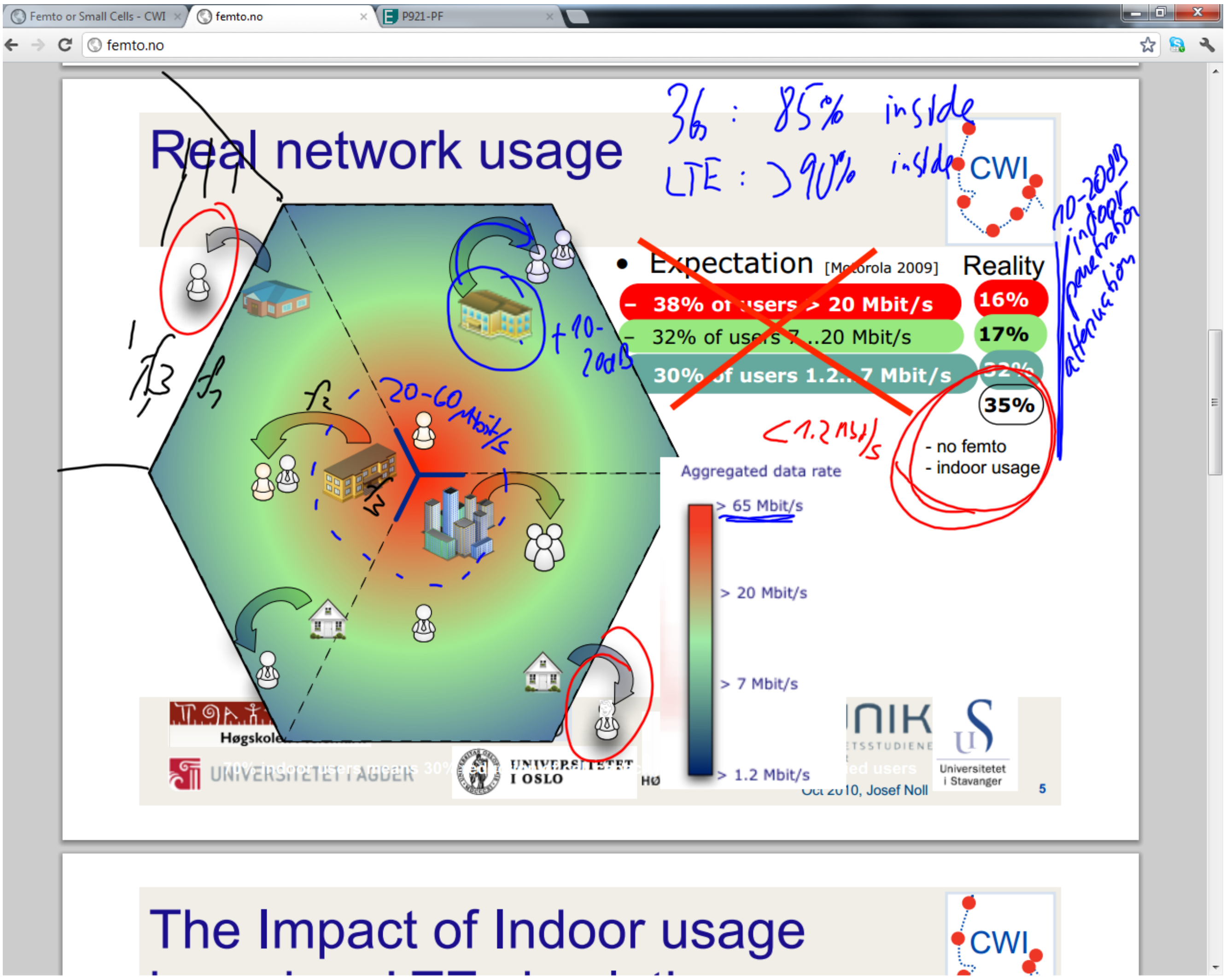
Indoor users: S/N ↓ ~~N↑~~ secondary

– path loss |wall| window w. metall S ↓

~> P_T ↑

~> N ↑

WCDMA: 1 frequency reuse (all within 5MHz)
LTE 1... 20 MHz band "reuse" (min 180kHz carrier)



Δf ~ 10% f_c ?

~ mobile band ?

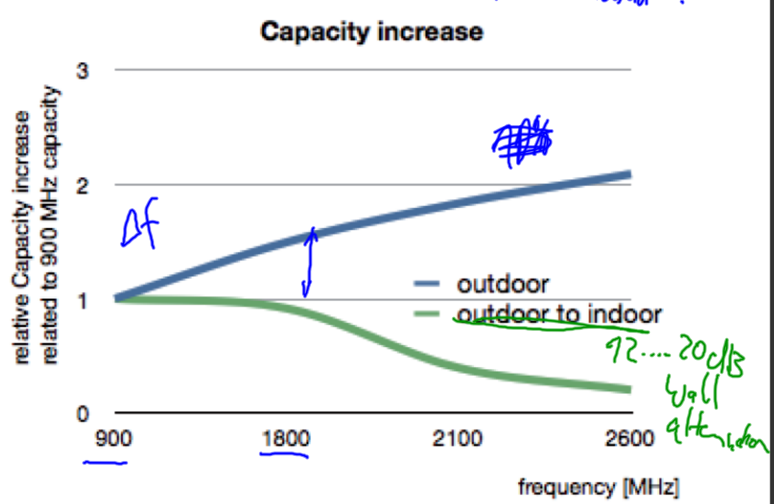


Figure 4. Relative Capacity in Indoor to Outdoor Scenario for LTE Network

3.1.3 WiFi Technology

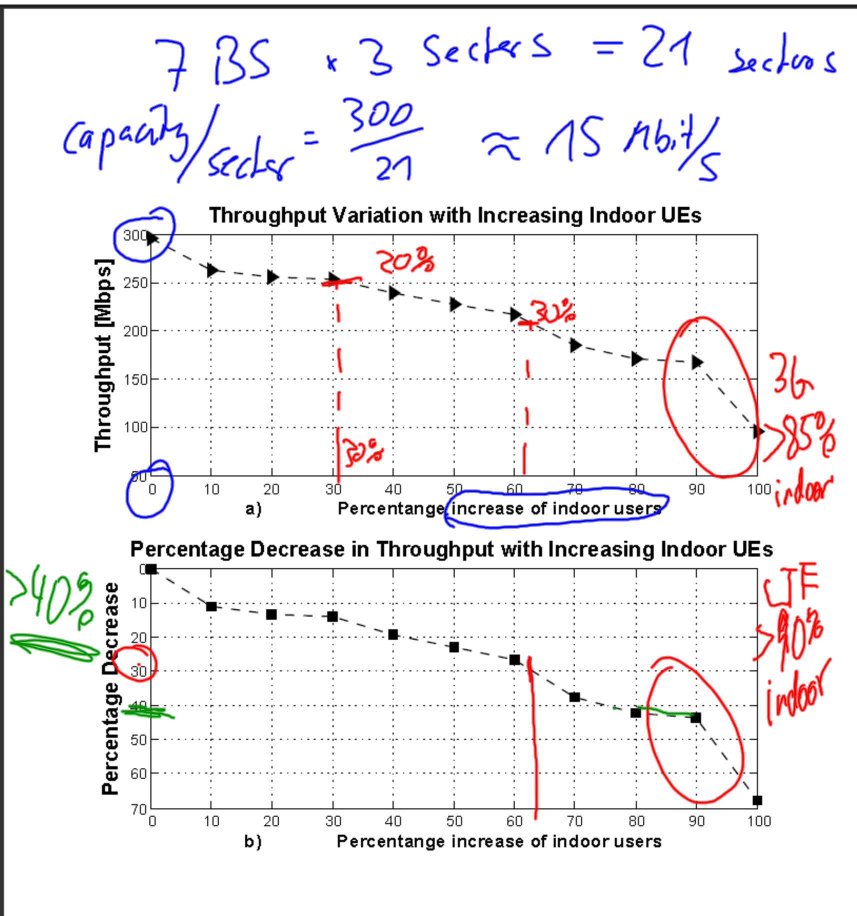


Figure 11. Decreasing throughput by increasing percentage of indoor UEs

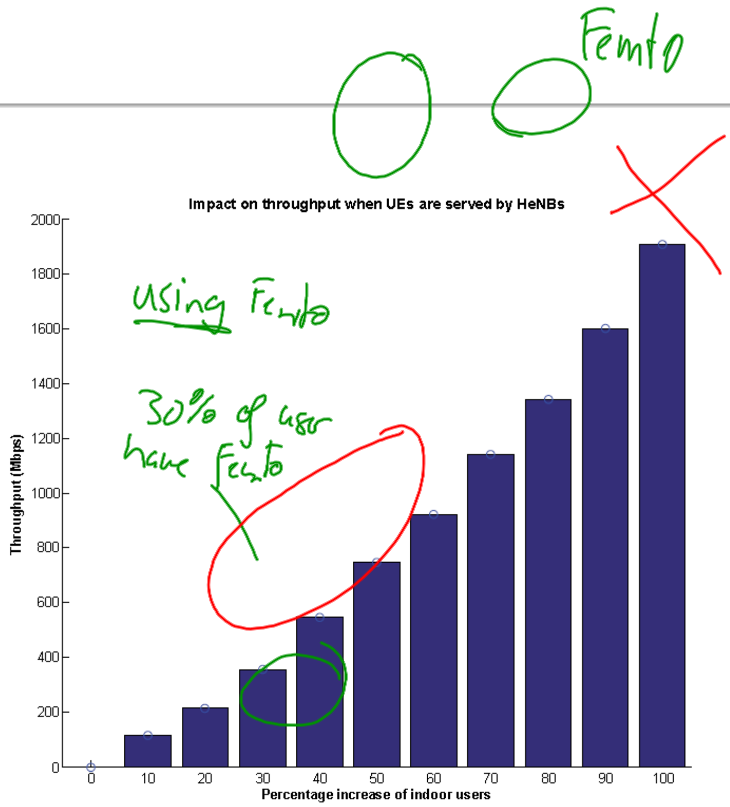


Figure 12. Increasing femtocells agreggated throughput by increasing percentage of indoor UEs

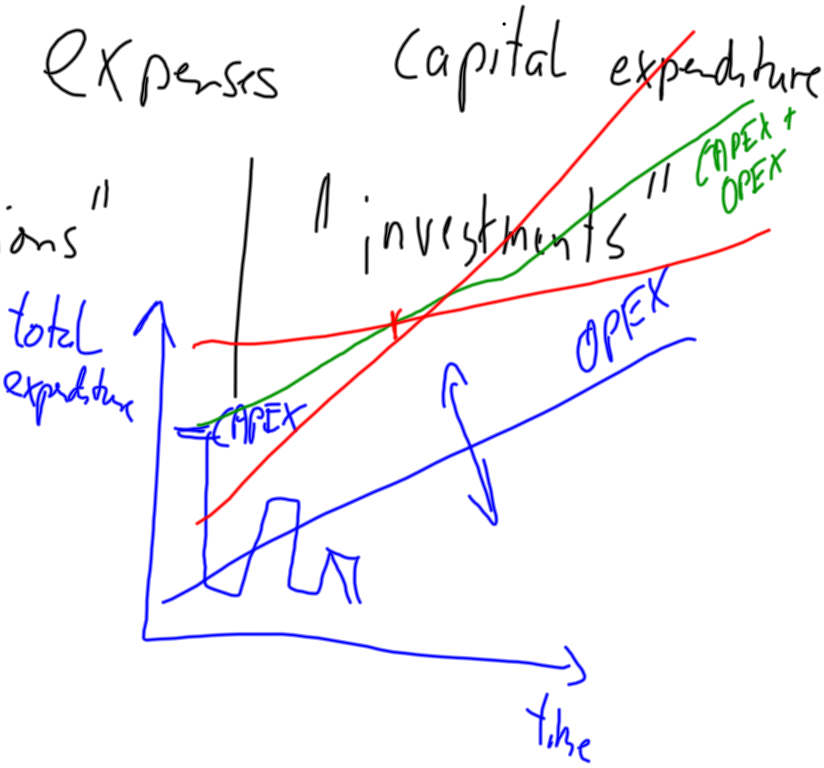
When more users move indoor, the traffic on macrocells offloads, this offloaded traffic is effi-

5,90 x 8,67 in

OPEX / CAPEX

Operational expenses | capital expenditure

"operations" | "investments"



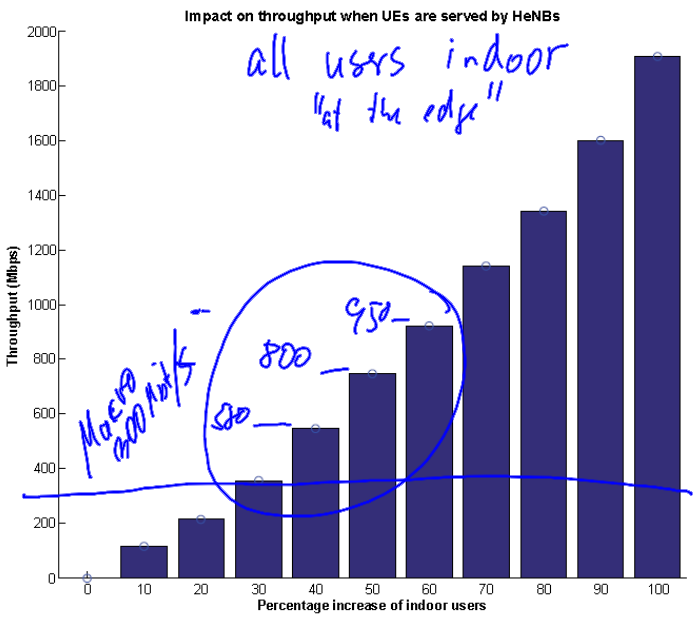


Figure 12. Increasing femtocells agreggated throughput by increasing percentage of indoor UEs

When more users move indoor, the traffic on macrocells offloads, this offloaded traffic is efficiently served by the operational femtocells, which results in getting maximum agreggated throughput. Hence better QoS is ensured. Comparing to our previous scenario, in the absence femtocells, Femto or Small Cells - CWI | femto.no | network norway femto cell

femto.no

Simulation results

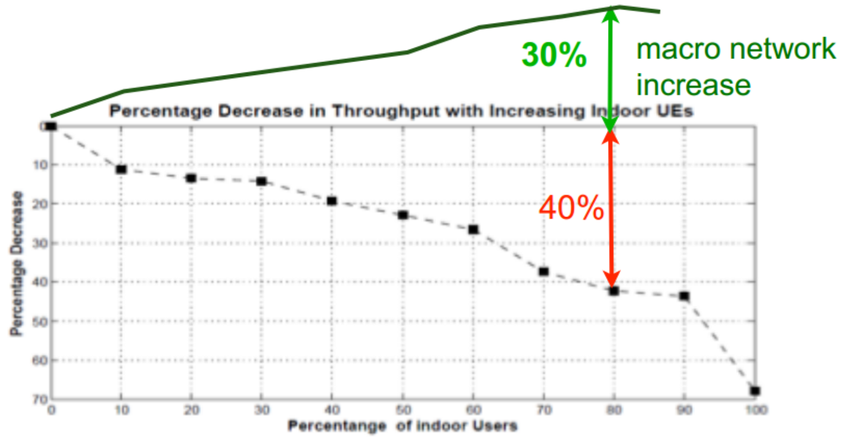


Figure 7: Decreasing Throughput by increasing percentage of Indoor users

Details of simulation

Telecom

Capex: "buy"

- house
- base station
- antennes
- core network

OPEX "operate"

- power
- lease line
- cost per MB
- people, upgrade

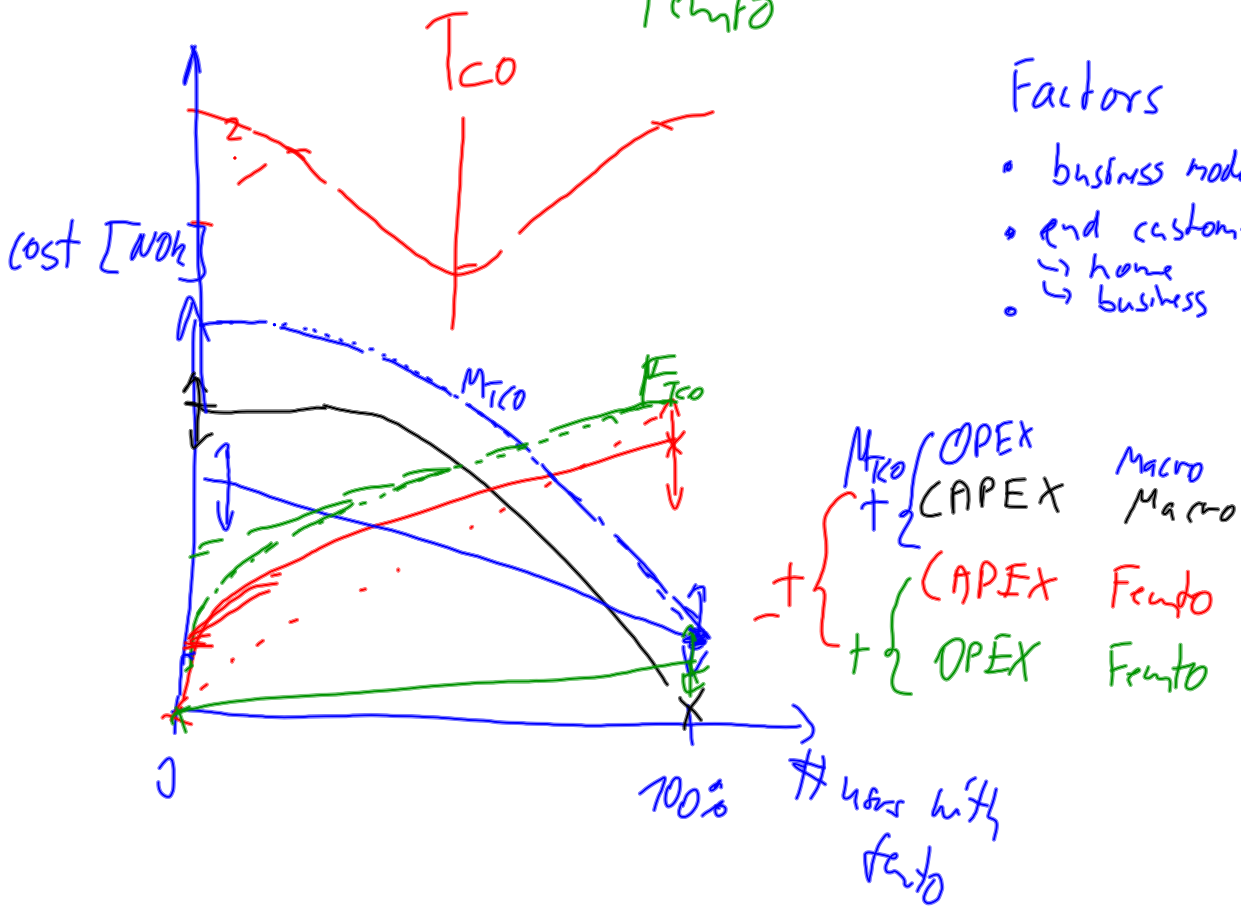
$\rightsquigarrow$ TCO total cost of ownership

Capex & Opex

femto

≙ capacity = const
↳ macro + femto

20 ... 60% users with Femto



Factors

- business model
- end customer
  - ↳ home
  - ↳ business
-

Femto

Advantages / Disadvantages

- initiall costs for preparing for Femto
- revenue for operators may decrease
- # Mobile Broadband Customers ⇓
+ high speed, better QoE

"higher speed costs more"

+ service continuity
+ roaming
+ security

(- Femto to SPAIN)

- loss of control
- handover macro - femto
demand
- multi-operator femto

" - Ownership "