Weaponizing Femtocells: The Effect of Rogue Devices on Mobile Telecommunication

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NDSS 2012, San Diego, 6th February 2012

Introduction

- Mobile data traffic is rapidly increasing (3G, 4G), but coverage often bad
- Operators seek for solutions to offload traffic to other networks
- Introduction of small/cheap cells in residential environments (home)
- As of Q2 2011, 31 operators in 20 countries adopted femtocell technology (Vodafone, AT&T, SFR, NTT DoCoMo, ...)

What is a femtocell (HNB or FAP)?

- Small and cheap base station, small coverage (around 50m)
- Deployed in home environment (no tamper resistance)
- Connected to operator backend via Internet

- Reduce expenditure by offloading traffic from public infrastructure
- Low maintenance and installation costs
- Improved 3G coverage in buildings
- Location based services

Contributions

- End-User risk assessment
  - Demonstrate attacks violating confidentiality, integrity and availability of subscriber traffic
- Femtocell/Infrastructure weakness analysis
  - Network attacks originating from a femtocell and design shortcomings in current architectures

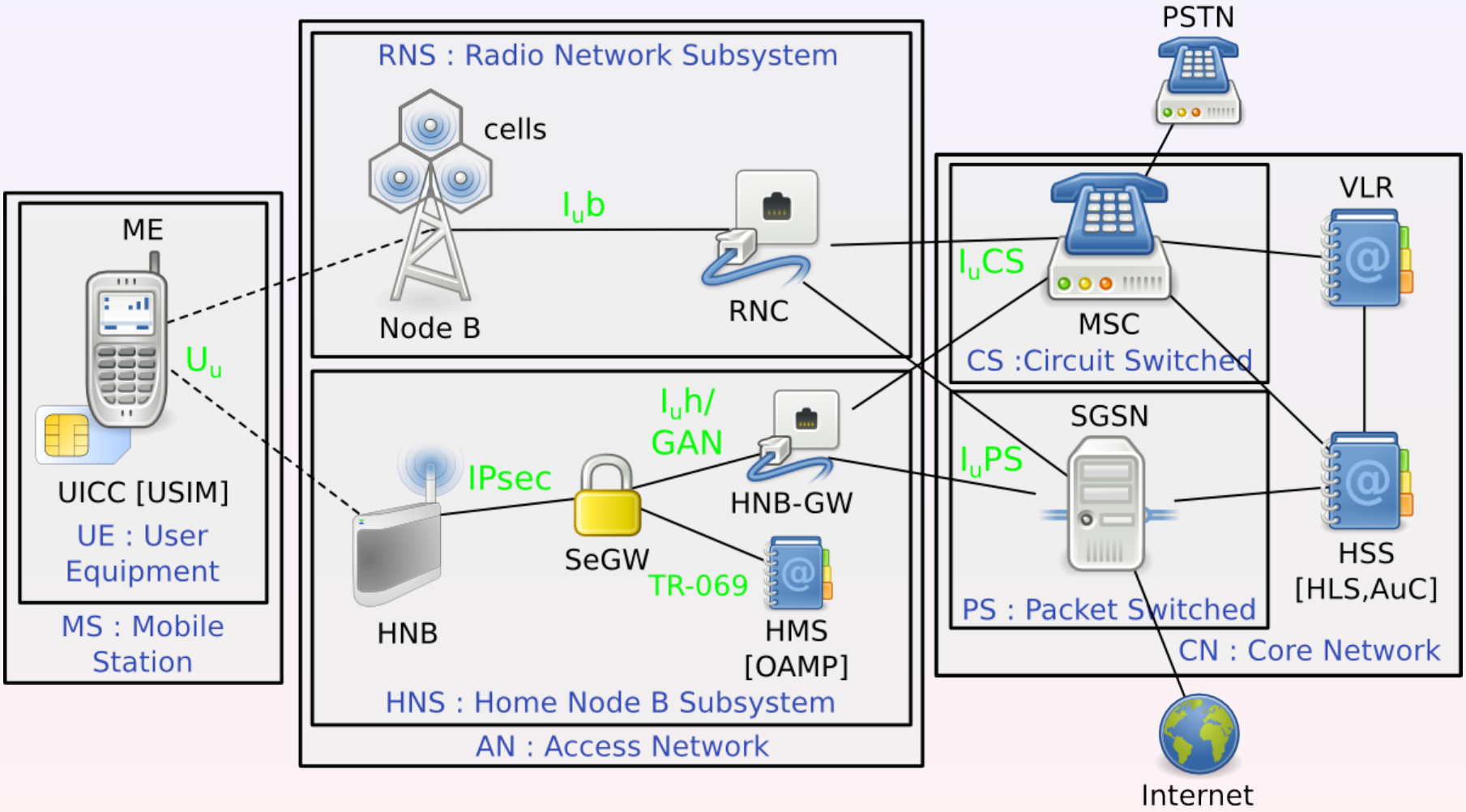
$\Rightarrow$ Implementation and evaluation in a real network

Assumption

We assume a rooted device!

More information on the rooting process is available in: *Ravishankar Borgaonkar, Kevin Redon and Jean-Pierre Seifert. "Security Analysis of a Femtocell device". 4th ACM International Conference on Security of Information and Networks (SIN)*

Home Node B Subsystem (HNS)



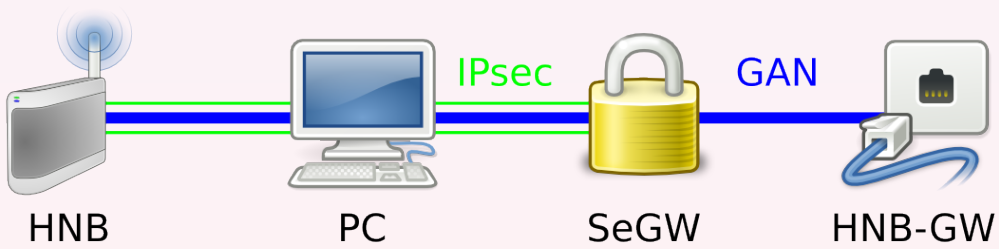
IMSI-Catching

- IMSI-Catching in GSM easy by just configuring the BTS with correct MCC/MNC
- In 3G subscribers are protected from IMSI-Catching by mutual authentication
- Authentication performed with the home network, not the actual cell
  $\Rightarrow$ Femtocells by design provide network authenticity!

- Given device access it is possible to:
  - Reconfigure MCC/MNC
  - Open access for all subscribers (roaming allowed by SFR)

Voice recording (Confidentiality)

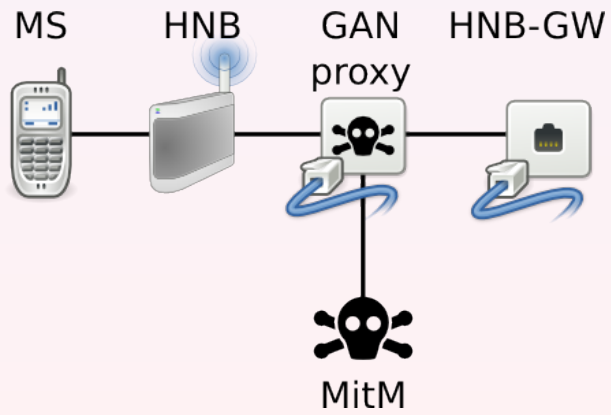
- Over-the-Air traffic encrypted but **decrypted** on the femtocell
- All traffic between femtocell and network is plaintext and only protected by IPsec
- Hijacking control flow of IPSec tunnel software
  ⇒ Decode IPsec traffic, extract voice/SMS
  ⇒ Femtocells can be a very cheap IMSI-Catcher



Traffic MitM (Integrity/Authenticity)

- What if we change the HNB-GW?
  $\Rightarrow$ Full control over all communication

- Modify traffic, impersonating subscribers
- Relay messages to subscriber whenever authentication is required
- Demo implementation based on SMS:
  Modify messages or inject SMS on behalf of subscriber (will be billed)



Detach subscribers (Availability)

- Disconnecting subscribers in GSM via IMSI DETACH message (unauthenticated!)
- Limited to a certain geographical location!

- Femtocell networks have one dedicated VLR
  $\Rightarrow$ Limitation vanishes
  $\Rightarrow$ DoS against subscribers by detaching the complete femtocell network

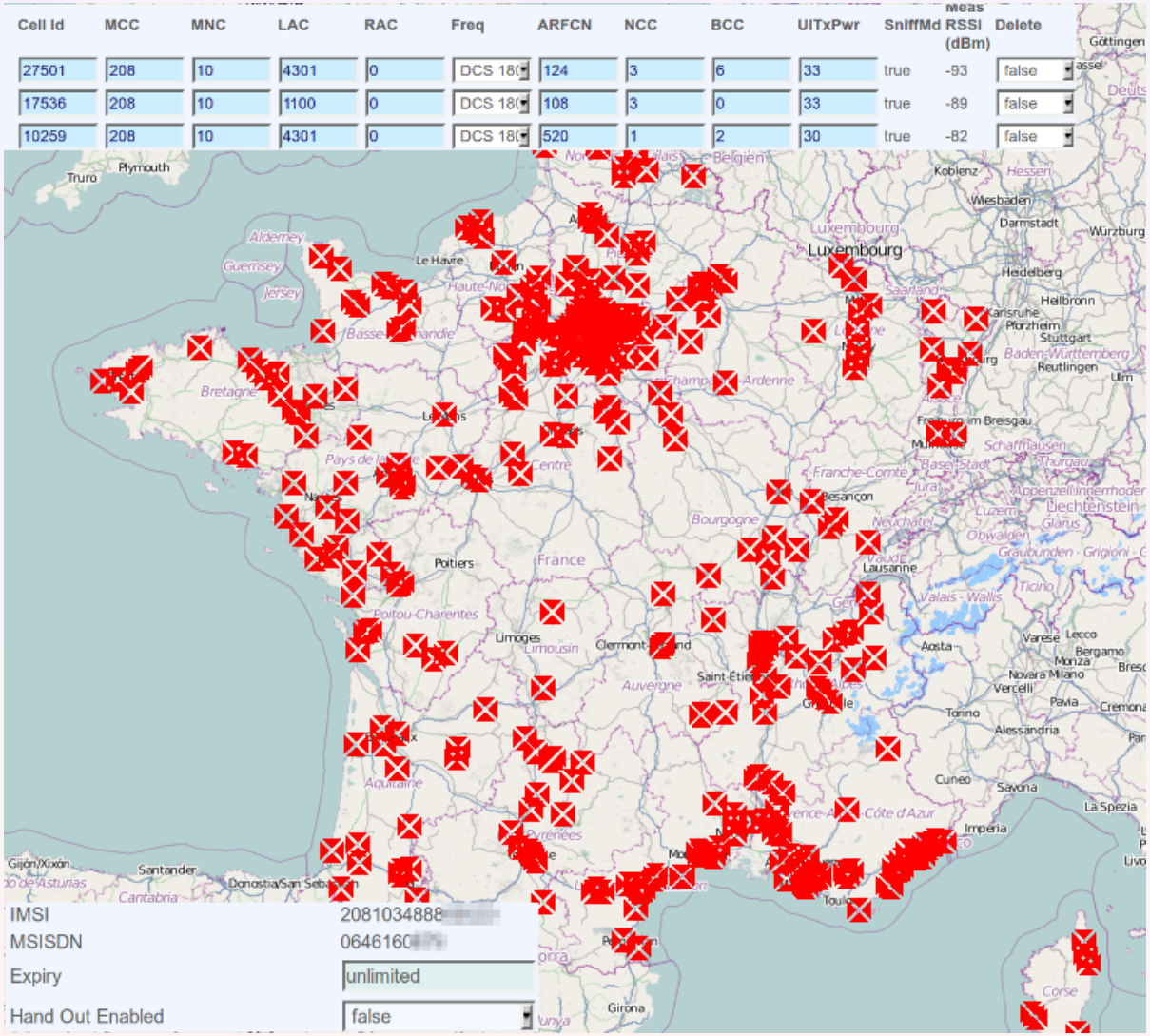
Datamining subscriber information

- Femtocells store various subscriber and location information (registered users, neighbour cells, ...)
- 3GPP specifications require Node-B's to submit measurement reports to a central entity

- Our device exposed a hidden technician web interface with broken authentication
  $\Rightarrow$ Subscriber and femtocell data exposed!
  $\Rightarrow$ No filtering for HNB$\Leftrightarrow$HNB communication
- Measurement reports are pushed to an FTP server, with a **shared account**!

Mapping femtocells

- Using neighbour cell list, you could, e.g., map femtocells



Femtocell attack surface

- Attack surface limited:
  - Network protocols: NTP, DNS spoofing (not tested)
  - Services: webserver, TR-069 provisioning (feasible)
  - TR-069 is the de-facto standard for femtocell remote provisioning
- Both HTTP; TR-069 is based on SOAP and XML
  $\Rightarrow$ Great potential for software vulnerabilities
- All services run as root

- Eventually we found a remote root vulnerability in the webserver (CVE-2011-2900)
  $\Rightarrow$ Take over femtocell network
  $\Rightarrow$ End-user threats become a global problem!

Possible infrastructure impact

- Signaling attacks a well known problem, e.g. HLR overload [1]
- TCP/IP based communication allows for easy signaling traffic generation at a high rate
  ⇒ Given a remote root bug this can be amplified with a femtocell botnet
- Connect to femtocell network without femtocell!
- Act as femtocell by using network protocols

[1] Traynor et al., On Cellular Botnets: Measuring the impact of Malicious Devices on a Cellular Core Network

Conclusion

- This is a big mess
- Given the history of rooted femtocells (Vodafone SureSignal, Samsung, SFR) security poorly implemented in practice
- Inherent trust in the physical security of these low cost devices may be wrong
- Femtocell security strongly affects subscriber privacy, authenticity, availability and operator network

Acknowledgements (in no particular order) & Questions

- Jean-Pierre Seifert
- Collin Mulliner
- Benjamin Michéle
- Dieter Spaar
- K2
- Nicholas Weaver

Thanks for the attention!
Questions?