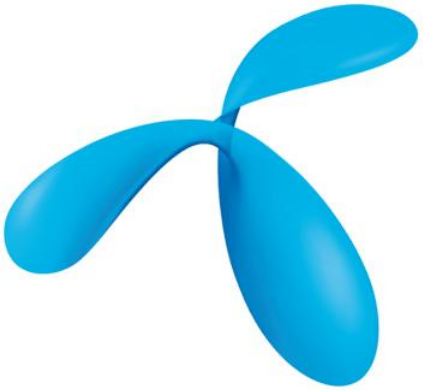

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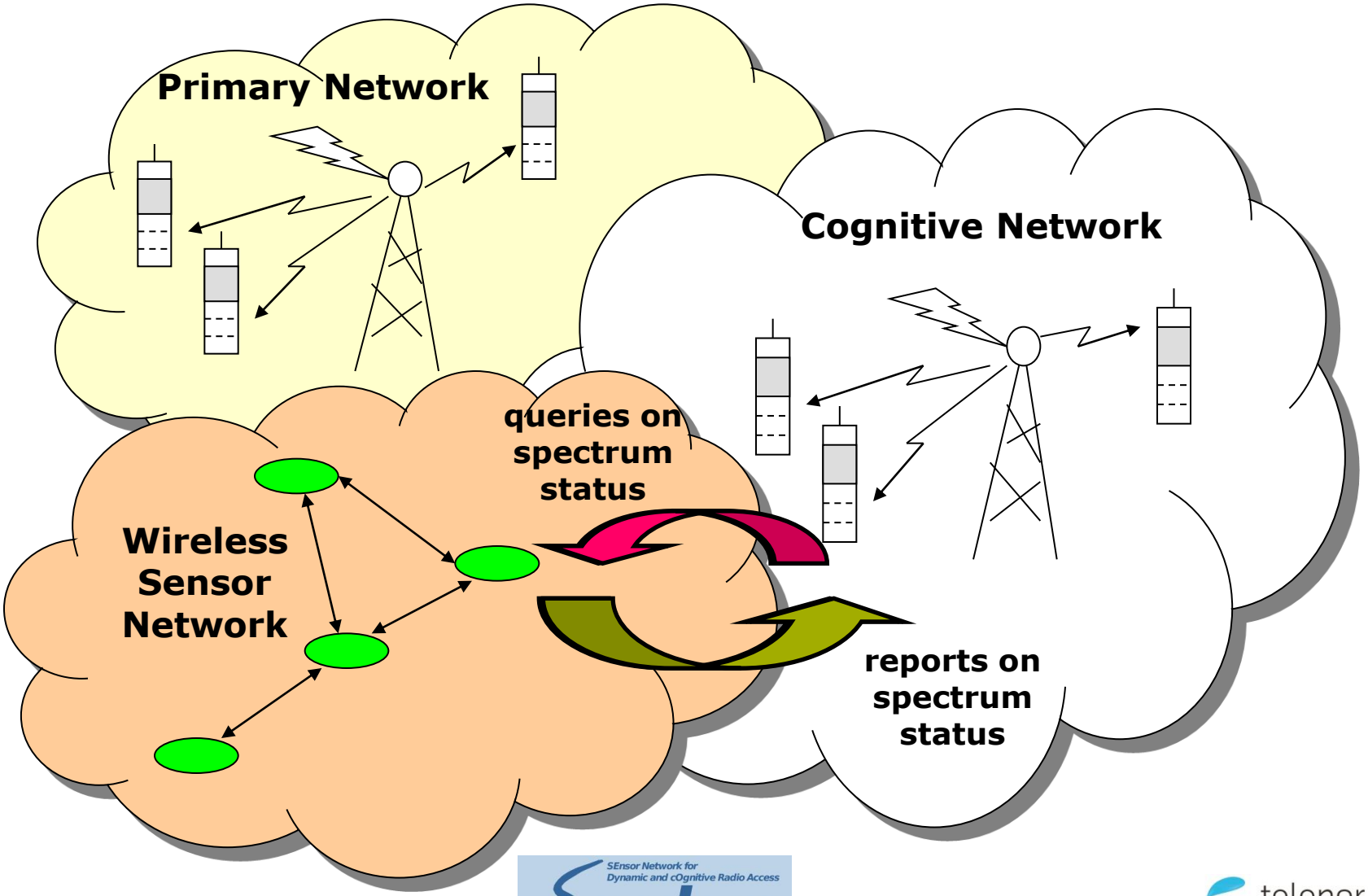
On the Optimal Cell Size in a Sensor Network Aided Cognitive Radio System

Pål Grønsund and Ole Grøndalen

SDR'11, WInnComm Europe
Brussels, June 22-24, 2011

The SENDORA concept can be described as a "Sensor Network aided Cognitive Radio" technology



SEnsor Network for Dynamic and cOgnitive Radio Access
Sendora

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Performance of a sensor network aided cognitive radio system

Goal: To find the optimal cell size of a sensor network aided cognitive radio system

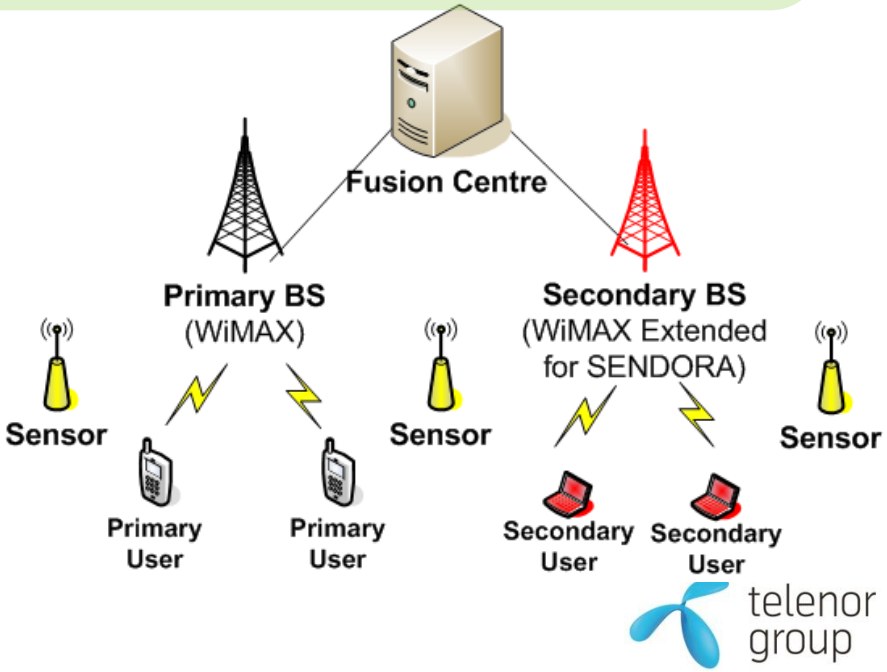
Method and tool: Simulations in the network simulator NS-2

Networks

1. Secondary Network (WiMAX with SENDORA functions, OFDMA)
2. Primary Network (WiMAX, OFDMA)
3. Wireless Sensor Network (rectangular grid of energy detecting sensors)

System Details

- Channels: 10 MHz channels
- Duplexing: Time Division Duplex (TDD)
- Frequency band: 2GHz
- Modulation: BPSK, QPSK, 16-QAM, 64-QAM
- Coding rates: 1/2, 2/3, 3/4



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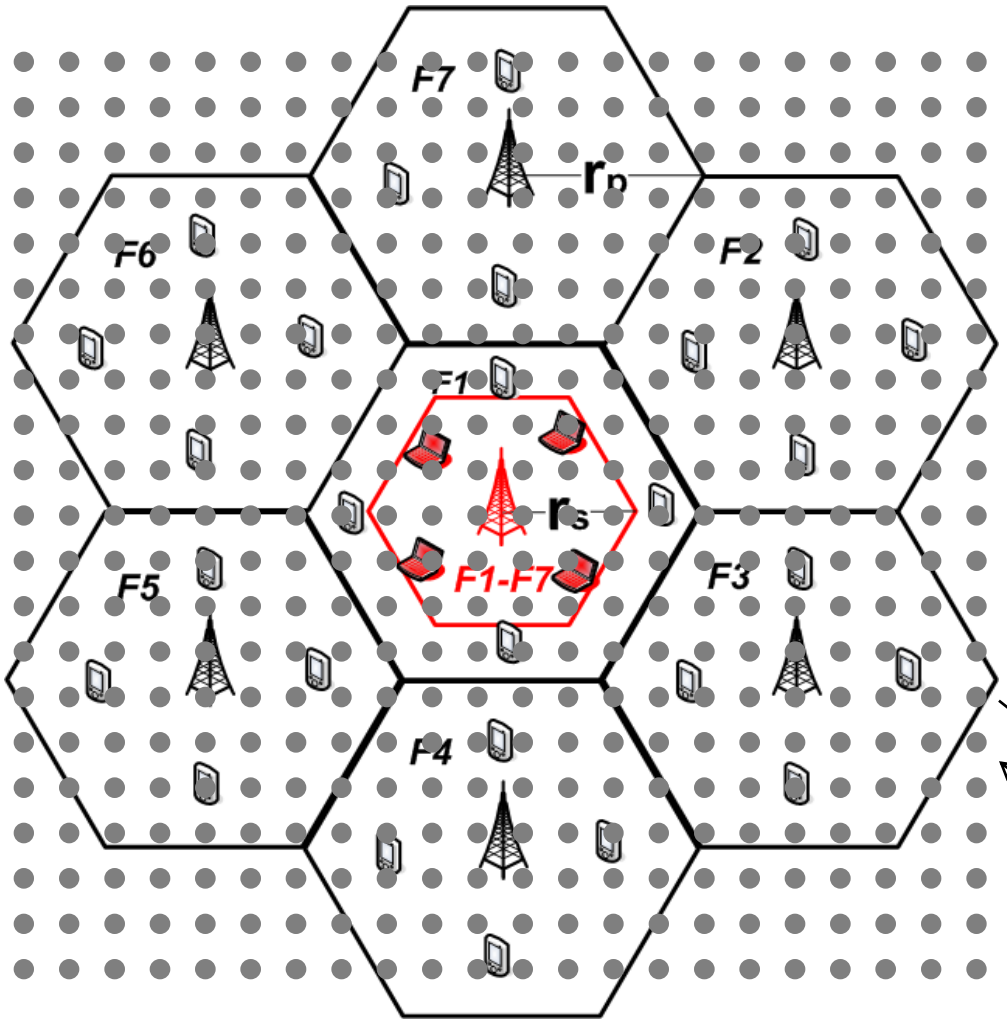
Simulation Scenario

Primary System
Inter-BS-dist: 2km
Radius rp=1.15km

Secondary System
Radius rs=?



Wireless Sensor Network*:

65 sensors/km^2

Sensor radius
r_{ws}=87.7m

(*values from business case analysis)

Primary BS

Primary terminal

Secondary BS

Secondary terminal

Sensor

Fusion Centre

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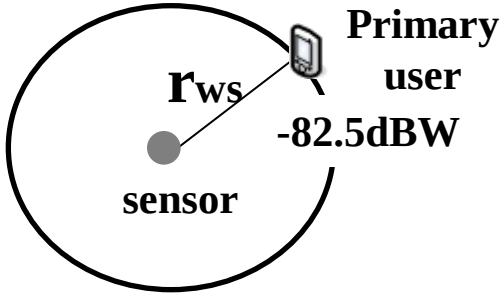
Key parameters for simulation scenario

- **Requirement:** the secondary system has to operate in such a way that the maximum interference experienced by the primary network corresponds to a 0.5 dB increase of the noise-floor with 90% probability.
- **Sensor threshold:** -82.5dBW, detection probability ≥ 95% (from D2.1)
- **Sensing:** Energy detection, duration 30ms, frequency 1/2 second



Parameter	Primary System	Secondary System
Traffic	CBR: 200Kbps	CBR: 1Mbps
Traffic direction	Downlink	Downlink
Nodes per BS	4	4
Nodes location	Random	Random
Nodes mobility	Random waypoint, random speed 1-20 m/s	No
Modulation / FEC	QPSK 1/2	QPSK 1/2
EIRP	13.5 dBW (for 90% area coverage)	-40, -35, … , -5 dBW

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Three cases for secondary cell size were studied

1. **Secondary cell size = 1/2 primary cell size (0.575 km)**
   - 25% co-location with primary BSs
2. **Secondary cell size = 2/3 primary cell size (0.767 km)**
   - 11.1% co-location with primary BSs
3. **Secondary cell size = primary cell size (1.15 km)**
   - 100% co-location with primary BSs

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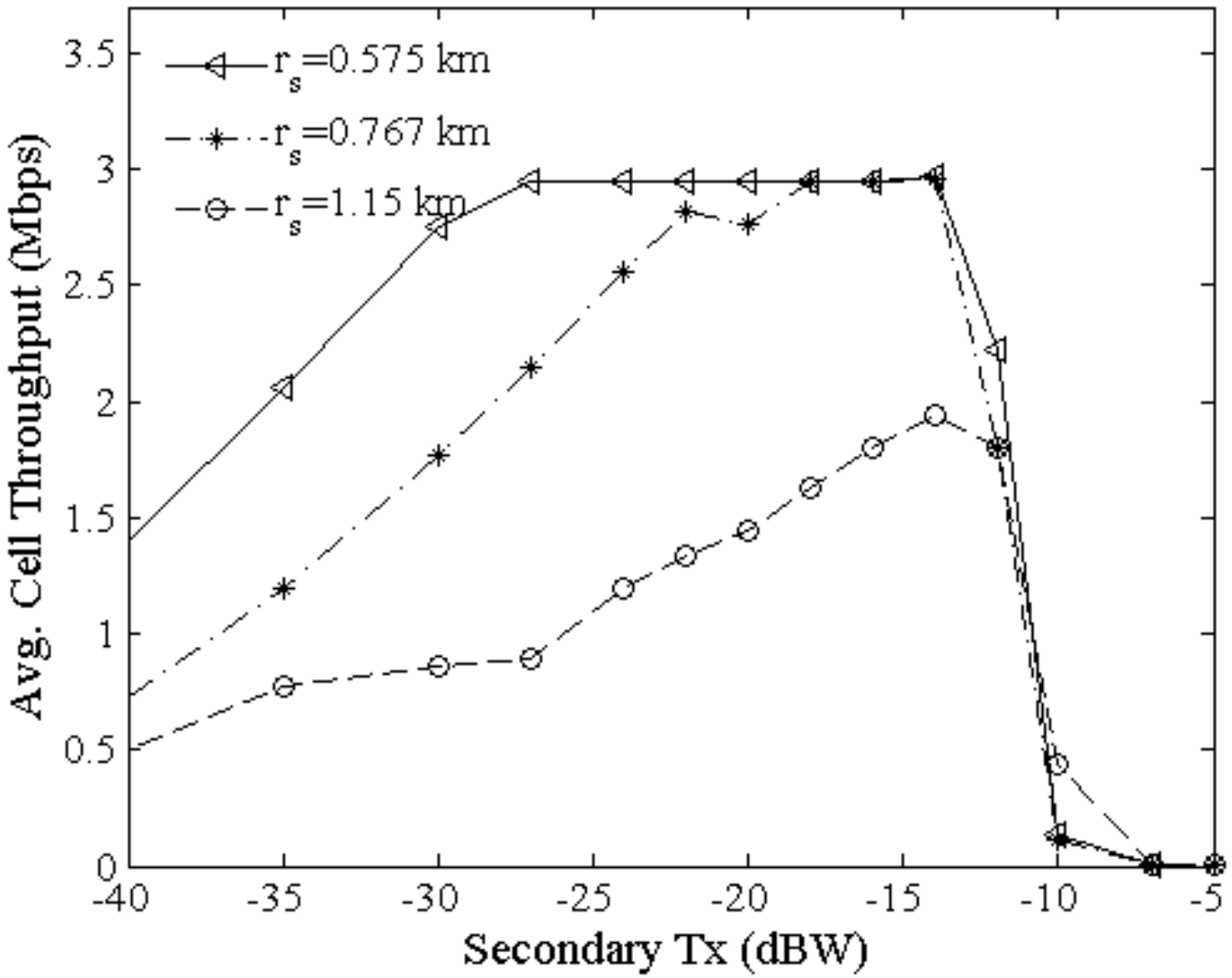
Secondary system performance



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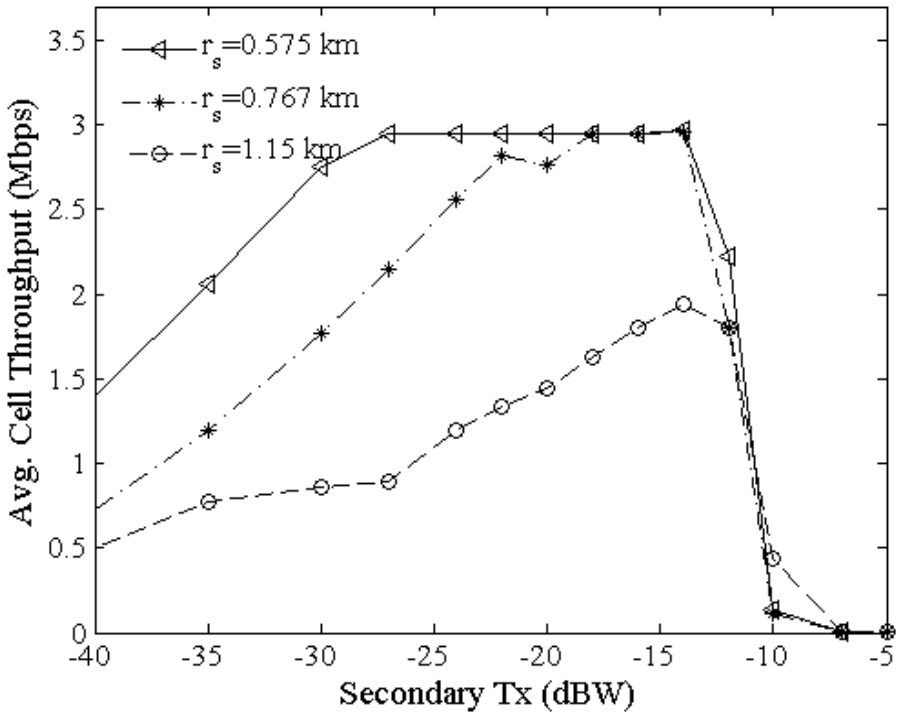
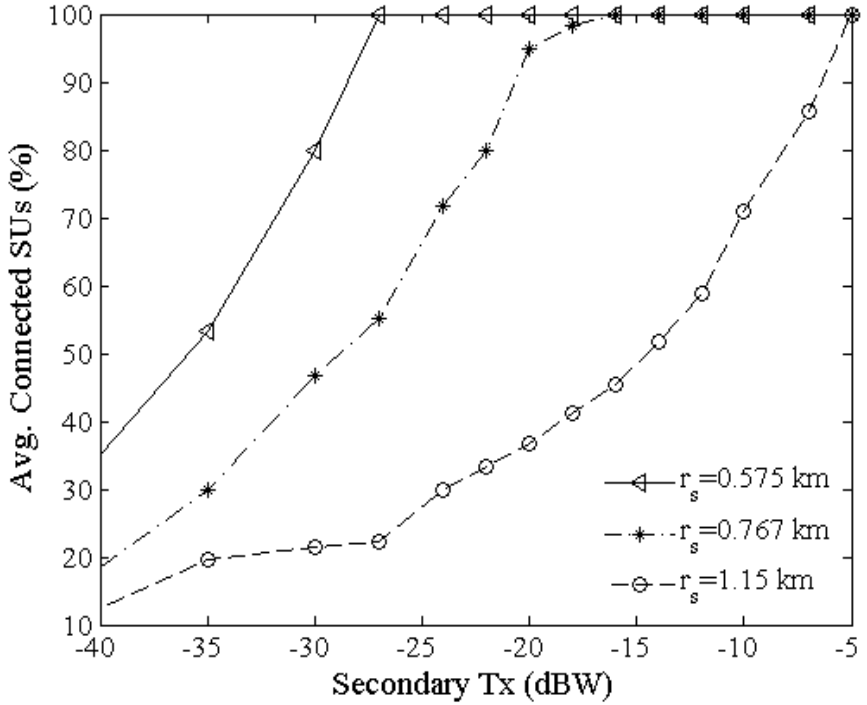
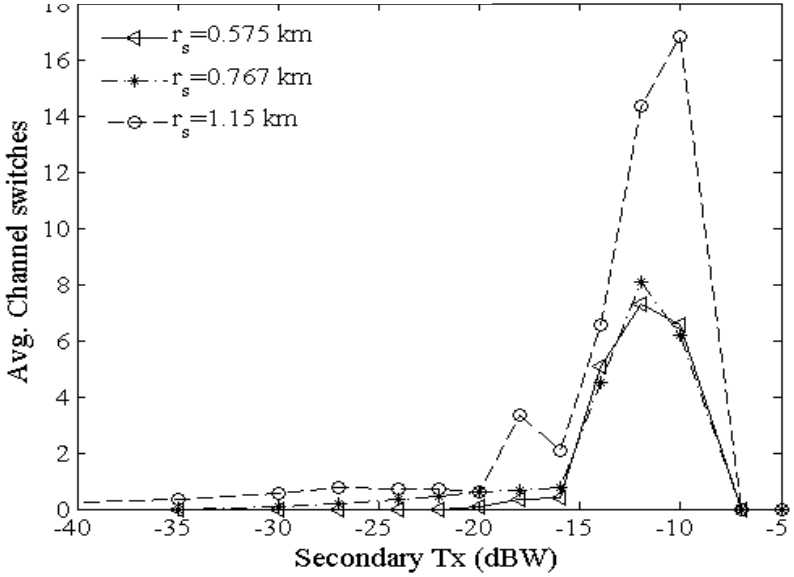
Secondary system performance







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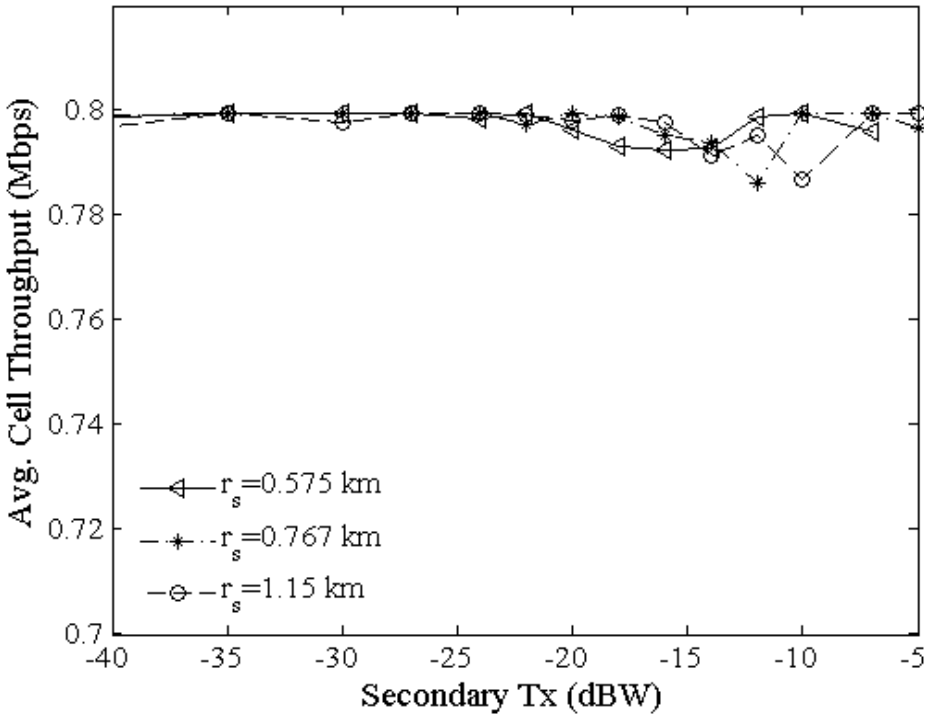
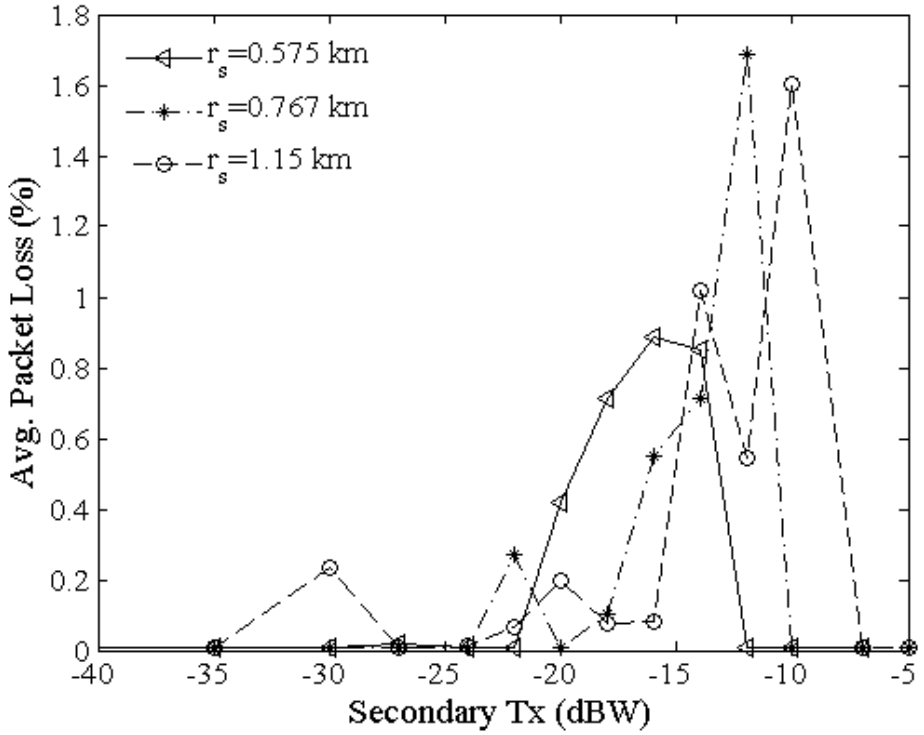
Impact on primary system performance





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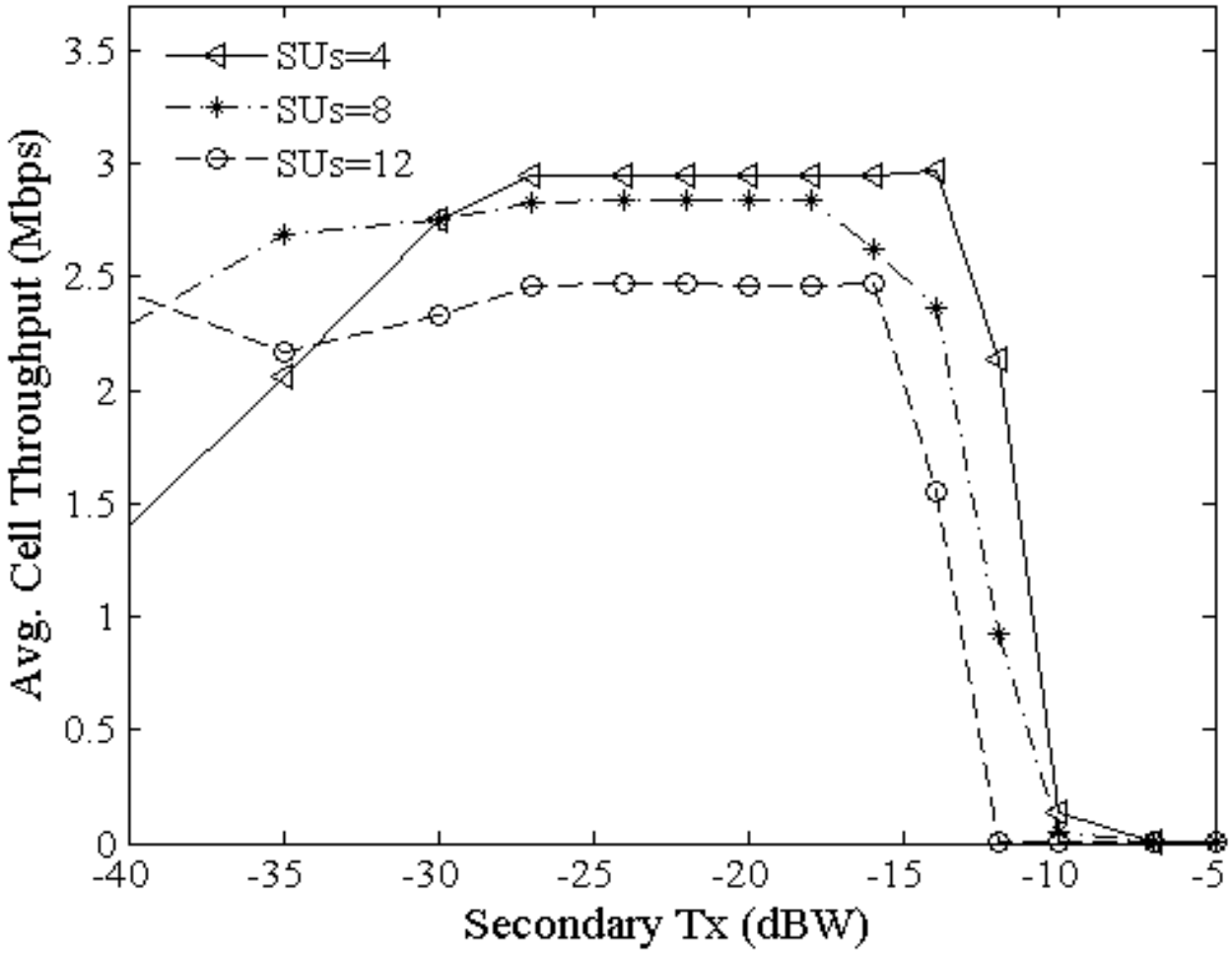
Secondary system throughput for increasing numbers of Primary Users



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In Conclusions

Secondary cell size equals 1/2 and 2/3 the primary cell size performed well and achieved maximum throughput

- Respectively, 25% and 11.1% of secondary BSs will not be co-located with primary BSs, leading to high costs for the establishment of new sites.
- This points in the direction of smaller and less expensive BSs such as WiFi access points and femto-cells.

Equal cell size for the secondary and primary systems with a cellular reuse pattern with seven frequencies is difficult to achieve

- 100% BS co-location will not be achieved
- Potential solutions which should be studied for future work
  - Cell sectorization
  - Relaxed requirement to allow secondary operation, and dynamic requirements when primary nodes have good connectivity
  - Dynamic transmit powers

Questions?
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