Analysis of a distributed inter-cell interference coordination scheme in a real-world office deployment scenario

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What is this all about?

Frequency Domain Inter-Cell Interference Coordination schemes (FD-ICIC) provide interference mitigation capabilitites in multicellular networks

Developing an experimental approach for the **concept validation** in practical real-world deployments
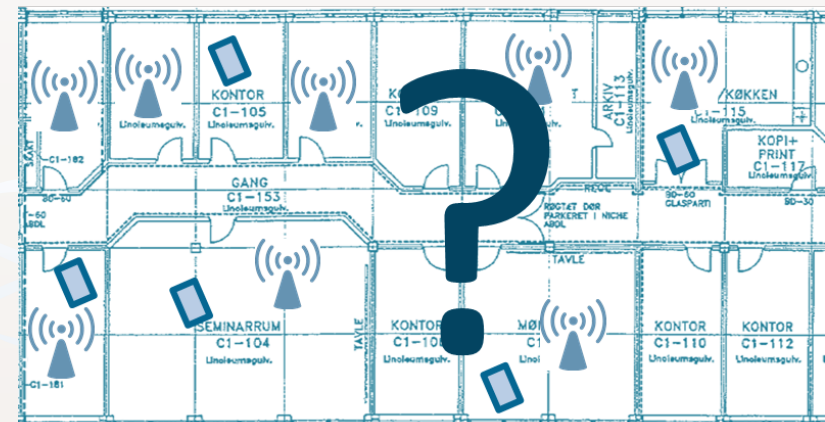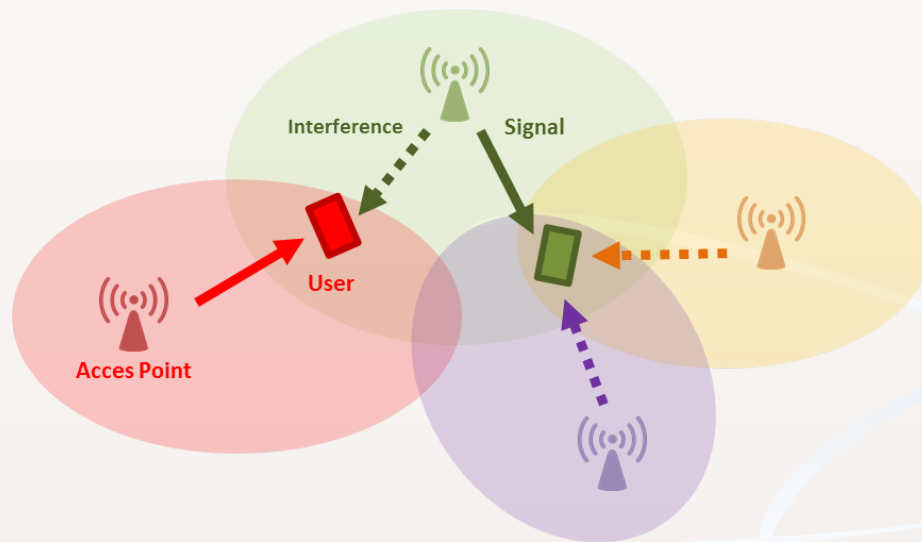
Exploiting on-field measurements in network anaysis

- A typical validation approach for Radio Resource Management (RRM) solutions relies on **system-level simulations** exploiting several abstraction models

- Scenario model assumptions play a fundamental role in shaping the network interference conditions

- Employ direct radio link measurements in place of scenario models
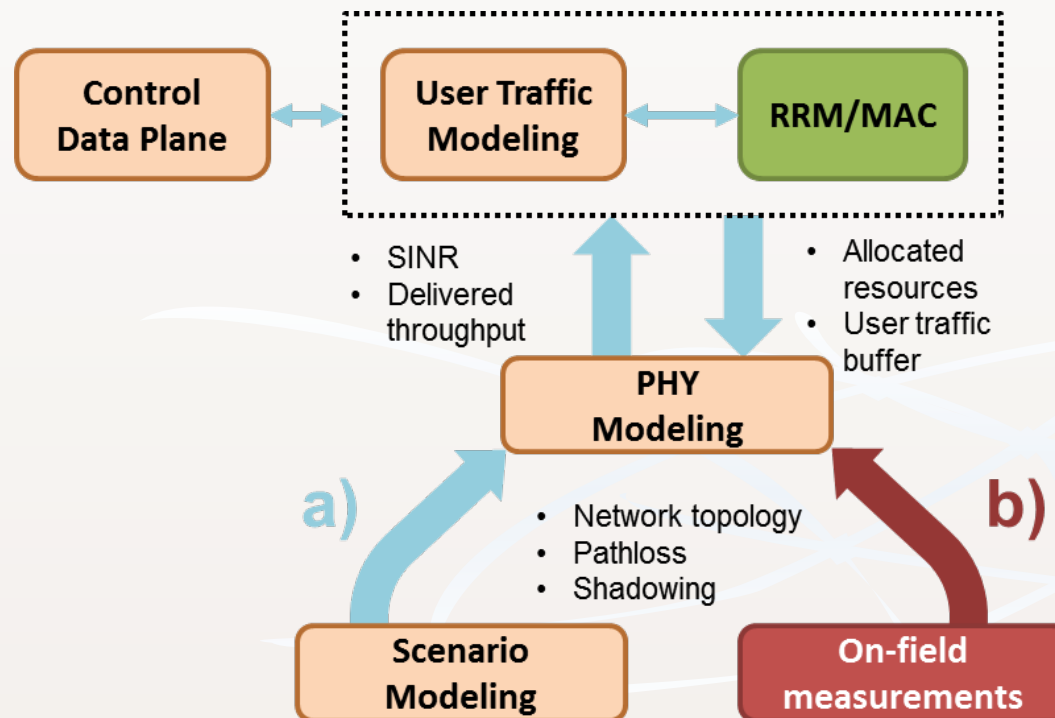
Our study case

- The Autonomous Component Carrier Selection (**ACCS**) algorithm
- De-centralized decision making process, relies on spectrum sensing information and explicit coordination
- Previously analyzed assuming reference scenario models
- Focus on the downlik performance
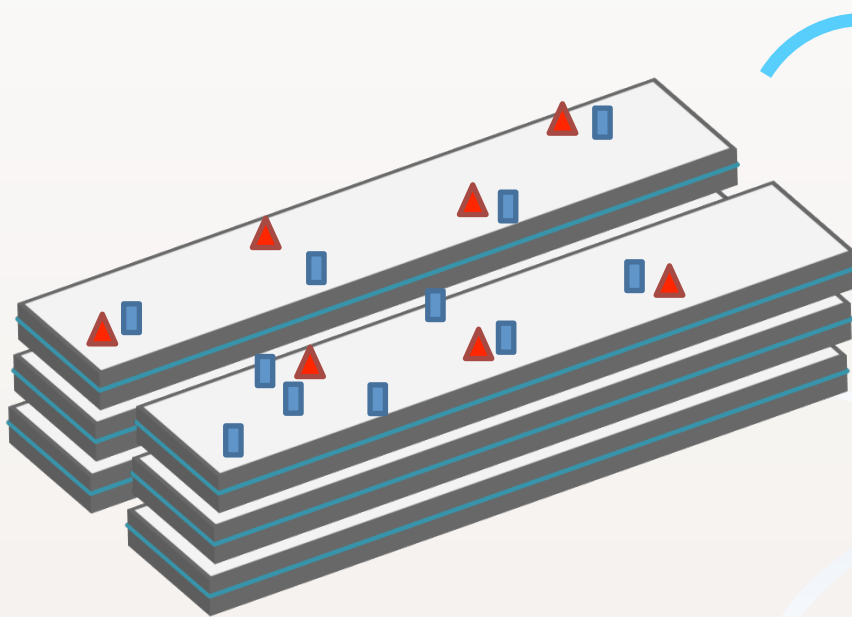
e.g. 3GPP Dual Stripe Scenario
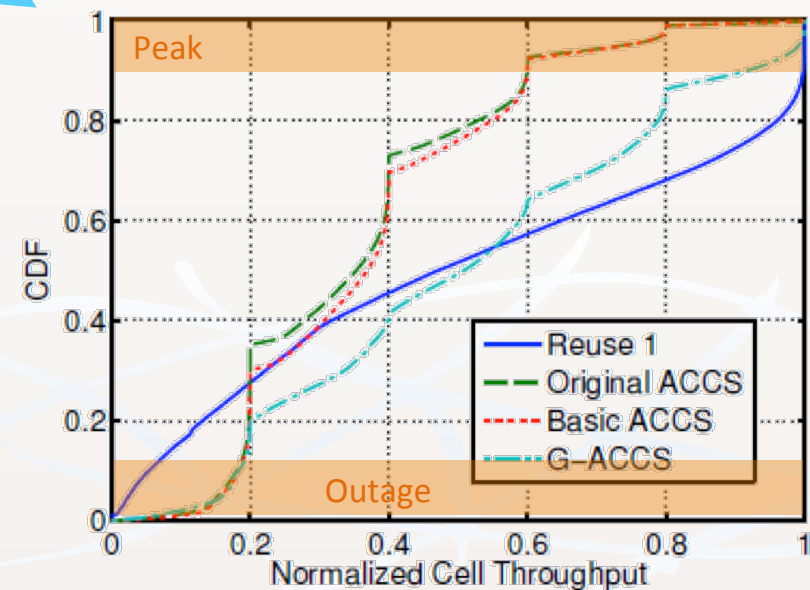
From: [1] L. G. U. Garcia, I. Z. Kovács, K. I. Pedersen, G. W. O. Costa and P. E. Mogensen, "Autonomous Component Carrier Selection for 4G Femtocells - A Fresh Look at an Old Problem," IEEE Journal on Selected Areas in Communications, vol. 30, no. 3, pp. 525-537, April 2012.

Measurement campaign in indoor office scenario

- Aiming for a large scenario data-set to be used with hybrid simulations

- 45 node locations → 990 radio links measurements

- 14 testbed nodes

- Multiple testbed re-deployments in static-propagation environment conditions
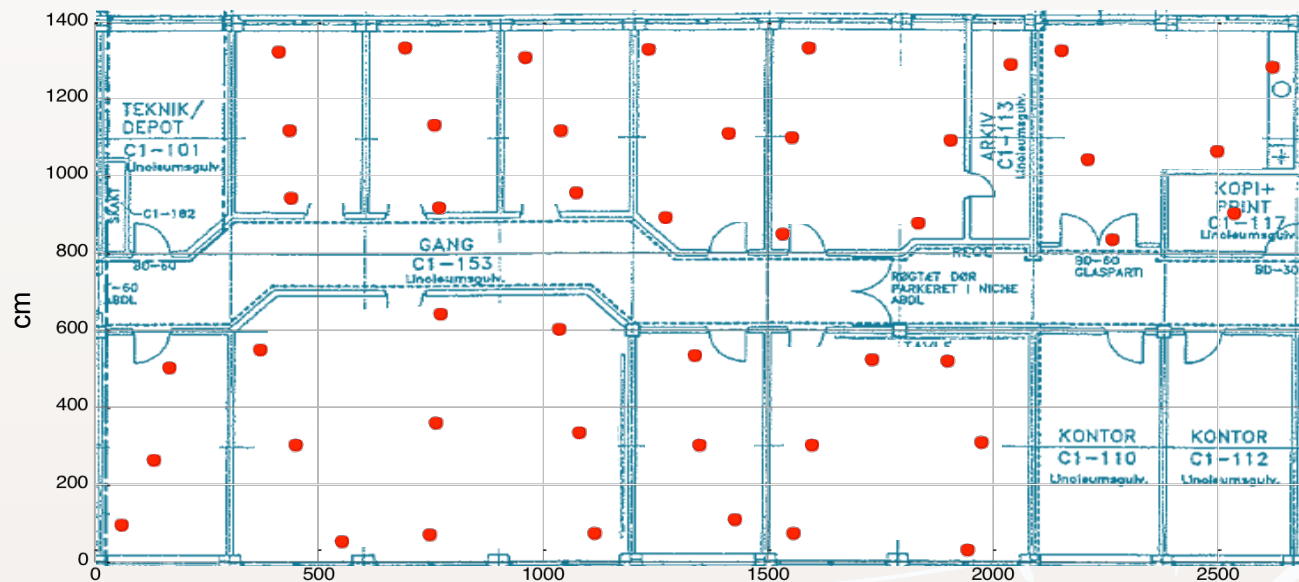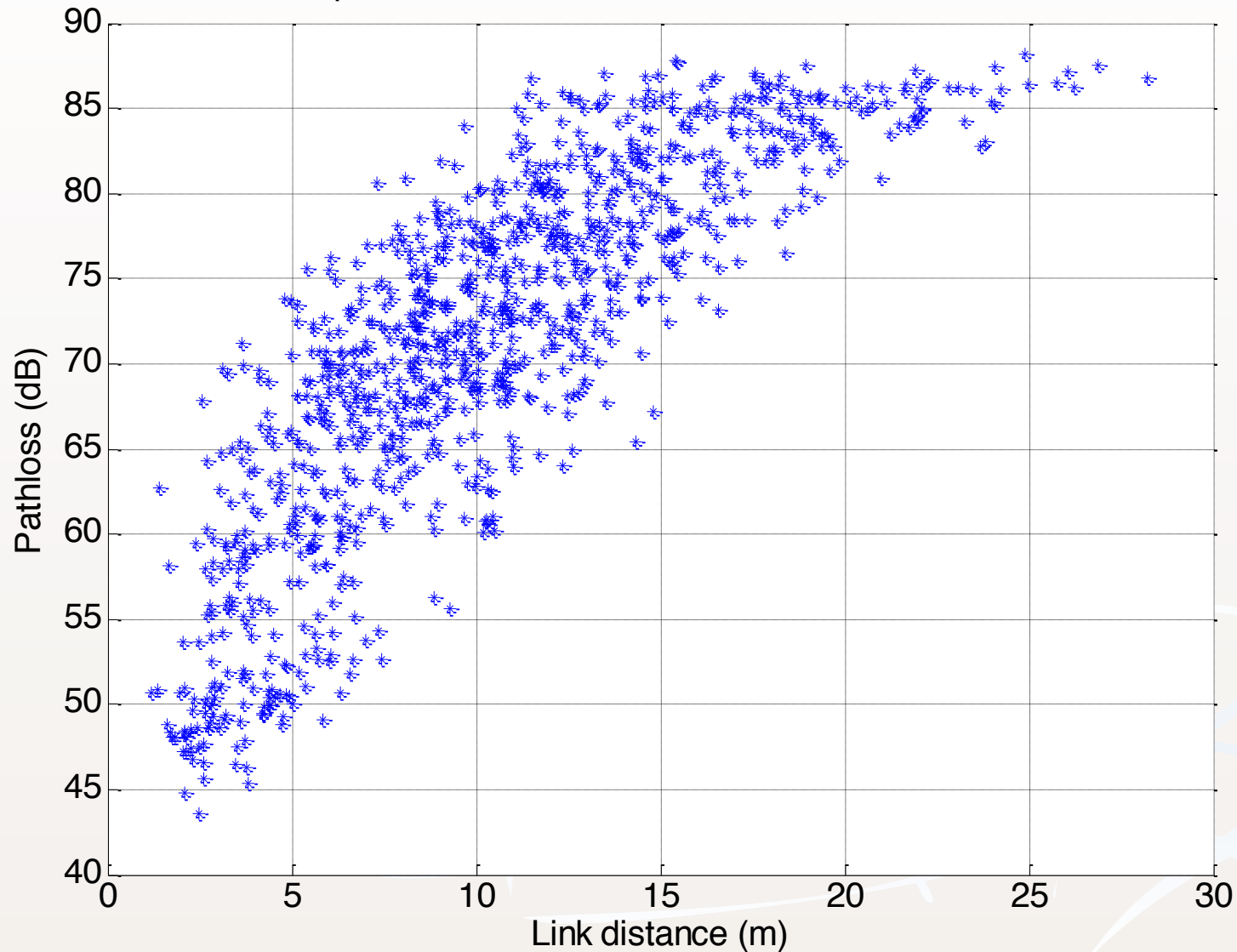
Experimental Setup

- USRP N200 boards with XCVR 2450 RF front-end

- 44 carrier frequencies analyzed in the 5GHz band

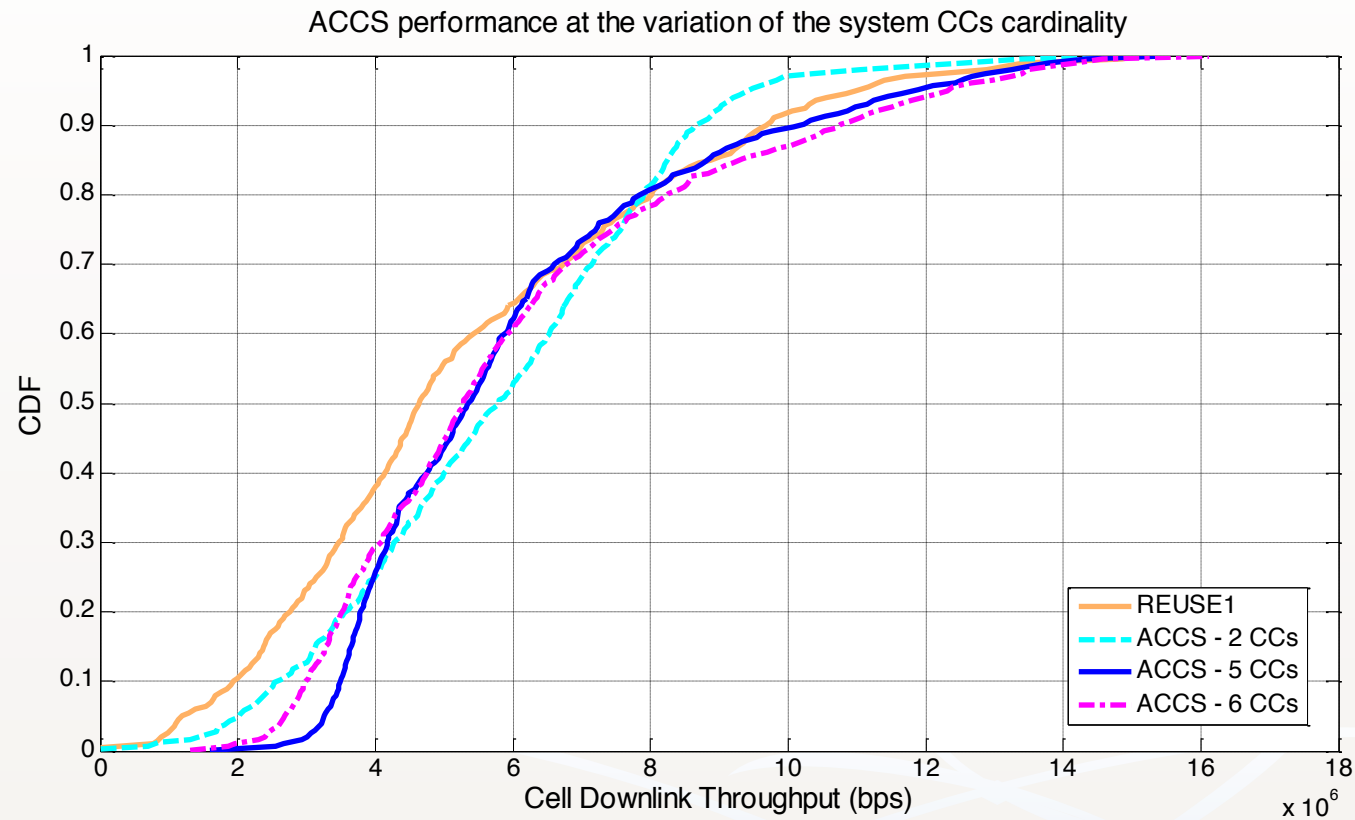- Up to 850 measurements in time and frequency per single-link

- A multi-node channel sounder application developed with the ASGARD SDR platform

- Frame-based execution of the measurements

- Automatic transceiver reconfiguration

Measured path loss values on the links

Link path loss measurements in the NJV12 Scenario

ACCS performance results in the selected scenario

ACCS performance at the variation of the system CCs cardinality

Legend:
- REUSE1
- ACCS - 2 CCs
- ACCS - 5 CCs
- ACCS - 6 CCs

X-axis: Cell Downlink Throughput (bps) ×10⁶
Y-axis: CDF

5CCs provide the best capacity improvement with respect to network outage

Performance comparison with literature studies

- Comparing the experimental scenario with the 3GPP dual stripe

Full frequency reuse SINR distribution in the network

Legend:
- 3GPP Dual Stripe Scenario 80% DR (red)
- 3GPP Dual Stripe Scenario 20% DR (orange)
- NJV12 Scenario (blue)
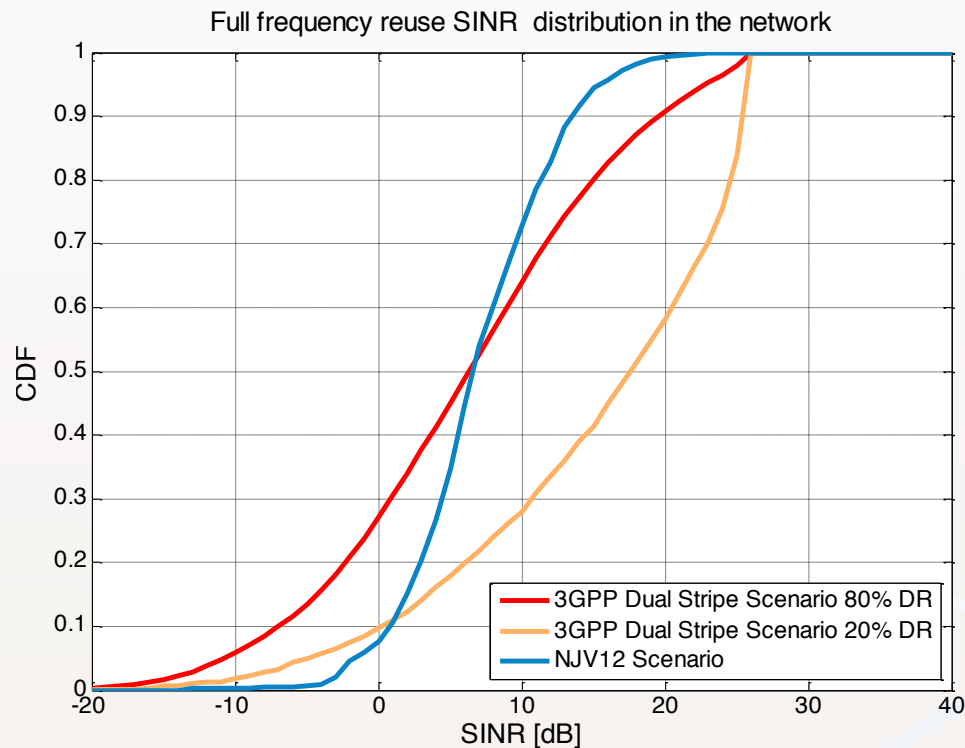
Normalized cell throughput results

| Scheme	Scenario	Outage	Avg	Peak
Reuse 1	NJV12	6.6%	29.7%	60.8%
	Dual Stripe 20% DR*	5%	60%	100%
	Dual Stripe 80% DR*	0.9%	21%	64%
ACCS	NJV12	18%	33.3%	65.8%
	Dual Stripe 20% DR*	19%	66%	100%
	Dual Stripe 80% DR*	12%	30%	59%
G-ACCS	NJV12	15.1%	33.3%	79.4%
	Dual Stripe 20% DR*	17%	70%	100%
	Dual Stripe 80% DR*	6%	32%	72%

* from: L. G. U. Garcia, I. Z. Kovács, K. I. Pedersen, G. W. O. Costa and P. E. Mogensen, "Autonomous Component Carrier Selection for 4G Femtocells - A Fresh Look at an Old Problem," IEEE Journal on Selected Areas in Communications, vol. 30, no. 3, pp. 525-537, April 2012.

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asgard.lab.es.aau.dk

ACCS performance results in the selected scenario (2)
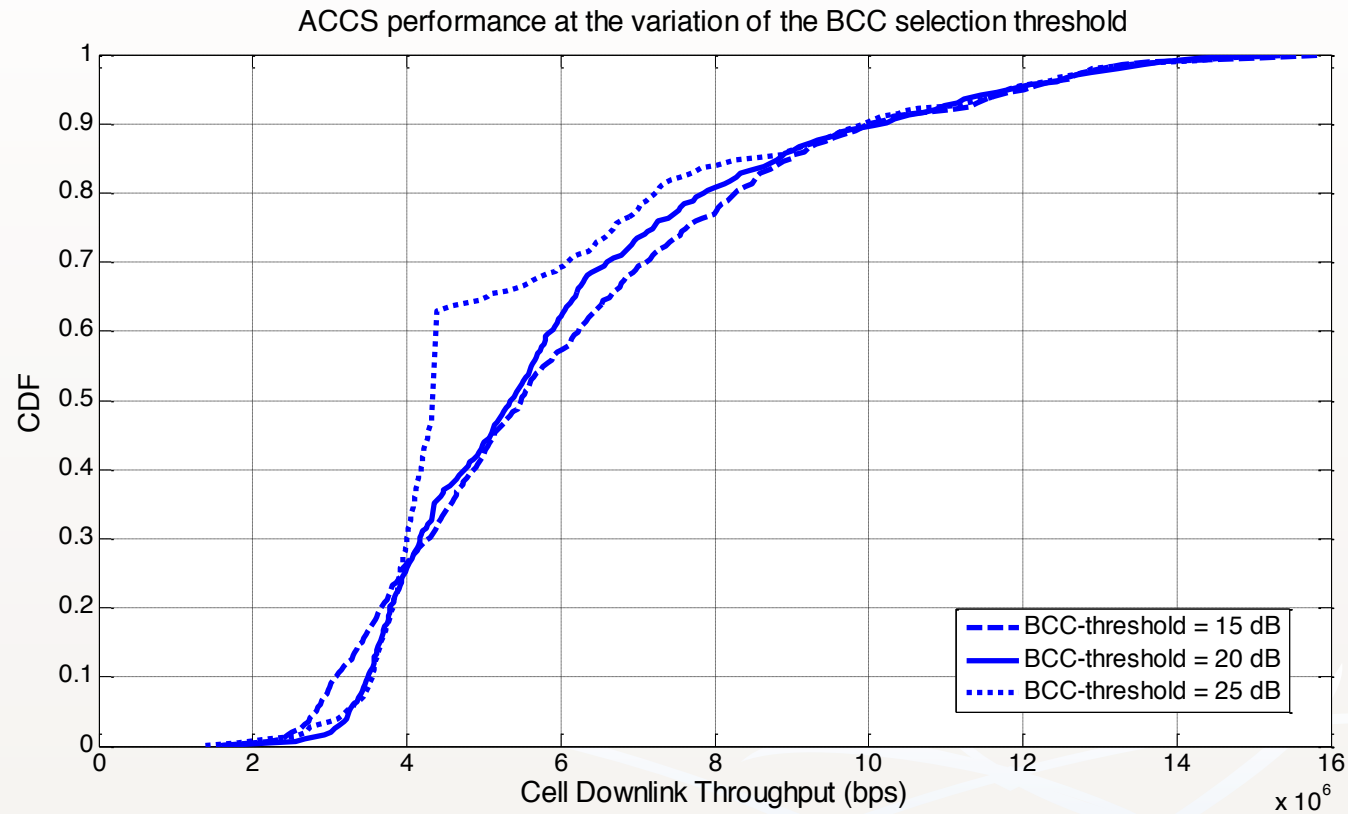
Optimal BCC selection threshold set at 20 dB