ECHOS-Enhanced Capacity 802.11 Hotspots

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Outline

- Introduction
- Observations on Carrier Sensing in 802.11
- Architecture and Algorithms
- Performance Evaluation
- Conclusions

Introduction

- Given the explosive growth in hotspot wireless usage, enhancing capacity of 802.11-based hotspot wireless networks is an important problem.

Introduction

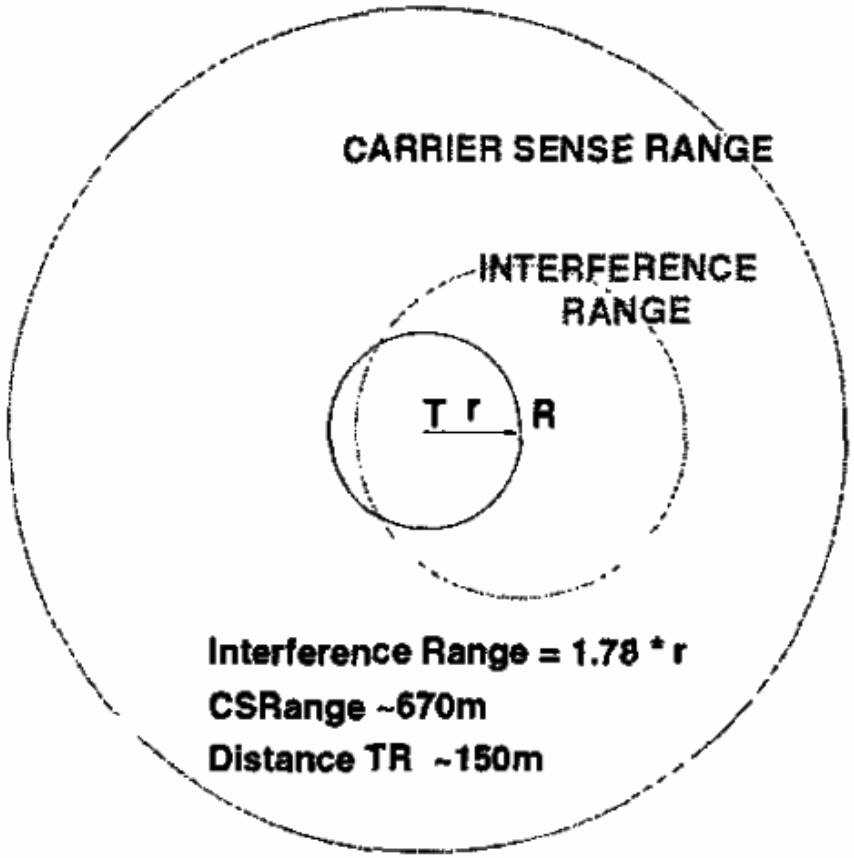
- First, the authors present the AP-CST algorithm that dynamically adjusts the Carrier Sense Threshold (CST) in order to allow more flows to co-exist in current 802.11 architectures.

Introduction

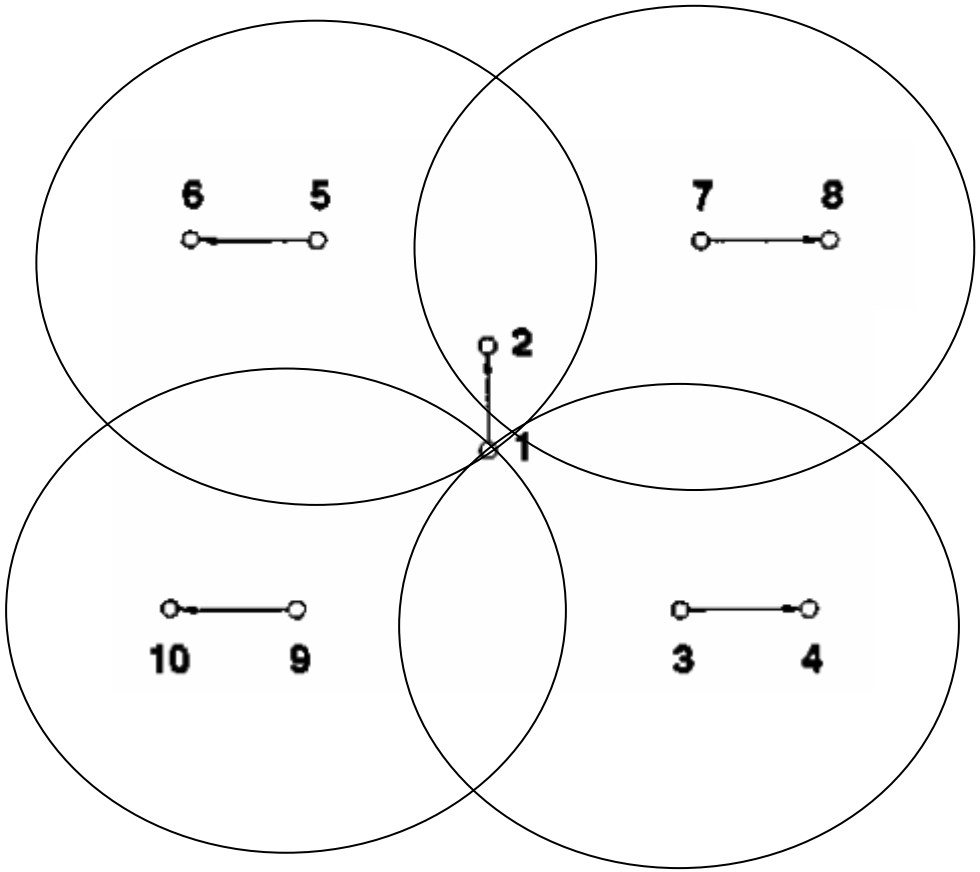
- Second, the authors present the RNC-SC algorithm that uses secondary channel when the load in a cell is overloaded in order to improve performance.

Observations

- Carrier Sense Threshold
  - Fixed



Observations



- CST = -93 dBm

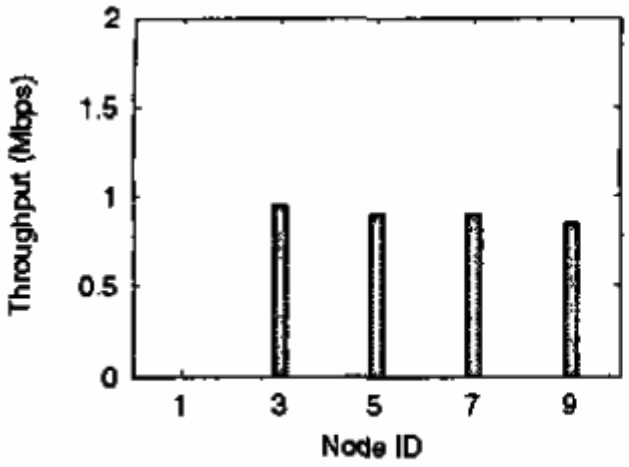


Fig. 2. RTS/CTS, -93dBm

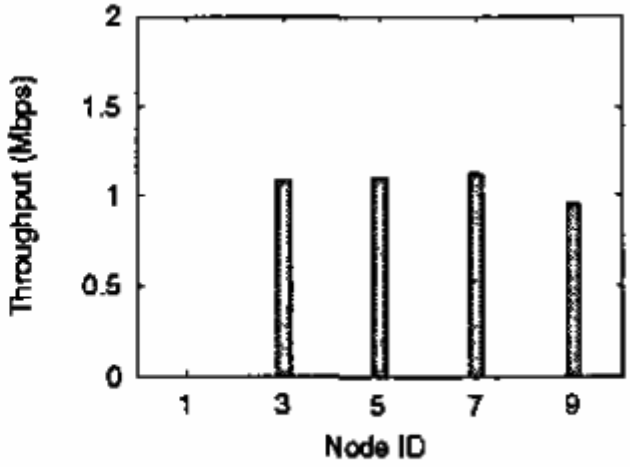


Fig. 3. No RTS/CTS, -93dBm

- CST = -83 dBm

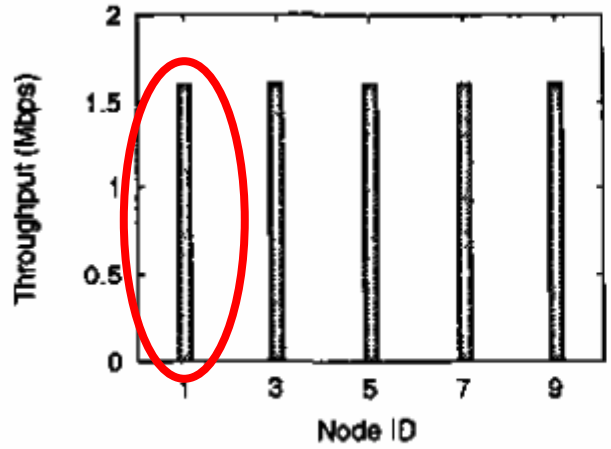


Fig. 4. RTS/CTS. -83dBm

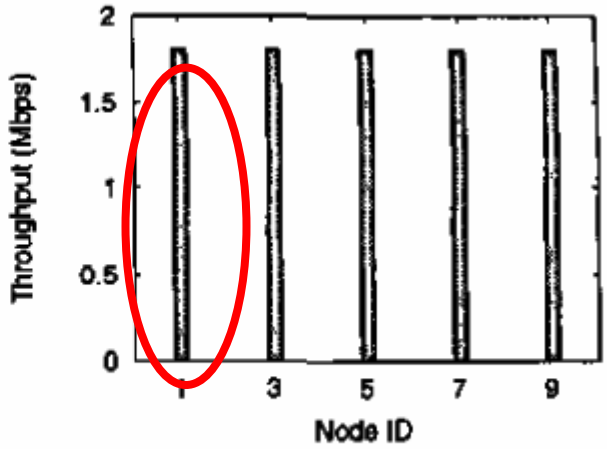
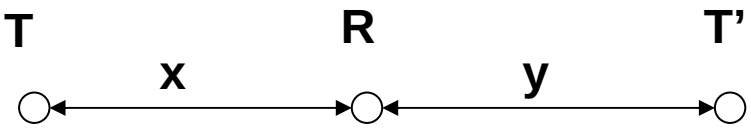


Fig. 5. No RTS/CTS. -83dBm

Observations

- Signal-to-Noise Ratio (SNR)



If (SNR > γ) then successful reception

SNR = (y/x)^4

successful reception:
(y/x) ^4 > γ [γ = 10 dB]

$\Rightarrow$ (y/x) ^4 > 10

$\Rightarrow$ y > 1.78x

Observations

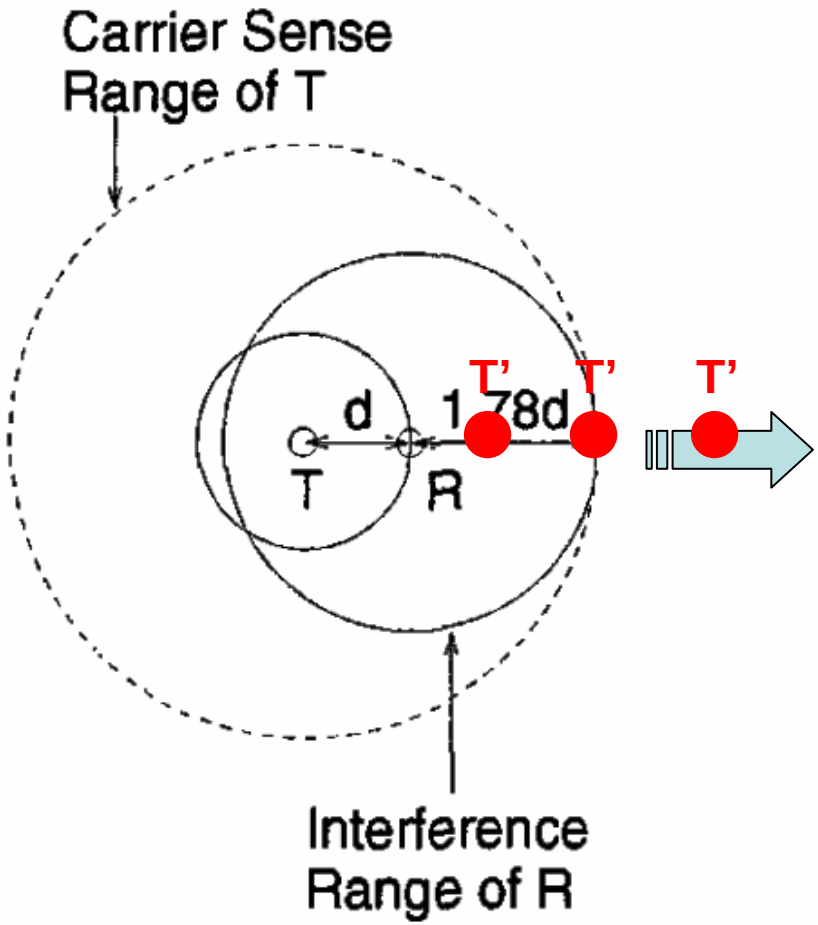


Fig. 7. The optimum value of CST is that at which the carrier sense range of S just covers the interference range of R.

The strength of the signal from the farthest distance of any interfering source, 2.78d, is given by

$k*P_0/(2.78d)^4$

Algorithms

- Access Points using Carrier Sense Threshold (AP-CST)
- Radio Network Controller using Secondary Channel (RNC-SC)

Algorithm AP-CST

- Algorithm AP-CST is run at each AP when it senses another cell in the same channel. It consists of two main steps:
  - Sets CST of each client while avoiding creation of new hidden terminals
  - Sets CST of AP while ensuring that all of its clients are still served

Architecture

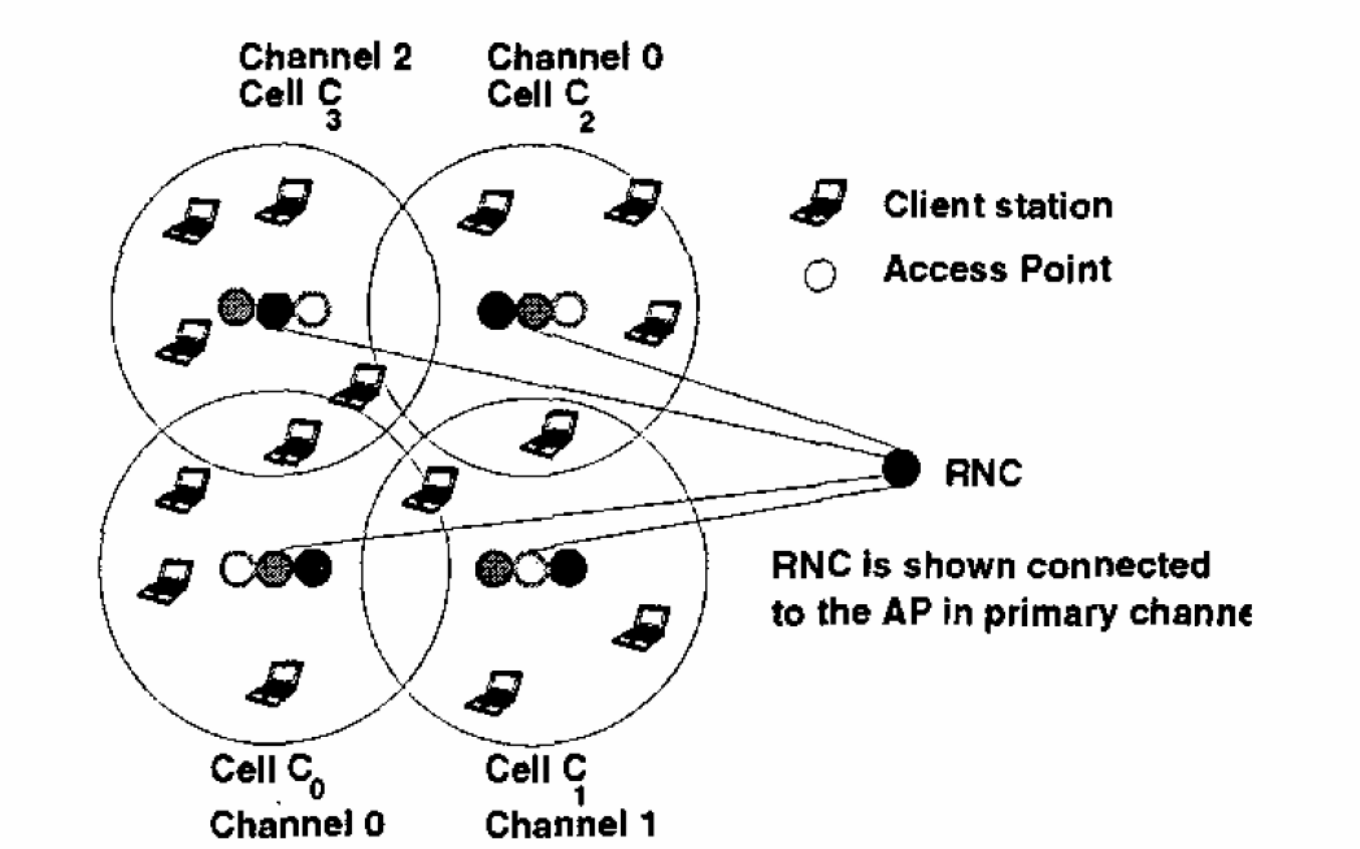


Fig. 8. The Echos Architecture. Each circle denotes the coverage range of the APs.

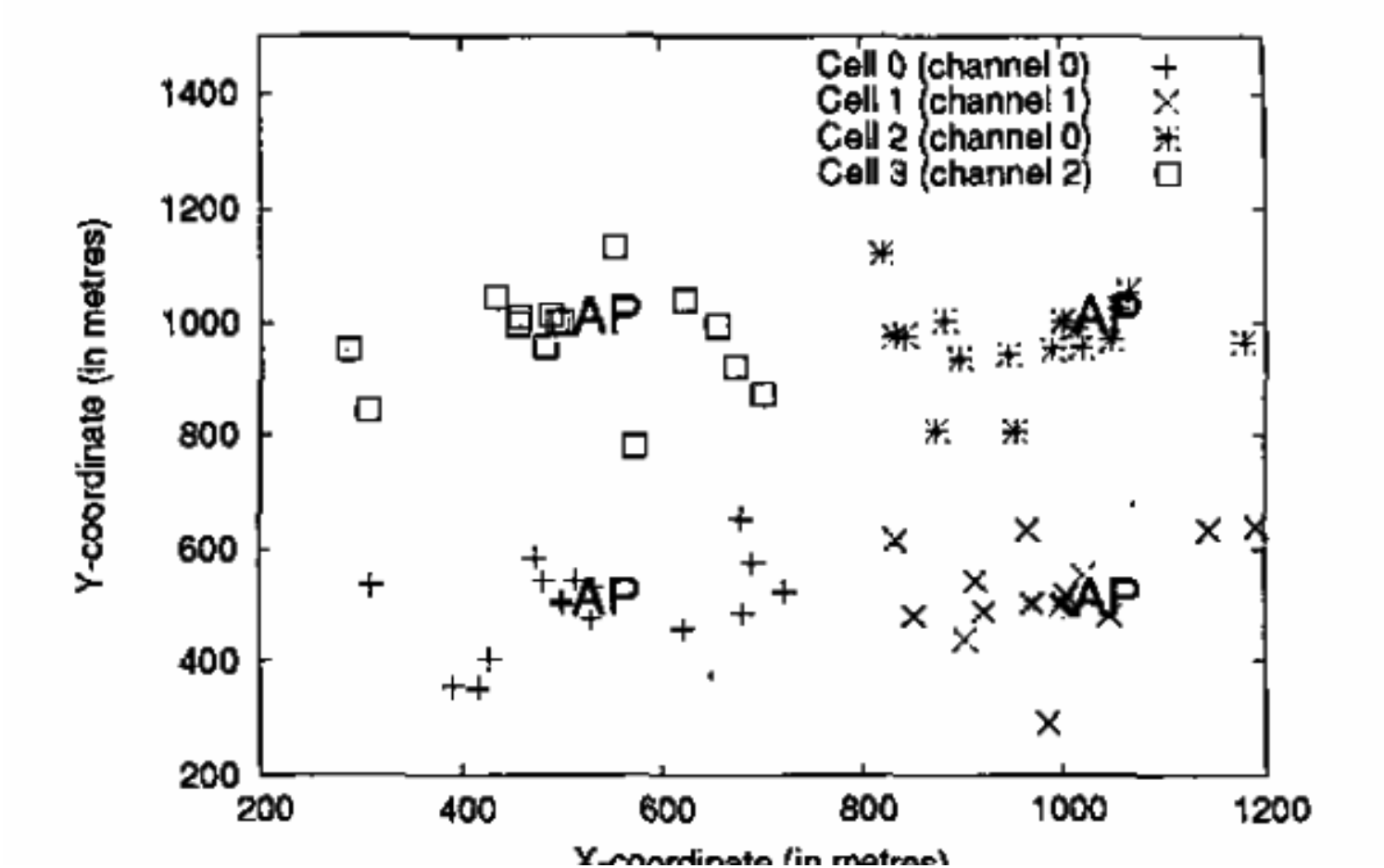
Algorithm RNC-SC

- In this mode, the APs are managed by a centralized Radio Network Controller (RNC) and each AP has access to all available channels. It consists of three main steps:
  - Determine if a cell is overloaded.
  - Choose and switch a client to a secondary channel in overloaded cell, if possible.
  - Run AP-CST at each AP

GET-CLIENT-SECCHANNEL

- Steps:
  - Compute maximum tolerated interference on each secondary channel k
  - Reduce the transmit powers of secondary AP and clients on each secondary channel k
  - Choose the (client, channel) pair such that the client observes minimum interference from outside the cell on that channel

Environment



Performance Evaluation

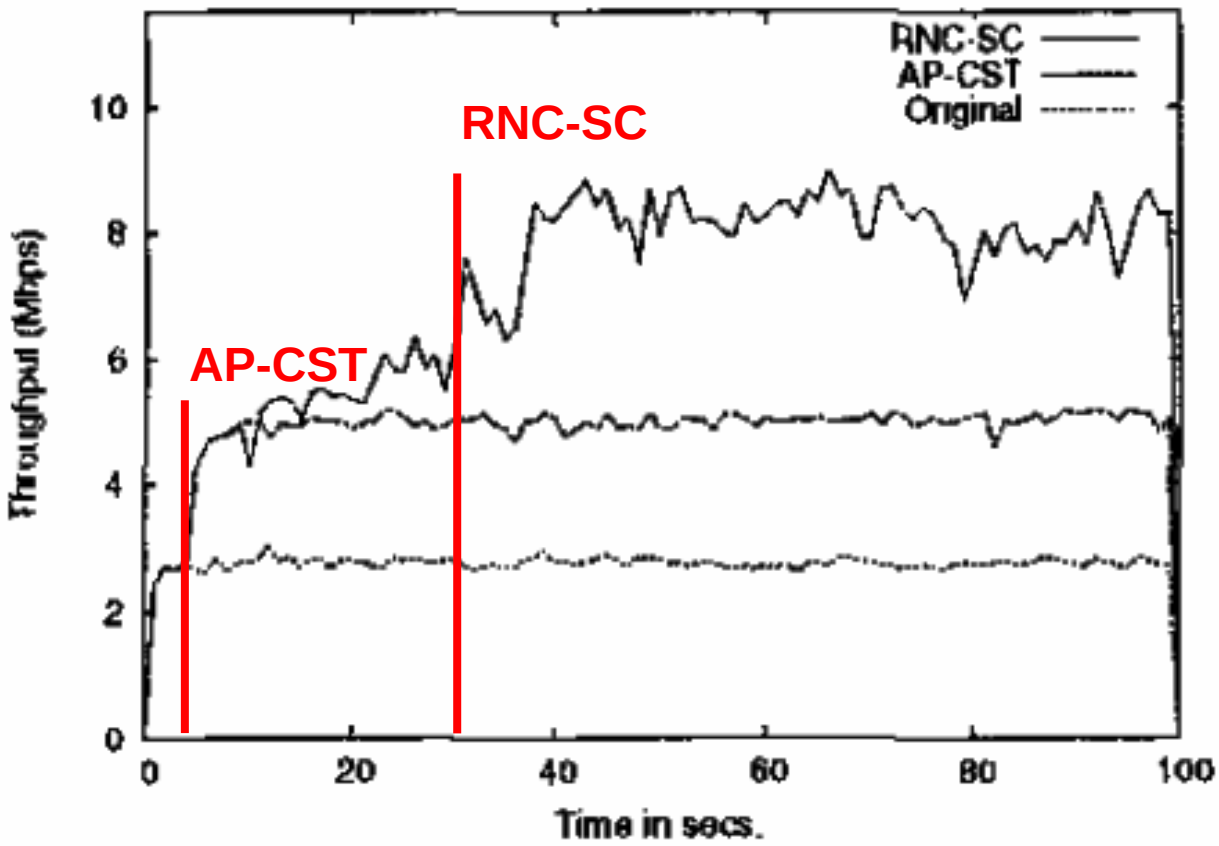


Fig. 12. Cell C_0 in Scenario I

Performance Evaluation

Cell	Old Tput (Mbps)	Dev. (% of Mean)	New Tput (Mbps)	Dev. (% of Mean)	Gain (% of Old)
0	2.76	0.85	8.15	3.35	195.28
1	3.38	6.94	3.35	5.07	-1.08
2	2.86	1.42	5.92	6.42	106.99
3	2.89	7.95	2.83	10.36	-1.81

TABLE V

IMPROVEMENTS ACHIEVED IN SCENARIO-I WITH C_0 AND C_2 MOST LOADED . OVERALL IMPROVEMENT IS 70.31%.

Conclusions

- The authors advocate that transmitters dynamically chose their CST values depending on their signal strength at the receiver.
- AP-CST improves the performance in cells which can sense another cell in the same channel by choosing an appropriate CST value.

Conclusions

- RNC-SC provides gains over those provided by AP-CST by creating secondary cells which co-exist with primary cells without causing any interference/reduction of throughput.