

Advantages of Code Channelization

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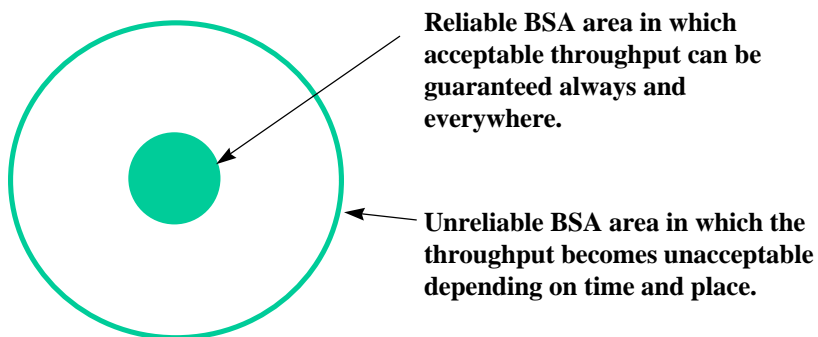
Objectives of the Document

- ***Conventional idea*** : Code Channelization of the direct sequence system is not useful because of :
 - Near-Far problem
 - No enough separation
 - Complexity of the CDMA system
- **This document is an introduction to overcome conventional ideas of the channelization and to prove usefulness of Code Channelization.**

Requirement of more frequency channels causes:

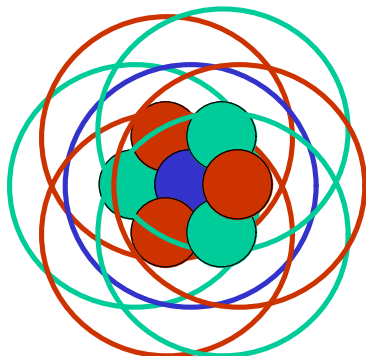
- Less robustness against multipath because of narrower spreading bandwidth
- Less sensitivity because of more bits/symbol
- Sometimes amplitude component of the signal, because of more bits/symbol, to consume more power than flat envelope.

Aspect of the BSA



MIS tries to build WLAN using reliable BSA area.

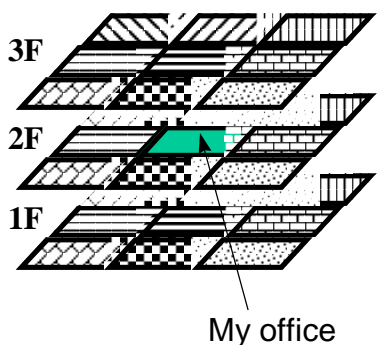
Three freq. channels are enough?



This figure shows conceptual BSA arrangement using three frequency channels.

Reliable BSA areas are well separated by frequency channels but unreliable BSA areas overlap reliable BSA areas to cause degradation of performance.

Undesirable neighbors



SOHO is a very attractive market for WLAN.

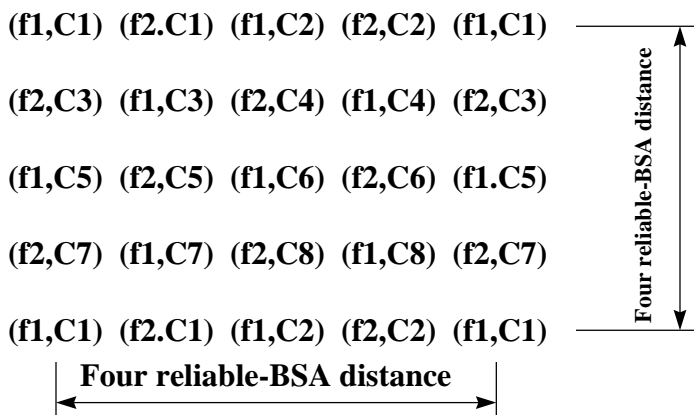
It requires many channels in order to avoid interference from neighbors' WLAN systems.

Management is not available against neighbors.

Micrilor's channelization proposal

- Two frequency channels are available within 2400 - 2483.5 MHz ISM band.
- Eight search-code channels are also available independently to frequency channels.
- *Sixteen total channels* are available by combination of frequency channels and code channels.
- Forty-eight data-code channels are also available.

An example of BSA arrangement by using 16 channels



Simulation

- Throughput for two adjacent BSAs with:
 - The same frequency channel and different code channels.
 - Same frequency channel and code channel.
- Throughput and delay time under interferences from neighbors' systems.
- Using **BONeS DESIGNER ver.3.6** by ALTA GROUP of Cedence Design systems, Inc.

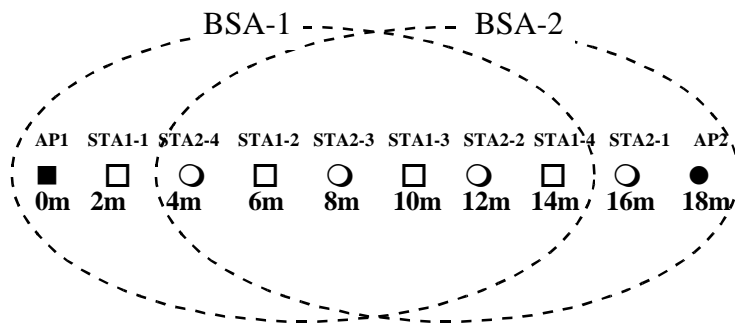
Conditions (1)

- (1) The channel access model is based on 802.11 (P802.11D6.1 pp 86-pp 98).
- (2) DATA type is INF_DATA and ACK only.
- (3) The INF_DATA packets are generated by Poisson distribution.
- (4) The radio propagation characteristic is ideal, namely Frame Error is caused by collisions only.
- (5) No hidden node is considered.
- (6) INF packets consist of same information with fixed length.
- (7) Header length not considered.
- (8) The positions of STAs are fixed.
- (9) Data flow direction : AP to STAs (config. 1 and 2)
STAs to AP (config. 3)

Conditions (2)

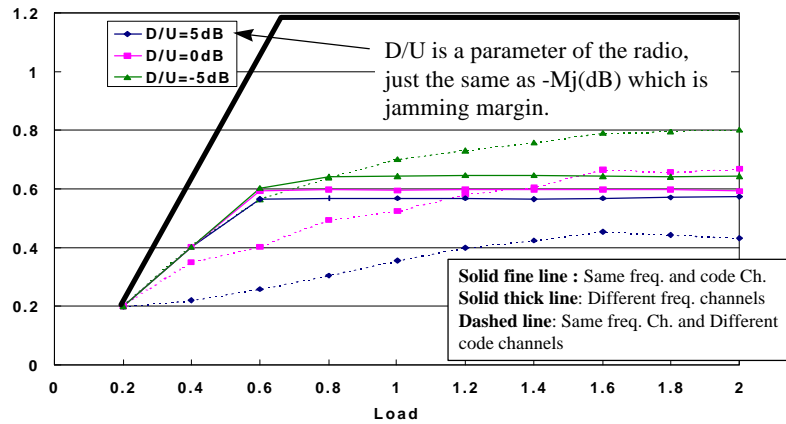
Parameter	Value
Propagation Delay[msec]	0.0001 (0.1[μsec])
ACK Length [bits]	112 (=14[bytes])
Transmit Speed [bps]	10M
Cwmin	32
Retransmission	3
Rx-Tx Delay [msec]	0.015
Mean Inter-Pulse Time [msec]	INF Length * Nodes / Transmit Speed / Load
Slot Time [msec]	Propagation Delay + Rx-Tx Delay
SIFS [msec]	Rx-Tx Delay
DIFS [msec]	SIFS + 2*Slot Time
Timeout Time	3 * Propagation Delay + Rx-Tx Delay + SIFS +(INF Length + ACK Length) / Transmit Speed

System Configuration - 1

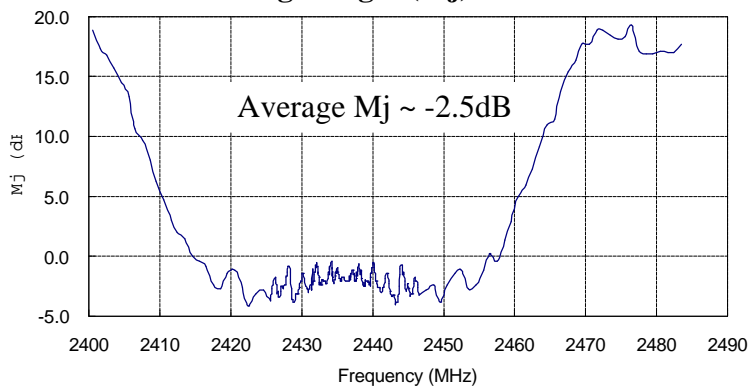


- : An AP belongs to BSA-1
- : Stations belongs to BSA-1
- : An AP belongs to BSA-2
- : Stations belongs to BSA-2

Throughput under config. -1 (INF Length = 4000 bit)

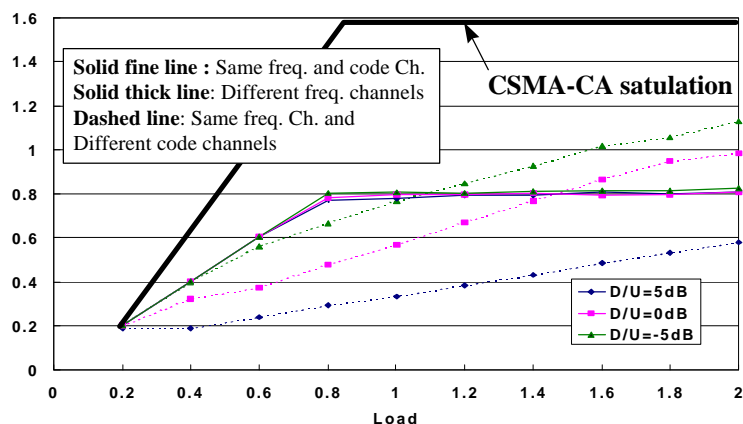


Jamming margin (Mj) of JX-4000F

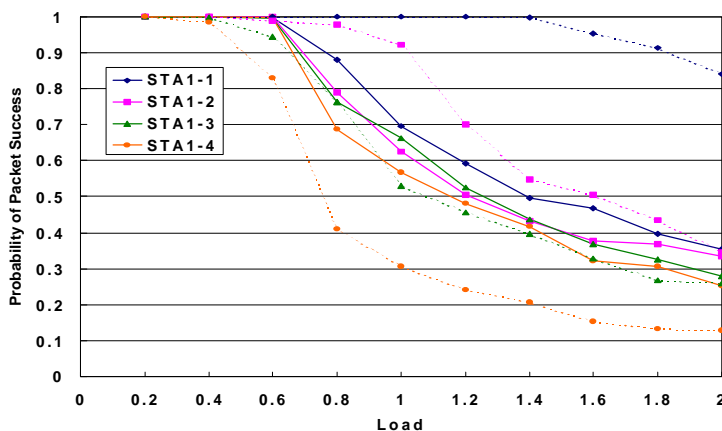


Baseband Modulation : 16 bit Bi-Orthogonal keying * 16 chips PN sequence
 Carrier Modulation : BPSK
 Decision Threshold : BER < 10⁻⁵
 Type of Jammer : CW

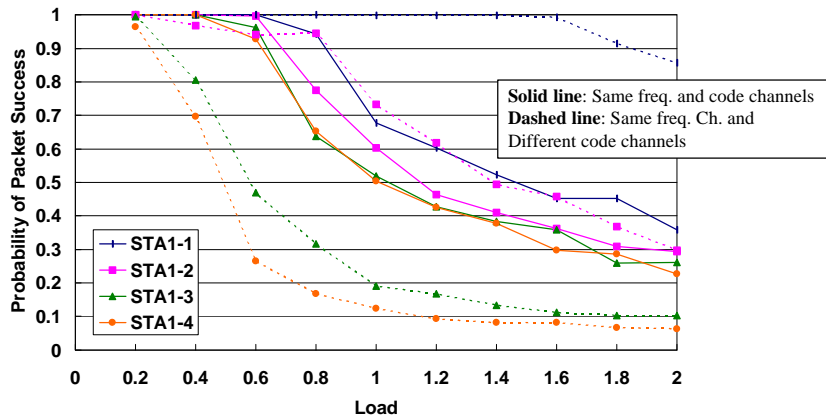
**Throughput under config. -1
(INF Length = 12000 bit)**



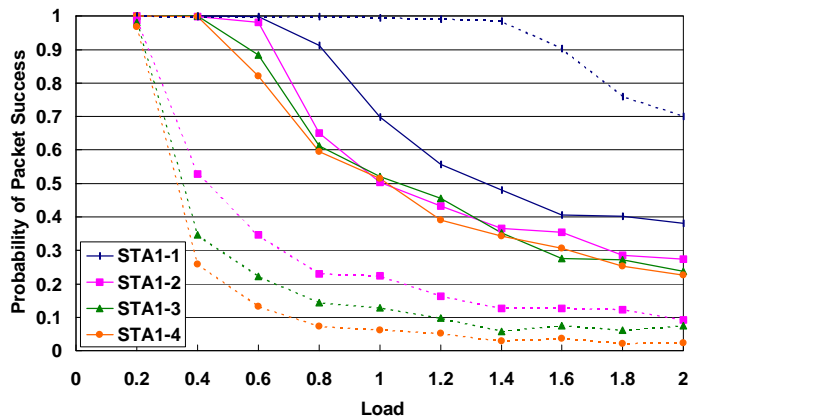
**Probability of Packet Success under config. -1
($Z_0 = -5dB$)**



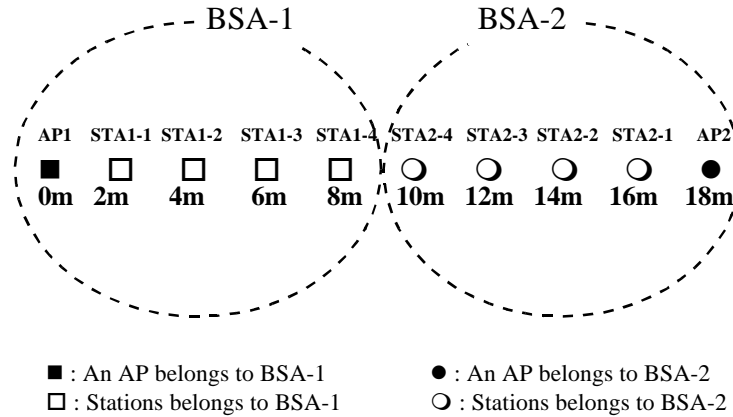
**Probability of Packet Success under config. -1
($Z_0 = 0dB$)**



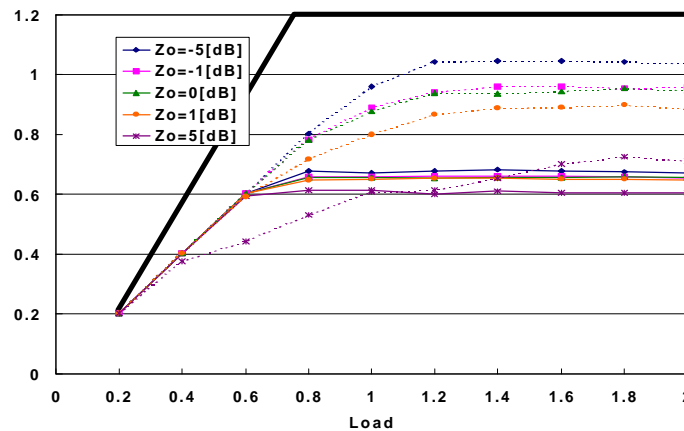
**Probability of Packet Success under config. -1
($Z_0 = 5dB$)**



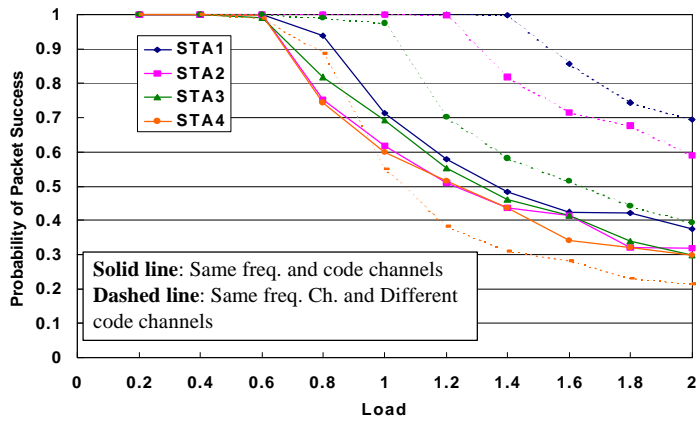
System Configuration - 2



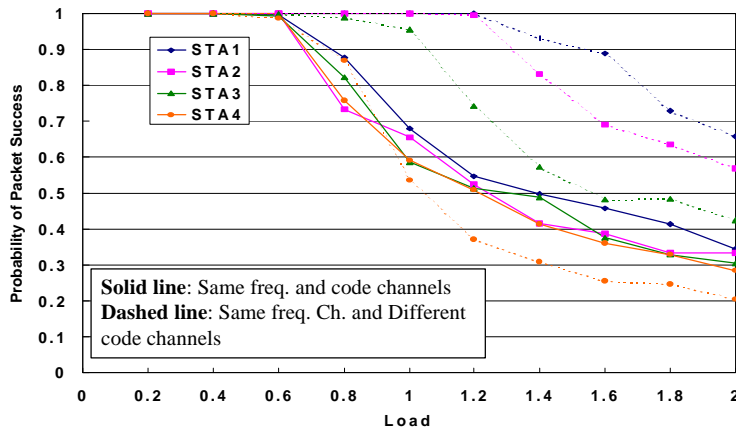
Throughput under config. -2 (INF Length = 4000 bit)



**Probability of Packet Success under config. -2
(INF Length = 4000 bit, $Z_0 = -1dB$)**



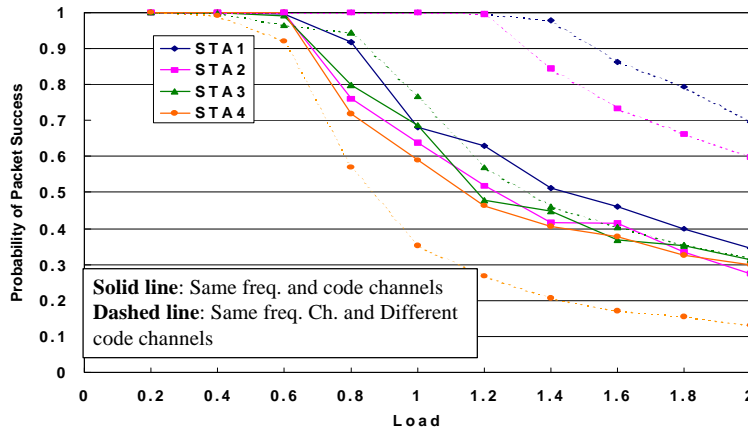
**Probability of Packet Success under config. -2
(INF Length = 4000 bit, $Z_0 = 0dB$)**



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Doc: IEEE802.11-98/118

**Probability of Packet Success under config. -2
(INF Length = 4000 bit, $Z_0 = 1dB$)**



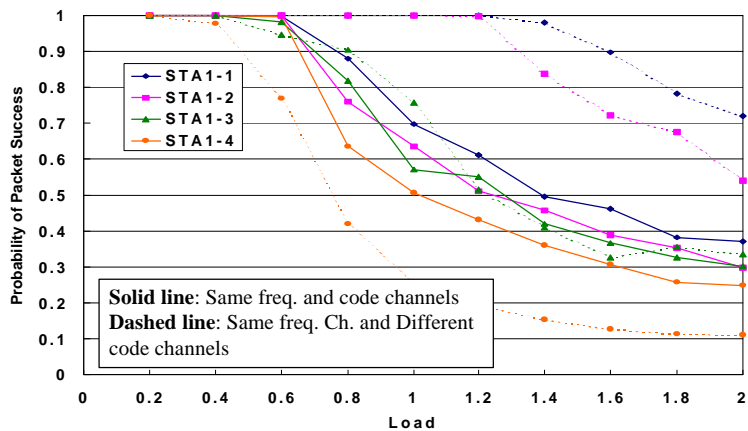
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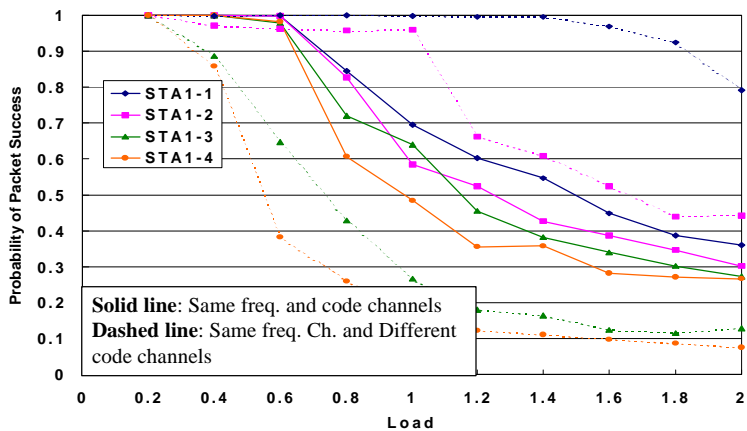
**Probability of Packet Success under config. -2
(INF Length = 4000 bit, $Z_0 = 2dB$)**



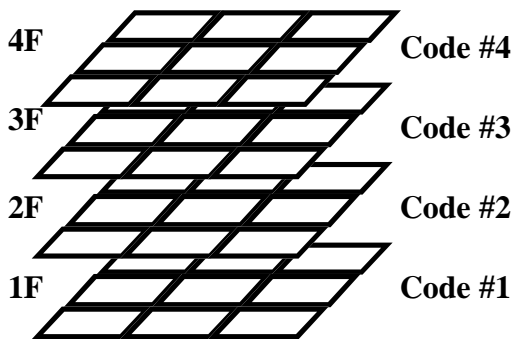
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**Probability of Packet Success under config. -2
(INF Length = 4000 bit, $Z_0 = 5dB$)**



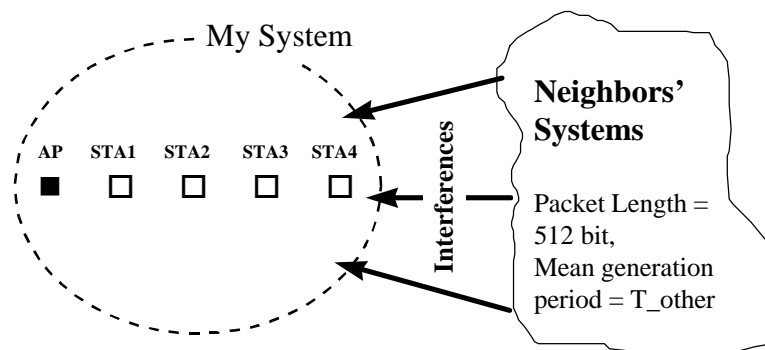
Prominent applications of code channelization



Code Channelization is useful especially in order to obtain *floor-to-floor isolation* or *room-to-room isolation*.

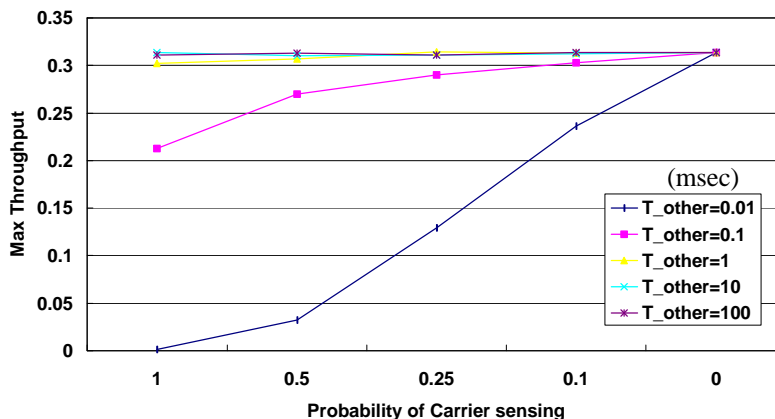
The effectiveness has been proved through many applications of Clarion's SS products in Japan.

System Configuration - 3



My system and neighbors' systems are being operated by the same frequency channel without code channelization. Signals from neighbors' systems can be sensed by probability of p . D/U ratio is always enough large to ignore errors by collisions.

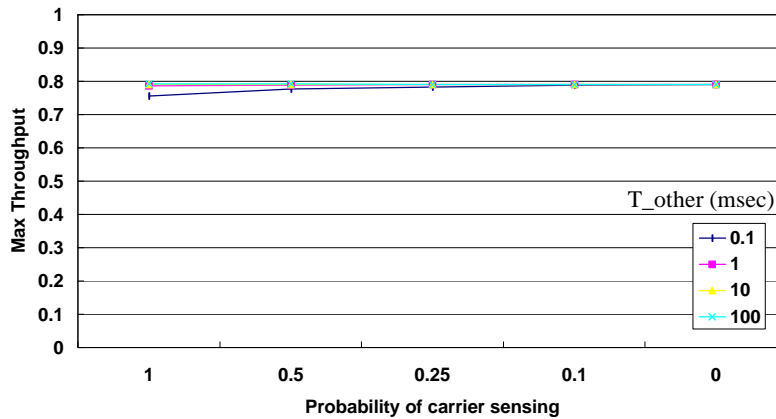
Maximum throughput under config. -3 (INF Length = 512bit)



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**Maximum throughput under config. -3
(INF Length = 12000bit)**



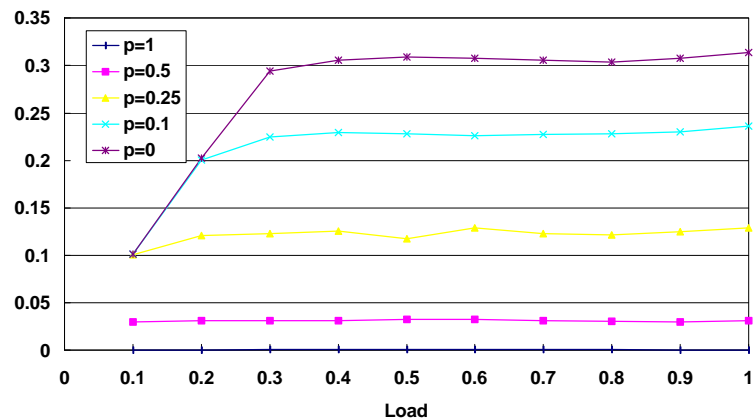
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**Load vs. Throughput under config. -3
INF Length = 512 bit, T_{other} = 0.01msec
(Aggregate Load of interference = 5.12)**



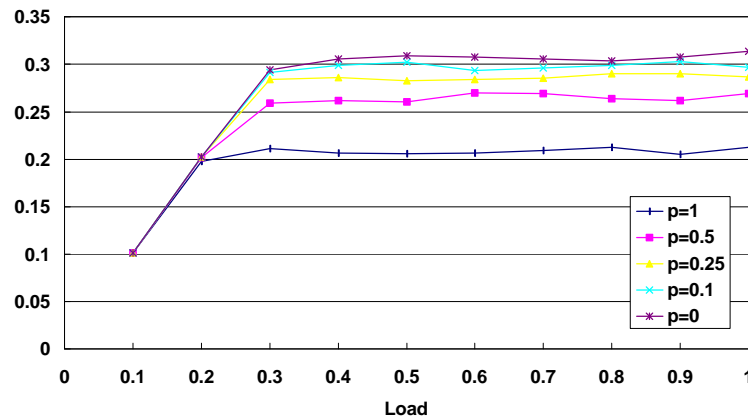
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Load vs. Throughput under config. -3
INF Length = 512 bit, $T_{other} = 0.1msec$
(Aggregate Load of interferences = 0.512)



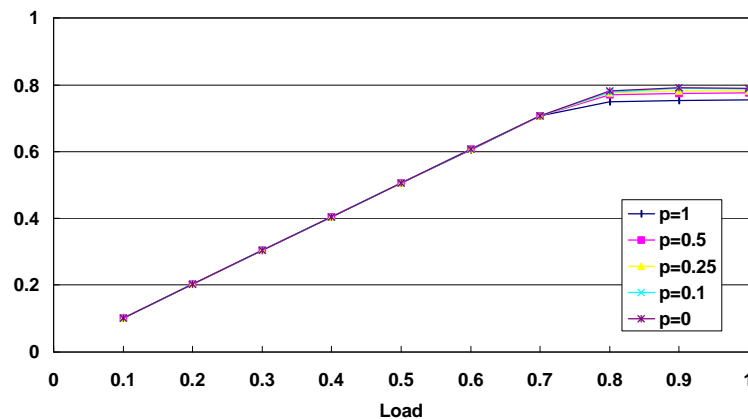
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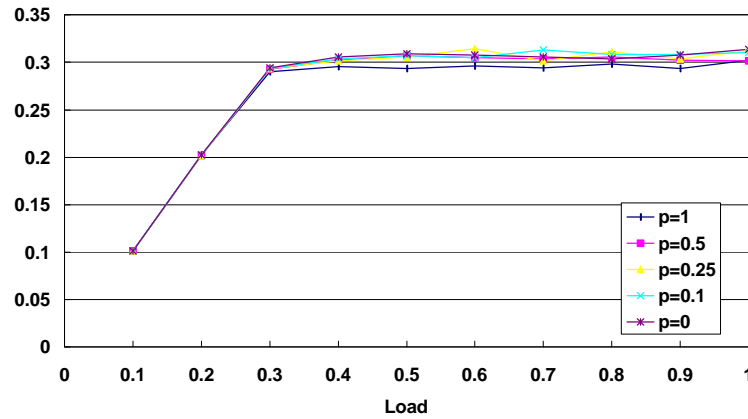
Load vs. Throughput under config. -3
INF Length = 12000 bit, $T_{other} = 0.1msec$
(Aggregate Load of interferences = 0.512)



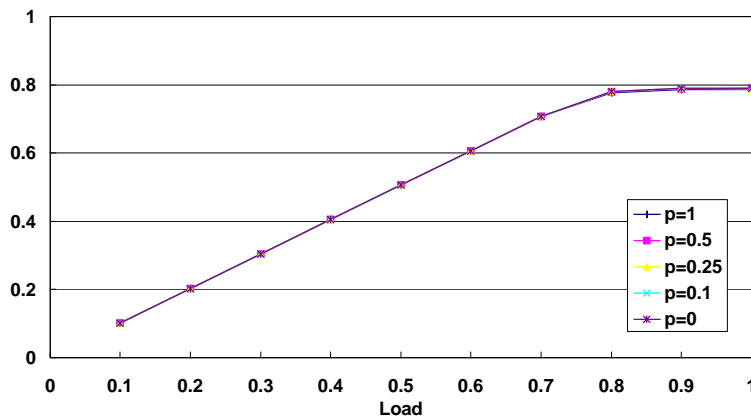
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Load vs. Throughput under config. -3
INF Length = 512 bit, $T_{other} = 1msec$
(Aggregate Load of interferences = 0.0512)



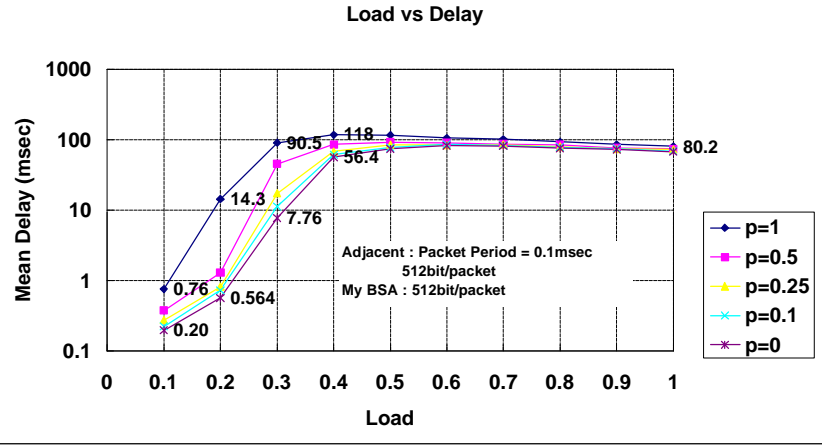
Load vs. Throughput under config. -3
INF Length = 12000 bit, $T_{other} = 1msec$
(Aggregate Load of interferences = 0.0512)



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Mean Delay under config. -3
INF Length = 512, $T_{other} = 0.1msec$
(Aggregate Load of interferences = 0.512)



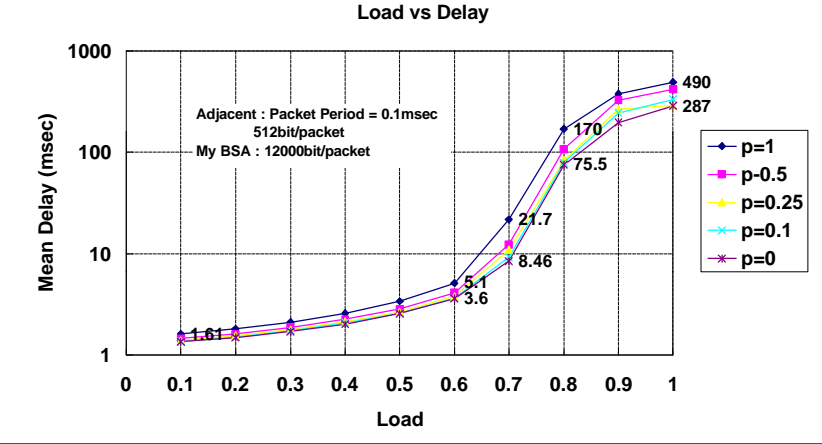
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Mean Delay under config. -3
INF Length = 12000, $T_{other} = 0.1msec$
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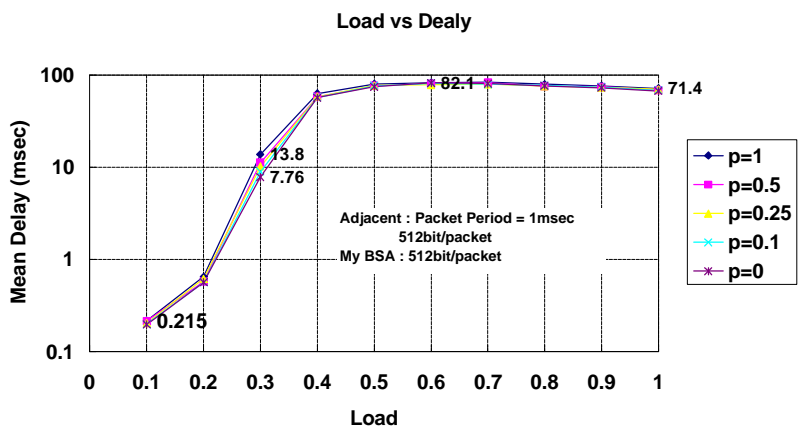
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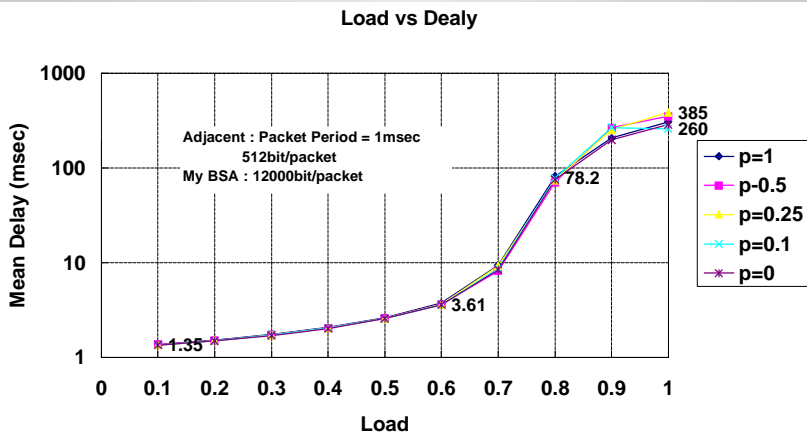
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Mean Delay under config. -3
INF Length = 12000, $T_{other} = 1msec$
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Conclusion

- **Code channelization provides better throughput if BSAs are not overlapped.**
 - To obtain floor-to-floor and room-to-room isolation.
 - For unmanaged BSAs (SOHO market).
- **Substantial overlapping of BSAs causes degradation because of the *Near-Far problem*.**
- **Next simulation must show system capacity and include interference and leakage (shared capacity) effects.**