Appendix A

The proposed scheme is better if \( \text{number of code searches for } AVC \leq \text{Number of code searches for CFA i.e.} \)

\[
z + \sum_{i=1}^{z} l_{x_i} + \sum_{i=z+1}^{z+1} t_{x_i} - 1 \leq 2^{L-l} - N_l + \sum_{i=1}^{N_l} (l_{x_i} + 2^{l+l_{x_i}} - 1) \quad \text{(A.1)}
\]

\[
z + \sum_{i=1}^{z} l_{x_i} + \sum_{i=z+1}^{z+1} t_{x_i} - 1 \leq 2^{L-l} - N_l + \sum_{i=1}^{N_l} l_{x_i} + \sum_{i=1}^{N_l} 2^{l+l_{x_i}} - 1 \quad \text{(A.2)}
\]

We can represent \( \sum_{i=1}^{N_l} l_{x_i} \) as

\[
\sum_{i=1}^{N_l} l_{x_i} = \sum_{i=1}^{z} l_{x_i} + \sum_{i=z+1}^{z+1} l_{x_i} \quad \text{(A.3)}
\]

using Equation A.3 in Equation A.2

\[
z + \sum_{i=1}^{z} l_{x_i} + \sum_{i=z+1}^{z+1} t_{x_i} - 1 \leq 2^{L-l} - N_l + \sum_{i=1}^{z} l_{x_i} + \sum_{i=z+1}^{z+1} l_{x_i} + \sum_{i=1}^{N_l} 2^{l+l_{x_i}} - 1 \quad \text{(A.4)}
\]

\[
z + \sum_{i=1}^{z+1} t_{x_i} - 1 \leq 2^{L-l} - N_l + \sum_{i=z+1}^{z+1} l_{x_i} + \sum_{i=1}^{N_l} 2^{l+l_{x_i}} - 1 \quad \text{(A.5)}
\]

\[
z + \sum_{i=1}^{z+1} t_{x_i} + N_l - 1 \leq 2^{L-l} + \sum_{i=z+1}^{z+1} l_{x_i} + \sum_{i=1}^{N_l} 2^{l+l_{x_i}} - 1 \quad \text{(A.6)}
\]

It can be easily find out that

\[
z \leq \sum_{i=1}^{N_l} 2^{l+l_{x_i}} - 1 \quad \text{(A.7)}
\]

where \( z \) is number of vacant code searched for adjacency.

Using Equation A.7 in Equation A.6, we

\[
\sum_{i=1}^{z+1} t_{x_i} + N_l - 1 \leq 2^{L-l} + \sum_{i=z+1}^{N_l} l_{x_i} \quad \text{(A.8)}
\]

Also,

\[
\sum_{i=1}^{z+1} t_{x_i} + N_l - 1 \leq 2^{L-l} \quad \text{(A.9)}
\]

As \( 2^{L-l} \) is total number of codes in layer \( l \), we can write

\[
0 \leq \sum_{i=z+1}^{N_l} l_{x_i} \quad \text{(A.10)}
\]

which is always true.
Appendix B

B.1 Pure top down code searches

For a new call with rate $2^{L-1} R$, the codes searched are

$$N_{TD} = 2(L-1) + 1$$  \hspace{1cm} (B.1)

B.2 CFA code searches

For a call of rate $2^{L-1} R$, the maximum number of code searched to find vacant code in layer $l$ is $2^{l-l}$. If there are $z$ vacant codes in layer $l$, for each code, $C_{I_x_i}$, $1 \leq i \leq z$, $1 \leq x_i \leq 2^{l-1}$, CFA scheme finds number of busy codes under immediate parent of each $C_{I_x_i}$. The total number of code searches for parents of each vacant code in layer $l+1$ are $z \times 2^{l+1}$. If a unique immediate parent code (say $C_{I+1,[y/2]}$) with maximum number of busy codes exists, new call will be assigned to its children and code searching stops. Otherwise, let $z_1$ number of parent codes in layer $l+1$ that leads to tie for maximum number of busy children. The number of code searches for layer $l+2$ are $z_1 \times 2^{l+2}$. If a unique result does not exist the procedure is repeated till layer $L$ giving maximum code searches. The total number of code searches for CFA becomes

$$N_{CFA} = 2^{(L-1)} + z \times 2^{l+1} + z_1 \times 2^{l+2} + ... + z_{L-2} \times 2^{L-1}$$  \hspace{1cm} (B.2)

B.3 Top down and dynamic code assignment (DCA)

DCA circumvent code blocking problem by providing zero code blocking at the cost of increased number of code searches which makes it unsuitable for real time applications. The use of top down scheme can significantly reduce code searches in DCA scheme as follows.

B.3.1 Conventional DCA

For new $2^{L-1} R$ call arrival, the maximum number of codes searched to find a vacant code are given by

$$N_{C_DCA} = 2^{L-1}$$  \hspace{1cm} (B.3)

If vacant code is available, procedure stops. Otherwise, let $k_1$ is the number of blocked codes denoted by $C_{I_x_i}$, where $1 \leq i \leq k_1$ and $1 \leq x_i \leq 2^{L-1}$ in the layer $l$. For each of the
blocked codes, the codes in layer $l$, $l \in \{1, 2, \ldots, L-1\}$ are checked to count number of busy children. The number of codes searched in layer $l$, $l \in \{l-1, l-2, \ldots, 1\}$ are $2^{l-l_i}$. The total code searches in layer $1$ to $L-1$ is $N_{DCA}^2 = k_1 \times (2 + 4 + \ldots + 2^{L-1})$.

Total number of codes searched in DCA becomes

$$N_{DCA}^I = N_{DCA}^1 + N_{DCA}^2 = 2^{L-l} + k_1 \times \sum_{l=1}^{l-1} 2^l$$

A code with minimum number of children codes is selected, reassignments needs to be carried out for it. Let at least one code in layer $p | p < l$ is busy, the number of codes need to be check for code availability is

$$N_{DCA}^R = \sum_{p=1}^{L-1} a_p \times 2^{L-p}$$

where $a_p = 0$ if layer $p$ do not have a busy code and $a_p = 1$ if layer $p$ has a busy code.

So, total number becomes

$$N_{DCA} = \sum_{l=1}^{L-1} \lambda_l \times [N_{DCA}^I + N_{DCA}^R]$$

$$N_{DCA} = \sum_{l=1}^{L-1} \lambda_l \times [N_{DCA}^I + N_{DCA}^R]$$

### B.3.2 DCA Top Down

The number of code searches required to identify suitable blocked code are

$$N_{TD-DCA} = 2(L-I)+1$$

If suitable code is $C_{l,l_i}$, let there are $p_{l'}, 1 \leq l' \leq l-1$ busy children of $C_{l,l_i}$ in layer $l'$, the total busy children who need reassignments are $\sum_{l'=1}^{l-1} p_{l'}$. The maximum number of searches required to identify $\sum_{l'=1}^{l-1} p_{l'}$ vacant codes are

$$N_{TD-DCA_2} = \sum_{l'=1}^{l-1} 2^{l'}$$

The number of code searches required to shift all $p_{l'}, 1 \leq l' \leq l-1$ busy codes are

$$N_{TD-DCA_4} = \sum_{l'=1}^{l-1} p_{l'} \times (2 \times (L-l') + 1)$$

The total code searches in top down DCA are

$$N_{TD-DCA} = N_{TD-DCA_1} + N_{TD-DCA_2} + N_{TD-DCA_4}$$

$$N_{TD-DCA} = 2(L-I)+1 + \sum_{l'=1}^{l-1} (2^{l'} + p_{l'} \times (2 \times (L-l') + 1))$$