average processor utilization level for volume servers, and (3) the use of power management on applicable servers. These issues are discussed in more detail below.

The increasing penetration of "energy efficient" volume server models will tend to decrease the average UEC across all volume servers in the U.S. installed server base. First, the penetrations of "energy efficient" models by year and space type were estimated, as summarized in Table A4-4.

Table A4-4. Percent of Installed Base of Volume Servers that is "Energy Efficient" by Space Type, Current Efficiency Trends Scenario, 2007 to 2011

Volume servers in:	**% of installed volume server base that is energy efficient**				
	2007	**2008**	**2009**	**2010**	**2011**
Server closets	1%	3%	5%	8%	12%
Server rooms	1%	3%	6%	9%	12%
Localized data centers	1%	3%	6%	9%	12%
Mid-tier data centers	1%	3%	6%	9%	12%
Enterprise-class data centers	1%	3%	6%	9%	12%

The estimates in Table A4-4 were generated using a server stock turnover accounting approach based on projected volume server shipments and retirements by year from IDC (2007a) for the current efficiency trends scenario. Because the number of installed servers in server closets was expected to grow more slowly than the number of installed servers in server rooms and data centers, the server closet penetration of "energy efficient" servers is slightly different than those of the other space types.

Using the data in Table A4-4, the weighted average volume server UEC (UEC_{AVG}) in year i for space type j was calculated using the following relation:

(A4-2) $$(UEC_{AVG})_{ij} = (UEC_{HT})_{ij} * (1 - x_{ij} + x_{ij}y_{ij})$$

where for each year i and space type j, UEC_{HT} is the average historical trends volume server UEC from Table A4-3, x is the percentage of the installed volume server base that is "energy efficient" from Table A4-4, and y is the % savings in UEC associated with an "energy efficient" volume server as compared to the historical trends volume server. (Recall from Chapter 3 that the assumed value of y in this report is 25%).

To account for the energy effects of increased processor utilization due to virtualization, as well as the energy effects of power management, representative industry data showing the relationship between system (i.e., server) energy use, processor utilization, and power management state (i.e., on or off) were used in this report. The data used to characterize this relationship are summarized in Figures A4-1a (AMD 2006) and A4-1b (Nordman 2005). Figure A4-1a depicts this relationship for servers manufactured in years 2006 and later; Figure A4-1b depicts this relationship for servers manufactured in years 2005 and earlier. The use of two separate graphs acknowledges the shift in the relationship between server energy use, processor utilization, and power management state that has occurred over time. The manufacturing age of