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發明專利說明書

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一、發明 名稱	中 文	供一資料處理系統用之電源管理之方法及系統
	英 文	"METHOD AND SYSTEM OF POWER MANAGEMENT FOR A DATA PROCESSING SYSTEM"
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(請先閱讀背面之注意事項再填寫本頁各欄)

裝

訂

線

五、發明說明 (1)

發明背景

1. 技術領域

本發明概略關係於資料處理系統之電源管理。更明確地說，本發明關係於一資料處理系統之物件導向電源管理的方法與系統。

2. 相關技術描述

在諸如可攜式膝上型電腦及筆記型電腦等運算裝置中管理並節約使用電力能源是一主要的工程設計考量。在一般用電池當作其主要電源來源而操作之行動運算裝置中特別的考量是電力能源之節省以便藉有效管理及使用電池電源而使作業時間極大化。例如，一種電源管理技術將電腦系統之元件電源關閉而在一特定時期內維持停機狀態。

在許多可攜式機器中，當機器自其諸如110伏特交流電等主要外部電力來源分離時，諸如電池等自我供應電力來源就成為主要電力來源。在某些狀況下，電池被當作一輔助電力來源以在機器遭遇突然喪失電源時維持某些關鍵電路有作用。此功能是維持機器的記憶體存活以保留儲存在記憶體內之任何資訊以免該資訊漏失。先進的管理體系監督各種功能並在不需該等元件時將電源自該等元件上移除以延長該裝置可由其內部電力來源供應操作之期間。此外，一暫停 (time out) 體系在某一時段以後將機器置於一待命模式下以便節省電源。例如在現代化膝上型電腦中很普遍的是當電腦維持無動作達某一時段以後即將其顯示螢幕電源移除。

五、發明說明(2)

膝上型電腦被設計成可自其內部電力來源供電操作某數個小時。為了延長這些膝上型電腦自我供電的時段同時維持最小的電池大小和重量，需要一複雜的電源管理體系以便僅提供電源予需要此種電源之諸電路與裝置並在不需某種電路時移除電源或使該電路進入一低耗電模式。該管理體系亦須持續監視各個電路與裝置，以便在需要時能立刻將電源再加諸此等電路與裝置而使其有作用。

更顯著地，大型現代化主機型電腦有複雜的結構而需大量電源。對這些大型系統之可用電源的管理與規劃呈現了與出現在膝上型電腦電源管理上所遭遇之類似的問題。譬如，電腦系統可能僅有有限的電源供應以操作該系統而該系統對電源消耗之潛在需求卻遠超過此電源供應量。故需電源管理系統以規劃整個系統的電源。

現行世代的電源管理技術有許多問題。主機型電腦與膝上型電腦共通的第一個現代電源管理系統問題是電源管理架構是隨系統而異的，故期望能提供一種可使用於任何電腦系統中的電源管理體系。此外，尚期望能提供一種可在任何電腦系統上運作之電源管理體系，但該體系可藉著設計該體系反應的規則而使其符合讓電腦系統最佳化所要求之電源標準以配合任何期望之電腦組態的需要。

所以，有一種需要要求提供可廣泛應用於不同型式之系統上的電源管理體系。一體系被設計之作業系統或核心程式最終可在許多種電腦系統上執行。此需要讓該種電源管理體系具備普遍性且能在由手持型相當固定功能之系統到

(請先閱讀背面之注意事項再填寫本頁)

裝

訂

線

五、發明說明 (3)

擁有成千個處理器之高電源需求的系統之大範圍系統中均可適用。每種型式的系統加上其本身須由電源管理體系滿足之關鍵需求。下列諸系統型式描述各系統型式及其可能的關鍵需求。

1. MPP 系統

此類系統是包含成百個或上千個處理元件的“大量平行處理器”(Massively Parallel Processor MPP)系統。此類型系統之目標係提供“生的”(raw)效能。該效能一般以處理能力為導向但一般有相當高頻寬的I/O以便饋送處理器效能。任何可能阻礙或限制系統效能的事均應避免。電源管理體系須能不干擾系統之效能。

2. 伺服器系統

此類系統被用來遞送某些服務予許多個其他的請求端。其一般被當作一檔案服務者，提供相當大量的檔案資料予許多個請求端。但此型式的系統可被用來提供任何型式的可供分享之服務(例如印表機服務)。這些系統所主要需求的是資料的信賴性及服務的高即時可用性。電源管理體系可滿足伺服器系統需求之方法是通知系統有關迫切的電源停止訊息並可能地切換至備用電力來源以“消除”停電危機。

3. 桌上型電腦系統

此類系統主要由終端使用者使用且一般為與終端使用者互動的系統。雖然此類系統有許多攸關終端使用者的屬性，但對終端使用者滿意度而言可能是最重要的一項屬性是

五、發明說明 (4)

回應時間。亦即當使用者發出一動作於系統上時，使用者“看到”某種回應所花的時間是決定使用者對系統滿意度的重要因素且大幅影響使用者對系統速度或效能的觀感。電源管理體系須不致造成此類系統之回應時間的大幅（可察覺）增加。

4. 膝上型電腦系統

此類系統類似於桌上型電腦系統亦由終端使用者使用。但與（經常停留在一位置上的）桌上型電腦系統不一樣的是這些系統是行動化的。亦即其時常被四處移動。這些系統的移動性的一部份是（常以電池為形式之）可攜式電源供應器。如桌上型電腦系統般，膝上型電腦系統之回應時間亦為一重要指標。但由於其移動特性，故需要該可攜式電源供應器儘可能地提供長時間的電力。此需要有時與快速回應時間的要求相衝突，但經常是犧牲某些回應時間以換取較長的電池供電時間。此類系統是以往電源管理所主要著重的焦點。此情況將持續直到系統本身的電力消耗大幅縮減以增長電池供電時間或電池技術有長足的進步而使電力消耗不再成為一顧慮或者是電力消耗有某程度之縮減且電池技術有改進二者的某種組合以產生“長”電池供電時間。

5. 植入型系統

這類型式的系統可分為二種類別：一般使用於類如工廠生產現場控制器之某種型式的程序控制中的“單基板電腦”，及被用作類如何伺服器系統中磁碟控制器之另一型式系

（請先閱讀背面之注意事項再填寫本頁）

裝

訂

○線

五、發明說明 (5)

統內次系統的一部份之“控制器”。此類型系統之主要著重點常為“即時”(real-time)。亦即軟體對系統效能特性有某種期許，而該系統效能特性是其所賴以完成正確作業者（亦即程式的正確性不但根據演算法正確性來判斷還包含一時間成份在內）。電源管理體系須讓即時應用程式可依一種方式運作而使其能符合其時間標準。

6. PDA 系統

此類系統為“個人數位助理”(Personal Digital Assistants)或手持型系統。它們遠較膝上型電腦系統小且常不像其他較普遍之電腦系統般地有彈性。PDA系統展現的需求主要有二。其一為極長的電池供電時間。若膝上型電腦系統之電池供電時間以小時或數天計算，則PDA系統之電池供電時間就至少要以月來計算。PDA系統之效能常被犧牲以換取較長的電池供電時間。另一需求是所謂的“立即開機”(instant on)。亦即PDA的“啟動”程序是以幾分之一秒來衡量的。

除了膝上型電腦及PDA以外，電源管理也在所有此類型系統中日趨重要。在所有系統中均需要電源供應器。在靜止型系統中，是電源供應器將市電（在美國是120伏特60赫芝）轉換成系統內部所需之各種直流電壓。一特定電壓所需之電流愈大，則電源供應器就愈大。較大的電源供應器一般較貴於較小的電源供應器。為使系統成本降低，製造商將使用可讓系統運作之最小的電源供應器。但終端使用者可能希望組成一系統而該系統會消耗較電源供應器

五、發明說明 (6)

所能提供的為多的電力。傳統上，使用者的解決方法是以較高的成本購買具有較大電源供應器之系統。所以會有期望能有一種可規劃系統中電源以解決此問題的系統。

在使用市電之系統中可能發生另一問題。一個能夠在系統內部產生較大電力的電源供應器必然地需要較多的輸入電力。在某些狀況下，是不可能獲得較多的輸入電力的。例如在一場所內安裝100個系統，每個系統消耗500瓦特，則總電力消耗即達50仟瓦。若這些系統所位在的建物能夠支援60仟瓦的負載，則無問題。但若該等系統被各消耗750瓦特之系統取代，則會產生問題，因為總電力消耗將達75仟瓦而超過該建物所能支援的負載15仟瓦。這就是愈來愈多低耗電的"綠色電腦"出現的原因。所以電源管理對所有型式的電腦系統均甚重要而非僅對膝上型電腦及PDA才重要。

電腦管理體系不可依賴任何硬體設施細節來界定其架構。例如某些處理器體系有特定的附加部份來處理電源管理（諸如電源管理碼之特別執行模式）。電源管理體系定義不可假定特定的處理器架構機能。此將會嚴重地限制該體系之應用於其他處理器架構。

類如國際商業機器公司的思考板（IBM Thinkpad）系列膝上型電腦之機器是以英代爾（Intel）公司的先進電源管理體系（Advanced Power Management Architecture）及其先驅為基礎。這些技術侷限於專門的英代爾架構處理器之SL系列而無法在以開放系統技術為基礎之軟體系統上使

五、發明說明 (7)

用。

先進電源管理 (Advanced Power Management) 使用一稱為系統管理模式 (System Management Mode) 的專用處理器模式來執行處理電源事件的碼。不幸的是，採用此一模式違反了開放系統的架構原理。開放系統假設其對處理器作業有完全的掌控。其一般以位址翻譯器有作用的情況下僅以機器普通的特權模式執行。在即時工作 (real time work) 情況時，若硬體進入系統管理模式下，則用來管理處理器資源的所有排程和所有演算法均被設為無作用。

此外，在多重處理器系統上，若一個處理器進入系統管理模式，則多重處理器組合中的其他處理器會認定該處理器故障並試圖將其自系統中排除。若該處理器又恢復正常執行，則系統就變成無法運作了。而且，若一處理器在一多重處理器組合中處理的同時進入了系統管理模式，則在處理程序中某特別類型的重要部份期間會發生僵局。例如，若作業系統核心正在執行一翻譯後備緩衝器停止 (Translation Lookaside Buffer Shutdown)，則諸處理器會進入一系列的旋轉及領受循環。若一正在旋轉的處理器進入了系統管理模式，則系統內的全部處理器可能都一起旋轉。

最後，先進電源管理 (APM) 係依賴基本輸入／出系統 (Basic Input/Output System BIOS) 之存在與使用。開放系統不使用 BIOS，因為其是可攜式的、可提供即時支援、

(請先閱讀背面之注意事項再填寫本頁)

裝

訂

線

五、發明說明(8)

在多重處理器硬體上執行並直接提供BIOS層的所有功能。根據上文所詳述的諸問題可知先進電源管理(APM)無法使用於開放系統中。

當“即時”(real time)一辭被導入時，傳統的電源管理設計就會被打破了，因為該類設計解決電源管理問題的方法是不讓“即時”應用程式執行或關閉電源管理。此會造成一非常次佳化的解決方案。若認為多媒體是一即時應用程式且其在市場上日趨重要，則即時的機能就是一須由電源管理體系處理的非常重要議題。“即時”在將電源管理納入考慮時很困難的原因是“即時”會要求可預測的服務可用性(即已知的次系統回應時間)。反之，傳統的電源管理不負責提供一致的次系統回應時間，其目標是犧牲效能與次系統回應時間以縮減電力且此二因素很可能會隨著“可感知的”系統活動而改變。

除了現代電源管理系統之不可攜性及無法規劃系統中總消耗電力以外，現行電源管理系統未考慮自一電源狀態轉換至另一電源狀態有關之電力成本，而且其亦無法規劃電源。以前的技術僅能使電腦系統元件之電力消耗極小化。一既定狀態之電力需求未被賦予價值，且狀態轉換被假設為零成本且是馬上完成的。例如，在使電力消耗極小化的努力中，電源管理將假設磁碟機在作業時消耗較多電力而在停止運轉時消耗較少的能源。故若磁碟機有一段時間未被使用，則電源管理會將磁碟機關機。此種簡化的電源管理方法之問題是其未將在把磁碟旋轉停止期間所耗電力及

五、發明說明 (9)

再將磁碟旋轉起來待再使用所耗電力列入考慮。故若磁碟機消耗不同量之電力並花一些時間來旋轉停止而消耗不同量的電力與時間來旋轉啟動，則電源管理體系在決定將磁碟機關機以節省電源之必要性時就應將這些成本列入考量。

一相關問題是熱量管理問題。當進行有關整個電腦系統的適當分佈與電力之判定時。電源管理系統最好將熱量對電力消耗及供應、元件信賴性和整體系統效能之影響列入考量。

所以有期望要提供一種不限定於硬體規格之用於資料處理系統的電源管理體系。如此將免除對每種電腦應用程式重新設計電源管理體系之需要。藉著使電源管理有更高的跨平台的可攜性，其結構更得以簡化而使更複雜的控制功能可輕易地併入電源管理中。此種系統尚期望能規劃整個系統之可用電源。而且，該種電源管理體系須不依賴任何設施規格來界定該架構。該電源管理系統亦將把狀態轉換之電力成本列入考量。最後，該電源管理系統應把熱量對電力消耗及供應之影響列入考慮。

發明摘要

根據本發明，在包含實體裝置的資料管理系統內之一種電源管理體系至少有一狀態，每一狀態有一對應電力值，且其中一系統狀態被界定為諸實體裝置全部現行狀態的集合。各對應於一實體裝置的電源物件及熱量物件包含有有關於該實體裝置各可能狀態之電源需求和熱量特性的資訊

五、發明說明 (10)

。電源與熱量物件亦描述被容許之自各可能狀態至另一狀態的狀態轉換及所有可能的狀態轉換之電力需求和熱量特性。其中亦有各實體裝置現行狀態之資訊。事件裝置產生表示系統內一事件發生之信號。一規則模組包含執行電源管理指揮一行動之規則，諸規則為事件及電源物件資訊的函數。一與諸實體裝置、諸熱量及電源物件、諸事件裝置、及規則模組溝通之控制器根據一事件改變諸實體裝置中任一實體裝置的狀態。該控制器根據規則模組規則決定是否改變一實體裝置狀態。

本發明的上述及額外的目的、機能及優點可在下文中詳細描述中更加明顯。

圖式簡述

相信為本發明之特點的獨特機能說明於所附申請專利範圍內。但本發明本身以及一種較佳的使用模式、其進一步之目的與優點可藉參考下文中一說明性具體實例的詳細敘述並同時參閱諸附圖而獲清晰的瞭解，諸圖式中：

圖1 顯示被本發明之電源管理體系管理的電腦系統元件圖；

圖2 顯示對應於被本發明之電源管理體系管理的電腦系統元件之電腦系統電源物件圖；

圖3 以圖形顯示一電源包封物件的內容；

圖4 係根據本發明之關聯於一實體裝置的物件圖；

圖5 以圖形顯示根據本發明之一事件來源物件的內容；

圖6 係根據本發明之實體裝置圖；

五、發明說明(11)

圖 7 以圖形顯示根據本發明之一事件來源物件的內容；

圖 8 係根據本發明之實體裝置圖；

圖 9 以圖形顯示根據本發明之一事件來源物件的內容；

圖 10 顯示當執行規則模組諸規則中一範例規則時由控制器執行的諸邏輯步驟之表列；

圖 11 顯示較佳發明的一種替代性較佳具體實例之次系統關係模型；

圖 12A 與 12B 顯示包括其諸物件及諸物件間關係之電源管理體系；

圖 13 顯示包括其諸物件及諸物件間關係之電源管理狀態次系統；及

圖 14 顯示包括其諸物件及諸物件間關係之電源管理事件次系統。

較佳具體實例詳述

本發明之電源管理體系依其被使用於膝上型電腦之較佳具體實例描述。但請注意本發明應不侷限於其在膝上型電腦內之應用。本發明能夠在任何電腦系統內運作且可同樣地應用於其上。本發明是可併入任何電腦系統內之電源管理體系，因為該體系的機制及指導該機制的規則是獨立的，從而使該機制、規則、或二者均為可攜式者。

現參照諸圖式，在圖 1 中顯示由本發明之電源管理體系的一種較佳具體實例管理的電腦系統元件圖。在此一簡化範例中，有 8 個膝上型電腦內受電源管理系統管理之實體裝置。圖 1 顯示 8 個被電源管理體系控制的實體裝置：中

(請先閱讀背面之注意事項再填寫本頁)

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五、發明說明 (12)

央處理單元 CPU 31、記憶體 32、顯示器 33、背景光 34 (背景光提供背景光源予顯示器)、磁碟機 35、鍵盤 36、風扇 37、電池 38、及交流電轉接器 39。這些元件包括膝上型電腦內受電源控制之元件。對每個實體裝置而言有一關聯的如圖 2 中所示之"裝置物件" (device object)。

圖 2 顯示 8 個實體裝置物件：CPU 物件 40、記憶體物件 45、顯示物件 50、背景光物件 55、磁碟機物件 60、鍵盤物件 65、風扇物件 70、及電池物件 80。一使用於此規格內之物件如該名詞廣為電腦程式師及軟體系統工程師所瞭解般地是一包含資料組並可能包含程序之軟體模組。物件擁有邏輯狀態及屬性、與其他物件之關係、及可在不同時間改變這些的動態能力。每個物件是一潛在有作用自動串列媒介，且同一時間最多執行一活動。物件藉產生事件 (event) 而溝通。事件產生之本質會改變，且會包括點對點訊息及非特定要求。事件會觸發轉換或新事件。此外，雖然較佳具體實例使用物件導向規劃未完成本發明，任何規劃方法或系統設計均可被用來在其他具體實例中實踐本發明之電源管理體系。

裝置物件包含於電源包封 (power envelope) 100 內。電源包封 100 提供一種將一特別種類之受管理物件以邏輯方式分群的方法。包封是一種代表系統組織的方便方法，其方式是把系統分割成許多包封並界定那些包封間的關係。例如包含於一包封內之電源物件或則供應電源予該包封內之物件或則自一供應器物件消耗電源。依此方法，系統

五、發明說明 (13)

之電源分佈組織可藉著將電源包封內之諸電源物件連網而界定。電源包封100本身是一"受管理物件"(managed object)。受管理物件是一透過控制器110受電源管理體系控制的物件。控制器110是用來執行一程序之處理器或其他邏輯引擎。

規則模組(policy module)120是一包含許多規則(rule)的物件，電源管理體系藉該等規則配置並控制電腦系統內的電源供應與消耗並控制電腦系統內之熱量傳輸。規則模組120直接饋入控制器110。控制器110藉判定包封100之組態及現行狀態並計算由規則模組120之規則指揮的行動而執行所要的電源管理。然後控制器110改變包含於電腦內之實體裝置的狀態以實施電源管理。

圖3-9以圖形顯示本發明中軟體物件之結構。實線方塊表示一在物件導向規劃中被概念化的邏輯物件。虛線方塊表示一實際物件的完全指明的階段。也就是說，虛線方塊是被實施以實現本發明之實際軟體模組或物件。每個邏輯物件包含代表該物件多重屬性之欄位。邏輯物件僅為一有用的工具用來根據實體裝置物件的類型將這些屬性分群但不代表被軟體實施的獨立物件。被用以標示一邏輯物件之參考編號是顯示於物件中"id"欄位內的號碼。無"id"欄位之物件有外部參考編號。

現參照圖3，該圖以圖形方式顯示一"包封物件"的內容。"電源包封物件"100具體實踐了被用以控制電源之物件。"熱量包封物件"具體實踐了被用以控制熱量傳輸之物件

五、發明說明 (14)

。管理物件 1 以其辨識 (ID) 編號 "1" 標示於電源管理體系。其型式被標示為一 "包封" 受管理物件 (managed object)，表示其提供一邏輯容器予一群受電源管理器管理之物件。此受管理物件如 "contained in=0" 所示般地不包含於任何其他包封內。該圖亦顯示電源包封物件不產生一事件來源 (event source)。物件 140 標明包含於包封內之物件類種。在此情況下，該包封被分類為一 "電源" 類，故而僅包含電源物件。該圖亦顯示影響該群的規則模組。物件 150 提供有關包含於電源包封內的那些實體裝置為電源供應者、那些是電源消耗者之資訊。在膝上型電腦的範例中，電池會被標示為電源供應者而 CPU、記憶體、顯示器、背景光、磁碟機、鍵盤及風扇會被標示為電源消耗者。

若包封物件為一熱量包封，則電池、CPU、記憶體、顯示器、背景光、磁碟機、鍵盤及風扇均會被標示為熱量來源。但可藉對流而傳送熱量之風扇亦會被標示為散熱器。

現參考圖 4，該圖顯示代表一電源消耗者實體裝置物件之邏輯物件、該裝置物件之可能狀態及被容許的轉換。受管理物件 2 被標示為 I.D. 編號 2。對此範例而言，受管理裝置為 CPU。故受管理物件類型為一 "實體物件" (Physical Object)，該實體物件是對應於電源包封 100 而包含於受管理物件 1 內。故受管理物件 2 為 CPU 電源物件。

物件 180 標明 CPU 裝置物件為一電源物件。電源物件

五、發明說明 (15)

190 描述 CPU 之電源規格。CPU 之被容許狀態被標示為實體狀態 3、4、及 5。電源物件 190 亦藉標示 CPU 在一特定時間點上佔據 3、4、或 5 狀態中的那一個狀態而標示 CPU 之現行狀態。"描述" (Description) 資訊標明對應於受管理物件 2 的實體裝置。

物件 190 將實體物件 180 標示為一電源"消耗者"。一消耗者在運作時使用較其產生者為多之能量。電源物件的另一種可能型式為"供應者"。一供應者在運作時產生較其消耗者為多之能量。

如圖 4 中所示，實體狀態 3 為 CPU 100%效能水準的狀態。要維持此實體狀態所需之電源水準為 5 瓦特。CPU 唯一可被容許自實體狀態 3 所做之轉換為實體轉換 6。故 CPU 僅能透過此實體轉換自其 100%效能狀態移動。為此實體轉換提供之資訊包括該轉換開始的狀態和該轉換結束的狀態。在此情形下，該轉換係自實體狀態 3 轉換至實體狀態 4。故在全能量運轉時，CPU 狀態唯一被容許之改變是減低至實體狀態 4 所示的一半效能。此實體轉換被標示為需消耗 5 瓦特電力並需 1 毫秒的時間來執行。

實體狀態 4 表示 CPU 以一半效能運轉之狀態。當在此狀態下運轉時，CPU 消耗 3 瓦特的電力。被容許由實體狀態 4 所做之轉換僅為實體轉換 7 與實體轉換 8。實體轉換 7 如圖所示般地自狀態 4 開始而結束於狀態 3，將 CPU 由 50% 效能拉上至 100%效能。此實體轉換需要 5 瓦特電力為期 1.5 毫秒。

五、發明說明⁽¹⁶⁾

實體轉換8讓CPU自50%效能轉換為關機。此轉換在圖示中開始於狀態4而結束於狀態5。此轉換消耗3瓦特電力且需時2毫秒。

若CPU現在處於關機狀態，則其電流狀態為實體狀態第5號。在此狀態下，CPU不消耗任何電力。被容許由此狀態所進行之實體轉換為實體轉換9與10。實體轉換9將CPU由關機狀態拉上成50%效能。實體轉換10將CPU由實體狀態5拉上至實體狀態3或全效能。

"事件來源物件" (event source object) 是一將實體事件發生的訊息告知電源管理控制器的物件。"事件來源物件"的一個範例是在膝上型電腦插上交流電源插座時或在交流電源插座喪失電力時提供訊息予電源管理控制器110的物件。又例如與鍵盤關聯之事件來源物件表示有一按鍵被壓下。

現參考圖5，受管理物件11為一事件來源物件。被列出之此物件屬性為其辨識號碼是11、它是一事件來源、它被包含在受管理物件1中、及可能被此物件產生的事件為12、13、41、及42。另一可能的屬性是表示為此事件來源之函數的規則模組 (policy module)。可產生事件12描述當時CPU變得忙碌。可產生事件13描述當時CPU已維持停機狀態達某一時段。此可產生事件是一種"臨限"型事件，因為此事件是在臨限值被超過時產生。在此範例中可見到CPU停機狀態的臨限值為250毫秒。可產生事件41是一臨限型事件，表示CPU已以高負載或速度運轉超過1.5秒的

五、發明說明⁽¹⁷⁾

臨限值。可產生事件 42 是一臨限型事件，表示 CPU 已以低負載運轉超過 0.5 秒的臨限值。

精於本技術領域者當可瞭解的是一實體裝置的任何數目個屬性均可由物件向電源管理控制器報告。受管理物件提供予控制器之資訊類型取決於系統設計者實施於電腦系統上的特定電源管理體系。實踐該體系之諸因素的平衡與諸機能的妥協被整合入由規則模組所提供之諸規則內。這此規則可被設計成規劃諸實體裝置間的電源、犧牲電力換取較佳效能、或犧牲電力以換取較佳的實體裝置信賴性。故在實施電源管理時，控制器根據規則模組諸規則與系統內所有實體裝置的現行狀態、已發生的任何事件、及提供所有實體裝置可能狀態及轉換狀態之屬性的電源物件資訊等關係而決定是否改變一實體裝置的狀態。

受管理的實體電源消耗者之第二範例為一磁碟機，該磁碟機的諸物件顯示於圖 6 與圖 7 中。參照圖 5，所示之磁碟機物件 60 的屬性是該受管理物件之辨識號碼為 14、其為一實體物件、且其為包含在電源管理包封內之電源消耗者。受管理物件 14 的二被容許狀態為實體狀態 15 及實體狀態 16。這些實體狀態由受管理物件向電源管理控制器報告為具有圖 6 中所列示的屬性。這些屬性包括：該實體狀態的辨識編號、該實體狀態之型式、自此實體狀態可能之轉換及此實體裝置在此狀態下之效能水準。磁碟機有一“已轉起”(spun up)的實體狀態 15，磁碟機在此狀態下以全功率運轉且消耗 8 瓦特之電力。僅有一實體轉換—實體轉換

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五、發明說明 (18)

17—源自此已轉起狀態。此轉換要用20秒並消耗10瓦特的電力。此"旋轉停止" (spin down) 實體轉換將磁碟機自己轉起狀態帶至實體狀態16的"已停轉" (spun down) 狀態。在實體狀態16下，磁碟機不消耗任何電力且僅被容許經過一實體轉換—實體轉換18—改變狀態。此實體轉換將磁碟機自己停轉狀態帶至已轉起狀態。為了要轉起，磁碟機要消耗12瓦特的電力為時30秒。

用與CPU範例類似的方式，一事件物件將信號傳送予控制器表示一可報告事件已發生於磁碟機內。如圖7中所示，受管理物件19提供3個可產生事件（信號或訊息）予控制器。此3個可產生事件為：表示磁碟機已忙碌運轉之可產生事件20、表示磁碟機有未定的工作之可產生事件21、及表示磁碟機已維持停機達一段時間之可產生事件22。這些可產生事件全為臨限型事件而需要某最小時間、或在可產生事件21情況下需要某最小數目個磁碟存取要求。當符合臨限值時，事件來源發送一可產生事件信號。雖然受管理物件19被描述為一單獨物件，但磁碟機物件可藉著能夠維持可產生事件而被視為一事件來源物件。例如，磁碟機物件60可有做為磁碟機電源消耗者物件及磁碟機可產生事件之事件來源物件等二重功能。

現參照圖8，該圖顯示做為實體電源消耗者第三種範例之電腦鍵盤的電源物件65。該受鍵盤管理的物件23具有100%效能狀態之實體狀態24、零效能狀態之實體狀態25。實體轉換26及27等僅僅被容許之實體轉換描述將鍵盤自完

五、發明說明 (19)

全運轉轉換為關機的規格。在圖9中，受管理物件28是一具有二可產生之事件的事件來源物件。可產生事件29在一鍵被按下時產生信號，而可產生事件30是一表示鍵盤停機時間的臨限型式之事件來源信號。

熱量物件 (thermal object) 係以一類似方式產生。一熱量物件對應於一實體裝置。熱量物件將包含有關該實體裝置各可能狀態的熱量需求或規格之資訊。此外，熱量物件將發送該實體裝置的現行狀態並提供一該狀態之熱量值。此熱量值可為自一溫度偵測器測得之實際溫度，或者亦可是以瓦特為單位測量之該實體裝置的熱傳播。

圖10中顯示被電源管理系統設計者規劃入規則模組120內之規則型式之一非常簡化範例。該圖顯示一具有3行的表格。第一行為“事件”行，描述10種可能被一事件來源物件偵測並被以一事件傳輸之事件。第一列與第二列包含“CPU在工作中”(CPU became busy)的相同事件。規則模組120之諸規則需要控制器注意系統狀態的情形，特別要注意“情況”行所示的電池電源負載。既然能存取到電池的電源物件，控制器即能獲得電池的現行狀態以便指揮系統模式。控制器將知悉加諸電池上之電源負載是低或高。規則模組之諸規則根據其結果要求如“行動”(action)行中所示的一特定行動。若加諸電池上之電源負載為低，則規則會要求將CPU置於狀態編號3。若加諸電池上之電源負載為高，則規則會要求將CPU置於狀態編號4。在此特殊範例中，控制器根據由系統狀態(亦即系統情況)及事件

五、發明說明 (20)

反應之規則模組的規則判定是否改變CPU的現行狀態及CPU應被轉換成何種狀態。在此範例中，若加諸電池上之電源負載為低且CPU之現行狀態為狀態編號3，則控制器將決定所需之行動為完全不作任何行動。但在該範例中，若加諸電池之電源負載為高，則CPU會被自狀態編號3切換至狀態編號4。

第三列第四列顯示僅依事件而變的規則模組規則之範例。若CPU為停機狀態，則第三列內之規則要求將CPU置入狀態編號5。當處理該特定規則時，系統之情況是無關緊要的。第六列與第七列提供有關磁碟機之類似範例。

第八列提供一更複雜規則模組之規則的範例。此規則要求控制器根據隨系統狀態、電源物件屬性、及一事件而變的規則模組規則判定是否改變一實體裝置狀態或系統狀態。對此範例而言，事件來源為磁碟機處於停機狀態。此規則實施時的情況要求控制器將磁碟機之電流狀態及由磁碟機電源物件報告之磁碟機屬性二者均列入考量。磁碟機電源物件提供之資訊包括磁碟機旋轉停止所需時間 T_{sd} 、進行此旋轉停止之狀態轉換所消耗之電力 P_{sd} 、磁碟機再度旋轉起來至正常所需時間 T_{su} 、磁碟機為進行此旋轉起來至正常之狀態轉換所消耗之電力 P_{su} 、及磁碟機在維持旋轉狀態期間所消耗之電力 P_s 。如此則控制器可進行“情況”(condition)計算，然後並根據期望的停機時間判定是否需要進行將磁碟機置入狀態編號16的行動。依此方式，電源管理體系設計者產生了一種讓控制器能決定最有效率

(請先閱讀背面之注意事項再填寫本頁)

裝

訂

線

五、發明說明⁽²¹⁾

的行動準則的規則，其方法是衡量比較讓磁碟機維持其現行旋轉狀態所消耗之電力與將磁碟機旋轉停止然後在稍後再使用時再將磁碟旋轉起來至正常所消耗之整體電力。

圖10的範例例示了由本發明之電源管理體系所獲得之彈性。電源物件、事件物件及規則模組全都與控制器一起運作而與電源管理體系所實踐於其上之硬體特定型式無關。根據本發明，電源管理體系之架構與功能提供一種可使用於期望的任何電腦硬體平台內之電源管理系統。故本發明可使用於膝上型電腦內或大量多重處理器系統內。但若要將本發明之電源管理系統實施入一系統內，則諸實體物件須被組態為對應於其被指派之實體裝置的特定屬性。而且不是為某一特定系統設計之廣泛的一般性規則模組不會在一特定應用程式中提昇足夠的效率。故規則模組可被設計成有更配合硬體特性的規則。

現參照圖11，該圖顯示本發明的一種替代性較佳具體實例之次系統關係模式。本發明的該替代性較佳具體實例是一物件導向電源管理體系。電源管理架構（power management framework PMF）200係包括含有電源管理基本結構之物件及裝置的次系統。電源管理事件次系統（power management events subsystem PME）300包括並處理包含諸可產生事件之所有事件物件。PMF 200與PME 300間之關係由連接二者之關係R51、R53、及R52界定。（這些關係將在下文中界定之）。電源管理狀態次系統（power management state subsystem）PMS 400包含界定

五、發明說明 (22)

電源管理之實體狀態及實體轉換的諸物件。PMS 400 透過兩組關係連接至 PMF 200：R42、R43、及 R44 成為一組，而 R40、R41、及 R45 成為第二組。（這些關係亦將在下文中界定之）。

為了要簡化圖 12-14 之敘述，所有的物件及所有的關係均使用一標準格式描述。在圖式中，方塊代表物件而菱形代表二物件間的關係。下文列示諸物件（亦即圖中之方塊）的標準格式：

[#]. [物件名稱]

[物件屬性及其他]

描述：[該物件之描述及其特性]

在各物件描述的下方包括有由該物件提供之屬性的描述。該等屬性之格式如下：

[#].X [關係名稱]

描述：[屬性的解釋]

在圖式中顯示為菱形的諸物件關係亦以下列標準格式表示：

R[#]. [關係]

描述：[該關係的簡單描述]

五、發明說明 (23)

請注意物件名稱前面的辨識號碼和關係名稱前面的辨識號碼對應於圖式中的參考號碼。

使用於圖式中用來辨識諸關係之功能的符號源自眾所熟知的希賴爾－美樂 (Shlaer-Mellor) 符號標示法。此符號標示法在本技術領域中為眾所熟知者。此符號標示法之描述請見希賴爾與美樂在1988年所著之“物件導向系統分析：資料世界的模式化”(Object Oriented Systems Analysis: Modeling The World In Data) 及希賴爾與美樂在1992年所著之“物件生命週期：狀態世界的模式化”(Object Life Cycles: Modeling The World In States)。此處所提供之符號標示法與希賴爾－美樂所使用者僅因箭頭未被使用而稍有差異。取代的標示法是藉將關係連接器的各端用一“1”標示來表示一一對一關係。來自相關的各有關物件之關係名稱被加至連接線並以括號括住。複數表示參與一關係之物件的發生數目且被標以“M”。三種基本複數關係形式為一對一、一對多、及多對多。這些關係係在圖式上使用“1”或“M”來表示。制約性表示以一情境關係決定一物件是否在每一狀況下均須參與一關係，一物件可能在某些狀況下不參與一關係。圖式中以字母“C”表示制約性並被放置在某些時候為真的關係辭詞之後。

現參照圖12-14，下文列述者描述包含於諸圖式中的物件、及電源管理架構對於這些物件如何行為所假設的特定細節。在物件表列之後的是描述諸物件間關係的關係表列

五、發明說明⁽²⁴⁾

。圖 12A 與 12B 顯示電源管理架構並包括其諸物件和諸物件間的關係。圖 13 顯示電源管理狀態次系統並包括其諸物件和諸物件間的關係。圖 14 顯示電源管理事件次系統並包括其諸物件和諸物件間的關係。

■k.power_mgmt. framework Subsystem

之物件及屬性描述

1. Managed_Object

(managed_object_id,
managed_object_type,
containing_envelope_id,
containing_envelope_type)

Description: A Managed_Object is a representative for some number of physical components in the system. As such they are usually associated with other more general components of the system such as device drivers. In the case of device drivers, it is not to be unexpected that a Managed_Object is actually part of the device driver itself. However, from a conceptual point of view and possibly from an interface implementation point of view, they can be thought of as being separate and independent of the device driver. There may also be cases where they are the only "real" interface that the device driver exports. There are usually many Managed_Objects in the system. To some extent the number of Managed_Objects in the system can be determined by the level of support in the underlying physical implementation of the system. However, major functional components of the system will probably implement managed objects regardless of the underlying support of the component. Managed_Objects are usually passive. They present information about themselves to the Power_Management_Policy but do not do anything of their own accord. To do so, the Managed_Object would be taking on some of the responsibility of the Power_Management_Policy which begins to defeat the goal of separation of mechanism and policy.

1.1 Managed_Object.managed_object_id

Description: The attribute that identifies the Managed_Object.

1.2 Managed_Object.managed_object_type

Description: Describes the type of Managed_Object that is represented by the current instance.

1.3 Managed_Object.containing_envelope_id

Description: This is a reference to the Envelope that directly contains the Managed_Object.

五、發明說明 (25)

1.4 Managed_Object.containing_envelope_type

Description: This is a reference to the type of Envelope that directly contains the Managed_Object.

2. Envelope

(managed_object_id,
managed_object_type,
envelope_id,
envelope_type,
controlling_policy_id)

Description: An Envelope is a container type of object. That is, it contains other Managed_Objects. It can contain other Envelopes as well. Envelopes are used to describe the power and thermal distribution topology in the system. They also provide convenient places to provide the connection between individual Managed_Objects and the Power_Management_Policy, since the policies are usually associated with collections of things rather than with individuals. Every Managed_Object is contained within an Envelope, including other Envelopes. There is one exception to this and that is the notion of the *Universal_Envelope*. This Envelope is special in that it is not contained by any other Envelope. It is the outer-most Envelope and it always exists.

2.1 Envelope.managed_object_id

Description: This attribute links the instance of a Managed_Object to an instance of an Envelope.

2.2 Envelope.managed_object_type

Description: This attribute is used to link an instance of Managed_Object to an instance of Envelope.

2.3 Envelope.envelope_id

Description: This is the attribute that identifies an Envelope. It is composed of two fields from the Managed_Object. Both of these fields together define this attribute.

2.4 Envelope.envelope_type

Description: Describes the type of Envelope that is represented by a particular Envelope.

五、發明說明 (26)

2.5 Envelope.controlling_policy_id

Description: This is a reference to the Power_Management_Policy that is responsible for the management of the Envelope and its contents.

3. Event_Source

(managed_object_id,
managed_object_type,
event_source_id,
events_for,
events_for_type,
receiving_policy_id)

Description: Event_Sources are the means by which various types of events about the system (in regards to power and thermal management) are delivered to a Power_Management_Policy. There are several different types of Event_Sources, but regardless of their type an Event_Source falls into either of the following categories. The first category of Event_Sources are those that are associated with other Managed_Objects. In this category of Event_Sources, the Event_Source is responsible for sending events to the Power_Management_Policy on the behalf of the associated Managed_Object. An example of this type of Event_Source would be a power failure signal being generated by a power supply. Another example would be a disk device driver indicating that it had been idle for some number of seconds. The second category of Event_Sources are those that are not associated with another Managed_Object. In this category of Event_Sources, the Event_Source usually represents some source of events that the Power_Management_Policy may be interested in but is not represented by another Managed_Object. An example of this type of Event_Source would be a switch on a lap-top's lid that changes states when the lid is either opened or closed. A Power_Management_Policy may wish to be informed of such an event.

3.1 Event_Source.managed_object_id

Description: This attribute links an instance of Managed_Object to an instance of Event_Source.

3.2 Event_Source.managed_object_type

Description: This attribute links an instance of Managed_Object to an instance of Event_Source.

五、發明說明 (27)

3.3 Event_Source.event_source_id

Description: This is the attribute that identifies an Event_Source. It is composed of two fields from the Managed_Object. Both of these fields together define this attribute.

3.4 Event_Source.events_for

Description: Refers to the Managed_Object that this Event_Source generates events for.

3.5 Event_Source.events_for_type

Description: Refers to the Managed_Object that this Event_Source generates events for.

3.6 Event_Source.receiving_policy_id

Description: Refers to the Power_Management_Policy to which the Event_Source will deliver its events.

4. Physical_Object

(managed_object_id,
managed_object_type,
physical_object_id,
physical_object_type,
current_physical_state_id,
current_physical_state_type,
physical_object_description)

Description: Physical Objects are representatives for the physical characteristics of the underlying system's implementation. They serve to model the characteristics of the system that are "interesting" from a power or thermal management point of view and therefore do not contain all of the characteristics that may be "interesting" from other points of view. The other characteristics are better modeled by other parts of the system (such as device drivers). Physical Objects model two basic characteristics -- power and thermal. Power management is interested in both the power characteristics of a physical entity and its thermal characteristics. In certain systems, management of the thermal aspects of a system may be as important (if not more important) than the power management of the system. From a power management point of view, thermal management is important because it can affect the power consumed by a system. If a system has fans that can be turned on and off based on some thermal criteria (such as internal temperature), the

五、發明說明 (28)

Power_Management_Policy must be aware of this because placing a physical part of the system into a particular power state, may require that one or more fans be turned on which would further increase the power consumption of the system. A Power_Management_Policy must also be aware that in some systems, turning on some part of the system may not exceed the power capacity, but it may exceed the capacity of the system to rid itself of the resultant waste heat that would be generated by that portion of the system.

4.1 Physical_Object.managed_object_id

Description: This attribute links an instance of Managed_Object to an instance of Physical_Object.

4.2 Physical_Object.managed_object_type

Description: This attribute links an instance of Managed_Object to an instance of Physical_Object.

4.3 Physical_Object.physical_object_id

Description: This is the attribute that identifies a Physical_Object. It is composed of two fields from the Managed_Object. Both of these fields together define this attribute.

4.4 Physical_Object.physical_object_type

Description: Describes the type of Physical_Object that is represented by a particular Physical_Object.

4.5 Physical_Object.current_physical_state_id

Description: This attribute references the Physical_State that represents the current state that the Physical_Object is in.

4.6 Physical_Object.current_physical_state_type

Description: This attribute references the Physical_States that represents the current state that the Physical_Object is in.

(請先閱讀背面之注意事項再填寫本頁)

裝

訂

線

五、發明說明 (29)

4.7 Physical_Object.physical_object_description

Description: This attribute describes the Physical_Object. It is used by a Power_Management_Policy to gain additional semantics about the Physical_Object. See the note attached to this attribute.

5. Power_Management_Policy (policy_id)

Description: The exact details of what a Power_Management_Policy does will not be covered here. The rationale for that is that different Power_Management_Policies will have different system parameters that are important and will have different goals for how the system is operated in respect to power and/or thermal management. The Power_Management_Policy will interact with the other objects in the power management subsystem to accomplish its goals.

5.1 Power_Management_Policy.policy_id

Description: This is the attribute that identifies the Power_Management_Policy.

6. Thermal_Envelope (envelope_id, envelope_type, thermal_envelope_id)

Description: A Thermal_Envelope is an Envelope that contains Thermal_Objects. Power_Envelopes are used to describe the thermal topology of the system. A Thermal_Envelope must contain at least one Thermal_Sink and one Thermal_Source.

6.1 Thermal_Envelope.envelope_id

Description: This attribute links an instance of an Envelope with an instance of a Thermal_Envelope.

6.2 Thermal_Envelope.envelope_type

Description: This attribute links an instance of Envelope with an instance of Thermal_Envelope.

五、發明說明 (30)

6.3 Thermal_Envelope.thermal_envelope_id

Description: This attribute uniquely identifies the Thermal_Envelope. It is composed of two fields whose values are taken from the attributes Envelope.envelope_id and Envelope.envelope_type.

7. Power_Envelope

(envelope_id,
envelope_type,
power_envelope_id)

Description: A Power_Envelope is an Envelope that contains Power_Objects. Power_Envelopes are used to describe the power topology of the system. A Power_Envelope must contain at least one Power_Supplier and one Power_Consumer.

7.1 Power_Envelope.envelope_id

Description: This attribute identifies the Envelope to which the Power_Envelope is related.

7.2 Power_Envelope.envelope_type

Description: This attribute links an instance of an Envelope to an instance of a Power_Envelope.

7.3 Power_Envelope.power_envelope_id

Description: This attribute uniquely identifies the Power_Envelope. It is composed of two fields whose values are taken from the attributes Envelope.envelope_id and Envelope.envelope_type.

8. Power_Object

(physical_object_id,
physical_object_type,
power_object_id,
power_object_type,
thermal_object_id,
thermal_object_type,
policy_id,
current_power_state,
containing_power_envelope)

Description: Power_Objects represent the power aspects of a physical component of the system. It is through the manipulation of Power_Objects that a power management

五、發明說明 (31)

policy is implemented (i.e. Power_Objects) are part of the mechanism of power management). In order to give a Power_Management_Policy the greatest latitude in how it is defined (i.e. a Power_Management_Policy does not have to make many assumptions), all of the power (both supply and consumption) in the system must be represented. This prevents power from "appearing" or "disappearing" in the system that the Power_Management_Policy cannot easily account for. Usually an individual Power_Object represents some well defined physical subcomponent of the system. However, in a large complex systems, a Power_Object may represent some logical component of the system. This logical subcomponent may include its own Power_Management_Policy and it is the interactions with the subcomponent's policy that allows the subcomponent to be controlled. This requires that a Power_Object be able to be used as a representative for a Power_Management_Policy.

8.1 Power_Object.physical_object_id

Description: This attribute links an instance of Physical_Object to an instance of Power_Object.

8.2 Power_Object.physical_object_type

Description: This attribute links an instance of Physical_Object to an instance of Power_Object.

8.3 Power_Object.power_object_id

Description: This attribute uniquely identifies the Power_Object. It is composed of two attributes from a Physical_Object, Physical_Object.physical_object_id and Physical_Object.physical_object_type.

8.4 Power_Object.power_object_type

Description: This attribute defines the type of Power_Object that is represented by a particular instance.

8.5 Power_Object.thermal_object_id

Description: This attribute references a Thermal_Object that will represent the thermal aspects of this Power_Object. This attribute provides the linkage between individual Power_Objects and Thermal_Objects to allow for the unification of power and thermal management.

五、發明說明 (32)

8.6 Power_Object.thermal_object_type

Description: This attribute references the type of the Thermal_Object that will represent the thermal aspects of this Power_Object.

8.7 Power_Object.policy_id

Description: This attribute when present, allows for a Power_Management_Policy to be nested and therefore be controlled by other Power_Management_Policies. It allows for a Power_Object to represent a Power_Management_Policy in "outer" envelopes. It is through this representative Power_Object that a Power_Management_Policy can be influenced by another Power_Management_Policy.

8.8 Power_Object.current_power_state

Description: This attribute refers to the Power_State that represents the current state of the Power_Object.

8.9 Power_Object.containing_power_envelope

Description: This is a reference to the Power_Envelope that directly contains the Power_Object.

9. Thermal_Object

(physical_object_id,
physical_object_type,
thermal_object_id,
thermal_object_type,
policy_id,
containing_thermal_envelope,
current_thermal_state)

Description: Thermal_Objects represent the thermal aspects of a physical component of the system. It is through the manipulation of Thermal_Objects that a thermal management policy is implemented (i.e. Thermal_Objects are part of the mechanism for thermal management). In order to give a Power_Management_Policy the greatest latitude in how it is defined (i.e. the Power_Management_Policy does not have to make many assumptions), all of the heat (both generation and dissipation) in the system must be represented. This prevents heat from "appearing" or "disappearing" in the system that the Power_Management_Policy cannot easily account for. Usually an individual Thermal_Object represents some well defined physical subcomponent of the system. However, in large complex systems, a Thermal_Object may represent some

五、發明說明 (33)

logical component of the system. This logical subcomponent may include its own Power_Management_Policy and it is the interactions with the Power_Management_Policy that allows the subcomponent to be controlled. This requires that a Thermal_Object be able to be used as a representative for a Power_Management_Policy.

9.1 Thermal_Object.physical_object_id

Description: This attribute links an instance of Physical_Object to an instance of Thermal_Object.

9.2 Thermal_Object.physical_object_type

Description: This attribute links an instance of Physical_Object to an instance of Thermal_Object.

9.3 Thermal_Object.thermal_object_id

Description: This attribute uniquely identifies a Thermal_Object. It is composed of two fields. These fields obtain their values from Physical_Object.physical_object_id and Physical_Object.physical_object_type.

9.4 Thermal_Object.thermal_object_type

Description: This attribute defines the type of the Thermal_Object.

9.5 Thermal_Object.policy_id

Description: This attribute when present indicates that the Thermal_Object is used as a representative for a Power_Management_Policy. This allows Power_Management_Policies to be nested in Thermal_Envelopes and to be controlled by "outer" Power_Management_Policies by treating the "inner" Power_Management_Policy as a Thermal_Object.

9.6 Thermal_Object.containing_thermal_envelope

Description: This attribute refers to the Thermal_Envelope that contains this Thermal_Object.

五、發明說明 (34)

9.7 Thermal_Object.current_thermal_state

Description: This attribute is a reference to the Thermal_State that represents the current Thermal_State of the Thermal_Object.

10. Power_Consumer

(power_object_id,
power_object_type,
power_consumer_id,
power_supplier_id)

Description: Power_Consumers are the Power_Objects that represent the consumption of power in the system. Usually an individual Power_Consumer represents some well defined physical subcomponent of the system. However, in systems that use nested Envelopes to represent the power distribution topology, a Power_Consumer may have to be used to represent the power consumption needs of a Power_Supplier in one of the inner Envelopes.

10.1 Power_Consumer.power_object_id

Description: This attribute links an instance of Power_Object with an instance of Power_Consumer.

10.2 Power_Consumer.power_object_type

Description: This attribute links an instance of Power_Object to an instance of Power_Consumer.

10.3 Power_Consumer.power_consumer_id

Description: This attribute identifies a Power_Consumer. It is composed of two fields from the Power_Object. Both of these fields together define this attribute.

10.4 Power_Consumer.power_supplier_id

Description: This attribute when present allow; the power consumption needs of a Power_Supplier in an inner Power_Envelope to be represented in an appropriate outer Power_Envelope. This allows the power distribution topology to be represented accurately.

五、發明說明 (35)

11. Power_Supplier

(power_object_id,
power_object_type,
power_supplier_id,
time_vs_power_consumption)

Description: Power_Suppliers are the Power_Objects that represent the supply of power in the system. In systems that use nested Envelopes to represent the power topology, a Power_Consumer will be used in an outer Envelope to represent the Power_Supplier's power consumption in the outer Envelope.

11.1 Power_Supplier.power_object_id

Description: This attribute links an instance of Power_Object to an instance of Power_Supplier.

11.2 Power_Supplier.power_object_type

Description: This attribute links an instance of Power_Object to an instance of Power_Supplier.

11.3 Power_Supplier.power_supplier_id

Description: This attribute uniquely identifies a Power_Supplier. It is composed of two attributes from Power_Object. Both of these attributes together define this attribute.

11.4 Power_Supplier.time_vs_power_consumption

Description: This attribute indicates the length of time that the Power_Supplier can supply power at the indicated power level.

12. Thermal_Source

(thermal_object_id,
thermal_object_type,
thermal_source_id,
thermal_sink_id)

Description: Thermal_Sources are the Thermal_Objects that represent the generation of waste heat in the system. Usually an individual Thermal_Source represents some well defined physical sub-component of the system. However, in systems that use nested Thermal_Envelopes to represent the thermal topology, a Thermal_Source may be used to

五、發明說明 (36)

represent the dissipation of heat from a Thermal_Sink in one of the inner Thermal_Envelopes.

12.1 Thermal_Source.thermal_object_id

Description: This attribute links an instance of a Thermal_Object to an instance of a Thermal_Source.

12.2 Thermal_Source.thermal_object_type

Description: This attribute links an instance of a Thermal_Object to an instance of a Thermal_Source.

12.3 Thermal_Source.thermal_source_id

Description: This attribute identifies the Thermal_Source. It is derived from the attributes Thermal_Source.thermal_object_id and Thermal_Source.thermal_object_type.

12.4 Thermal_Source.thermal_sink_id

Description: This attribute allows a Thermal_Source in an exterior Thermal_Envelope to represent the Thermal_Sink in an interior Thermal_Envelope. This defines the flow of heat from an interior Thermal_Envelope to an exterior Thermal_Envelope.

13. Thermal_Sink

(thermal_object_id,
thermal_object_type,
thermal_sink_id)

Description: Thermal_Sinks are the Thermal_Objects that represent the movement of heat from one portion of the system to another. A Thermal_Envelope must contain at least one Thermal_Sink. It is the content Thermal_Envelopes that describe how the thermal load in a system is dealt with.

13.1 Thermal_Sink.thermal_object_id

Description: This attribute links an instance of a Thermal_Object to an instance of a Thermal_Sink.

五、發明說明 (37)

13.2 Thermal_Sink.thermal_object_type

Description: This attribute links an instance of a Thermal_Object to an instance of a Thermal_Sink.

13.3 Thermal_Sink.thermal_sink_id

Description: This attribute uniquely identifies the Thermal_Sink. It is composed of two fields whose values are obtained from the attributes Thermal_Object.thermal_object_id and Thermal_Object.thermal_object_type.

14. Physical_Object_Dependency

(dependent_upon_object_id,

dependent_upon_object_type,

dependent_object_id,
dependent_object_type)

Description: This object is used to formalize the relationship between two Physical_Objects where one Physical_Object is dependent upon another. The relationship can be such that a dependent Physical_Object can be dependent upon more than one other Physical_Object. A Physical_Object that is dependent upon another can itself be depended upon by a third Physical_Object. A Physical_Object can be dependent upon other Physical_Objects when the first Physical_Object depends upon the other Physical_Object(s) to be in particular state(s) in order for the first Physical_Object to be in a particular state. An example might be with the case of a CPU and memory. The CPU would be dependent upon the state of the memory (i.e. it doesn't make too much sense to have the CPU in a high power state and have the memory turned off).

14.1 Physical_Object_Dependency.dependent_upon_object_id

Description: This attribute refers to the Physical_Object that the Physical_Object is dependent upon.

14.2 Physical_Object_Dependency.dependent_upon_object_type

Description: This attribute refers to the Physical_Object that the other Physical_Object is dependent upon.

五、發明說明 (38)

14.3 Physical_Object_Dependency.dependent_object_id

Description: This attribute refers to the Physical_Object that is dependent upon the other Physical_Object that is identified by this Physical_Object_Dependency.

14.4 Physical_Object_Dependency.dependent_object_type

Description: This attribute refers to the Physical_Object that is dependent upon the other Physical_Object that is identified by this Physical_Object_Dependency.

Relationship Descriptions
for the
mk.power_mgmt.framework Subsystem

R1. Managed_Object is a supertype of Event_Source
Event_Source is a subtype of Managed_Object
Managed_Object is a supertype of Physical_Object
Physical_Object is a subtype of Managed_Object
Managed_Object is a supertype of Envelope
Envelope is a subtype of Managed_Object

R10. Power_Management_Policy (1) controls Envelope (Mc)
Envelope (Mc) is controlled by
Power_Management_Policy (1)

R11. Managed_Object (Mc) is manipulated by
Power_Management_Policy (1)
Power_Management_Policy (1) manipulates
Managed_Object (Mc)

R12. Power_Management_Policy (1c) is represented by
Power_Object (1c)
Power_Object (1c) represents Power_Management_Policy
(1c)

R13. Thermal_Object (1c) represents
Power_Management_Policy (1c)
Power_Management_Policy (1c) is represented by
Thermal_Object (1c)

R14. Power_Object (M) contained in Power_Envelope (1)
Power_Envelope (1) contains Power_Object (M)

五、發明說明 (39)

- R15. Thermal_Object (M) contained in Thermal_Envelope (.)
Thermal_Envelope (1) contains Thermal_Object (M)
- R2. Envelope is a supertype of Thermal_Envelope
Thermal_Envelope is a subtype of Envelope
Envelope is a supertype of Power_Envelope
Power_Envelope is a subtype of Envelope
- R20. Event_Source (Mc) generates events for Managed_Object (1c)
Managed_Object (1c) has events generated by Event_Source (Mc)
- R21. Event_Source (Mc) sends events to Power_Management_Policy (1)
Power_Management_Policy (1) receives events from Event_Source (Mc)
- R22. Physical_Object (Mc) has dependents Physical_Object (Mc)
Physical_Object (Mc) is dependent on Physical_Object (Mc)
- R3. Physical_Object is a supertype of Power_Object
Power_Object is a subtype of Physical_Object
Physical_Object is a supertype of Thermal_Object
Thermal_Object is a subtype of Physical_Object
- R4. Power_Object is a supertype of Power_Consumer
Power_Consumer is a subtype of Power_Object
Power_Object is a supertype of Power_Supplier
Power_Supplier is a subtype of Power_Object
- R40. Physical_State (M) is a state of Physical_Object (1)
Physical_Object (1) contains Physical_State (M)
- R41. Power_State (M) is a state of Power_Object (1)
Power_Object (1) contains Power_State (M)
- R42. Thermal_Object (1) contains Thermal_State (M)
Thermal_State (M) is a state of Thermal_Object (1)
- R43. Physical_Object (1) is currently in Physical_State (1)
Physical_State (1) represents current state of Physical_Object (1)

五、發明說明 (40)

R44. Power_Object (1) is currently in Power_State (1)
 Power_State (1) represents current state of
 Power_Object (1)

R45. Thermal_State (1) represents current state of
 Thermal_Object (1)
 Thermal_Object (1) is currently in Thermal_State (1)

R5. Thermal_Object is a supertype of Thermal_Sink
 Thermal_Sink is a subtype of Thermal_Object
 Thermal_Object is a supertype of Thermal_Source
 Thermal_Source is a subtype of Thermal_Object

R51. Event_Source (1) can generate the events that are
 described by
 Generatable_Event (M)
 Generatable_Event (M) describes the events that can
 be generated by an
 Event_Source (1)

R52. Event (Mc) generated by Event_Source (1)
 Event_Source (1) generates Event (Mc)

R53. Power_Management_Policy (1) receives Event (Mc)
 Event (Mc) is sent to Power_Management_Policy (1)

R6. Power_Object (1) represents the power aspects
 Thermal_Object (1)
 Thermal_Object (1) represents the thermal aspects
 Power_Object (1)

R7. Power_Consumer (1c) is represented inside of the
 envelope by Power_Supplier
 (1)
 Power_Supplier (1) is represented outside of the
 envelope by Power_Consumer
 (1c)

R8. Thermal_Sink (1) is represented outside of the
 envelope by Thermal_Source
 (1c)
 Thermal_Source (1c) is represented inside of the
 envelope by Thermal_Sink
 (1)

R9. Managed_Object (Mc) contained by Envelope (1)
 Envelope (1) contains Managed_Object (Mc)

五、發明說明 (41)

Object and Attribute Descriptions
for the
mk.power_mgmt.events Subsystem

101. Generatable_Event

(generatable_event_id,
generatable_event_type,
event_source_id,
masked)

Description: This object describes a particular type of Event that can be generated by an Event_Source. An Event_Source can potentially generate many different types of Events. Each type of Event is described by a unique Generatable_Event. Generatable Events also control the generation of the Events that it describes.

101.1 Generatable_Event.generatable_event_id

Description: This attribute uniquely identifies a Generatable_Event instance. Each Generatable_Event has its own unique ID.

101.2 Generatable_Event.generatable_event_type

Description: This attribute identifies the type of the Generatable_Event (i.e. what type of Event can be generated). A Generatable_Event can only generate one type of Event.

101.3 Generatable_Event.event_source_id

Description: This attribute references the Event_Source that generates the Events that are described by this Generatable_Event.

101.4 Generatable_Event.masked

Description: This attribute indicates if the Generatable_Event can generate events. If the Generatable_Event is masked, it cannot generate an event. It can only generate events if it is not masked.

五、發明說明 (42)

102. Event

(event_id,
event_type,
generatable_event_id,
generatable_event_type,
event_source_id,
policy_id)

Description: This object is responsible for delivering an asynchronous event to a Power_Management_Policy. The Event carries information about the type of event and any additional information that a Power_Management_Policy would need to interpret the Event.

102.1 Event.event_id

Description: This attribute uniquely identifies an Event.

102.2 Event.event_type

Description: This attribute identifies the type of the Event. The value for this attribute is derived from the attribute Event.generatable_event_type (i.e. the type of the Event must be related to the type of the Generatable_Event).

102.3 Event.generatable_event_id

Description: This attribute refers to the Generatable_Event that is responsible for describing this Event.

102.4 Event.generatable_event_type

Description: This attribute refers to the type of the Generatable_Event that describes this Event.

102.5 Event.event_source_id

Description: This attribute is a reference to the Event_Source that generated the Event based upon one of the Generatable_Events belonging to the Event_Source.

102.6 Event.policy_id

Description: This attribute refers to the Power_Management_Policy that is to receive the Event.

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五、發明說明 (⁴³)

103. Simple_Generatable_Event

(generatable_event_id,
generatable_event_type,
simple_generatable_event_id)

Description: A Simple_Generatable_Event is a Generatable_Event that describes how Simple_Events are generated. Simple_Generatable_Events usually describe some physical sensor in the system. It is the Simple_Generatable_Event that describes the sensor to the system so that its values can be returned to the Power_Management_Policy.

103.1 Simple_Generatable_Event.generatable_event_id

Description: This attribute provides a link between an instance of a Generatable_Event and an instance of a Simple_Generatable_Event.

103.2 Simple_Generatable_Event.generatable_event_type

Description: This attribute provides a link between an instance of a Generatable_Event and an instance of a Simple_Generatable_Event.

103.3 Simple_Generatable_Event.simple_generatable_event_id

Description: This attribute uniquely identifies a Simple_Generatable_Event. It is derived from the attributes Simple_Generatable_Event.generatable_event_id and Simple_Generatable_Event.generatable_event_type.

104. Notification_Generatable_Event

(generatable_event_id,
generatable_event_type,

notification_generatable_event_id,
notification_type)

Description: A Notification_Generatable_Event is a Generatable_Event that is responsible for describing a Notification_Event. A Notification_Event informs a Power_Management_Policy that some event occurred that requires a fairly complex set of data to be sent back to the Power_Management_Policy.

五、發明說明 (44)

104.1 Notification_Generatable_Event.generatable_event_id

Description: This attribute provides a link between an instance of a Generatable_Event and an instance of a Notification_Generatable_Event.

1 0 4 2
Notification_Generatable_Event.generatable_event_type

Description: This attribute provides a link between an instance of a Generatable_Event and an instance of a Notification_Generatable_Event.

1 0 4 3
Notification_Generatable_Event.notification_generatable_event_id

Description: This attribute uniquely identifies an instance of a Notification_Generatable_Event. It is derived from the attributes Notification_Generatable_Event.generatable_event_id and Notification_Generatable_Event.generatable_event_type.

104.4 Notification_Generatable_Event.notification_type

Description: This attribute describes the type of the Notification_Generatable_Event. This attribute also describes the data that is presented to a Power_Management_Policy when a Notification_Event is delivered to it.

105. Threshold_Generatable_Event

(generatable_event_id,
generatable_event_type,

threshold_generatable_event_id,
threshold_value,
threshold_direction)

Description: A Threshold_Generatable_Event is a Generatable_Event that describes how Threshold_Events are generated. Threshold_Events usually describe some attribute of another object that has changed that the Power_Management_Policy is interested in. Usually the Power_Management_Policy is not interested in all changes but only some of them. It would adjust the parameters of a Threshold_Generatable_Event to be informed when the changes are such that the Power_Management_Policy would be interested.

五、發明說明 (45)

105.1 Threshold_Generatable_Event.generatable_event_id

Description: This attribute links an instance of a Generatable_Event to an instance of a Threshold_Generatable_Event.

105.2 Threshold_Generatable_Event.generatable_event_type

Description: This attribute provides a link between an instance of a Generatable_Event and an instance of a Threshold_Generatable_Event.

1 0 5 3
Threshold_Generatable_Event.threshold_generatable_event_id

Description: This attribute uniquely identifies the Threshold_Generatable_Event. It is derived from the attributes Threshold_Generatable_Event.generatable_event_id and Threshold_Generatable_Event.generatable_event_id.

105.4 Threshold_Generatable_Event.threshold_value

Description: This attribute defines the value that when exceeded in the manner described by the attribute Threshold_Generatable_Event.threshold_direction will cause the Event_Source to generate an Event.

105.5 Threshold_Generatable_Event.threshold_direction

Description: The attribute indicates the direction of the change of value that will trigger the sending of an Event.

106. Simple_Event

```
(event_id,
event_type,
simple_event_id,
generated_by,
simple_event_data)
```

Description: A Simple_Event is responsible for delivering an asynchronous event to a Power_Management_Policy. The Simple_Event carries a very limited amount of information about the Event that is being represented.

五、發明說明 (⁴⁶)

106.1 Simple_Event.event_id

Description: This attribute provides a link between an instance of an Event and an instance of a Simple_Event.

106.2 Simple_Event.event_type

Description: This attribute provides a link between an instance of an Event and an instance of a Simple_Event.

106.3 Simple_Event.simple_event_id

Description: This attribute uniquely identifies the Simple_Event. It is derived from the attributes Simple_Event.event_id and Simple_Event.event_type.

106.4 Simple_Event.generated_by

Description: This attribute refers to the Simple_Generatable_Event that is responsible for describing this Simple_Event.

106.5 Simple_Event.simple_event_data

Description: This attribute describes the data that will be delivered to the Power_Management_Policy by the Simple_Event. It usually represents the current state of some sensor in the system.

107. Notification_Event

(event_id,
event_type,
notification_event_id,
generated_by,
notification_event_data)

Description: This object is responsible for delivering an asynchronous ``notification'' event to a Power_Management_Policy. A Notification_Event carries with it information about the Event, specifically the data describing the why the Event was sent. Notification_Events are usually set up to inform the Power_Management_Policy that an event occurred that the Power_Management_Policy should be aware of that cannot be satisfied by either of the other two Event types. Usually the information sent by a Notification_Event is more complex than can be expressed with the other Event types.

五、發明說明 (47)

107.1 Notification_Event.event_id

Description: This attribute provides a link between an instance of an Event and an instance of a Notification_Event.

107.2 Notification_Event.event_type

Description: This attribute provides a link between an instance of an Event and an instance of a Notification_Event.

107.3 Notification_Event.notification_event_id

Description: This attribute uniquely identifies the Notification_Event. It is derived from the attributes Notification_Event.event_id and Notification_Event.event_type.

107.4 Notification_Event.generated_by

Description: This attribute refers to the Notification_Generatable_Event that describes this Notification_Event.

107.5 Notification_Event.notification_event_data

Description: This attribute describes the data that is delivered by the Notification_Event. The data is described by the attribute Notification_Generatable_Event.notification_type.

108. Threshold_Event

(event_id,
event_type,
threshold_event_id,
generated_by,
crossing_direction,
compared_value)

Description: A Threshold_Event object is responsible for delivering an asynchronous event to a Power_Management_Policy. The Threshold_Event informs the Power_Management_Policy that some threshold level has been exceeded. It contains information about the threshold (i.e. the value that caused the event to be generated) that the Power_Management_Policy can use in determining a course of action.

五、發明說明 (48)

108.1 Threshold_Event.event_id

Description: This attribute links an instance of an Event to an instance of a Threshold_Event.

108.2 Threshold_Event.event_type

Description: This attribute links an instance of an Event to an instance of a Threshold_Event.

108.3 Threshold_Event.threshold_event_id

Description: This attribute uniquely identifies the Threshold_Event. It is derived from the attributes Threshold_Event.event_id and Threshold_Event.event_type.

108.4 Threshold_Event.generated_by

Description: This attribute refers to the Threshold_Generatable_Event that is responsible for describing the Threshold_Event.

108.5 Threshold_Event.crossing_direction

Description: This attribute indicates the direction of the change of value that will trigger the sending of an Event.

108.6 Threshold_Event.compared_value

Description: This attribute contains the value that was compared to determine that a threshold had been exceeded.

Relationship Descriptions for the mk.power_mgmt.events Subsystem

- R101. Generatable_Event is a supertype of Simple_Generatable_Event
- Simple_Generatable_Event is a subtype of Generatable_Event
- Generatable_Event is a supertype of Notification_Generatable_Event
- Notification_Generatable_Event is a subtype of Generatable_Event

五、發明說明 (49)

Generatable_Event is a supertype of
Threshold_Generatable_Event
Threshold_Generatable_Event is a subtype of
Generatable_Event

R102. Event is a supertype of Simple_Event
Simple_Event is a subtype of Event
Event is a supertype of Notification_Event
Notification_Event is a subtype of Event
Event is a supertype of Threshold_Event
Threshold_Event is a subtype of Event

R104. Generatable_Event (1) generates an Event (Mc)
Event (Mc) is generated from a Generatable_Event (1)

R105. Simple_Event (Mc) is generated from a
Simple_Generatable_Event (1)
Simple_Generatable_Event (1) generates a
Simple_Event (Mc)

R106. Notification_Event (Mc) is generated from a
Notification_Generatable_Event (1)
Notification_Generatable_Event (1) generates a
Notification_Event (Mc)

R107. Threshold_Event (Mc) is generated from a
Threshold_Generatable_Event (1)
Threshold_Generatable_Event (1) generates a
Threshold_Event (Mc)

R51. Event_Source (1) can generate the events that are
described by
Generatable_Event (M)
Generatable_Event (M) describes events that can be
generated by an
Event_Source (1)

R52. Event (Mc) generated by Event_Source (1)
Event_Source (1) generates Event (Mc)

R53. Power_Management_Policy (1) receives Event (Mc)
Event (Mc) is sent to Power_Management_Policy (1)

五、發明說明 (50)

Object and Attribute Descriptions for the mk.power_mgmt.states Subsystem

201. Physical_state

(physical_state_id,
physical_state_type,
physical_object_id,
physical_object_type,
status,
reliability,
performance)

Description: A Physical_Object may have any number of Physical_States indicating various characteristics about the Physical_Object that a Power_Management_Policy might be interested in. Every Physical_Object has at least one Physical_State. Simple Physical_Objects whose state cannot be changed (at least from a power or thermal management point of view) are specified by having only one Physical_State. Each Physical_State has a number of attributes that describe the state. A state's particular semantic content is defined only by its attributes. For example, one cannot infer anything about a state by its ordinal relationship to other states. For example, for a given Physical_Object that has eight Physical_States, one cannot infer that Physical_State 5 is more or less consuming than Physical_State 4.

201.1 Physical_State.physical_state_id

Description: The attribute that identifies a specific Physical_State.

201.2 Physical_State.physical_state_type

Description: This attribute describes the type of Physical_State that is represented by the current instance.

201.3 Physical_State.physical_object_id

Description: This attribute refers to the Physical_Object to which this state belongs. The Physical_State must be of a type that is compatible with the Physical_Object (i.e. a Thermal_State cannot refer to a Power_Object).

五、發明說明 (51)

201.4 Physical_State.physical_object_type

Description: This attribute refers to the type of Physical_Object to which this state belongs. The Physical_State must be of a type that is compatible with the Physical_Object (i.e. a Thermal_State cannot refer to a Power_Object).

201.5 Physical_State.status

Description: This attribute describes the status of the Physical_State. It indicates how the contents of the other attributes of the Physical_State should be treated. When Physical_State.status is inactive, it means that the Physical_State is not the current state of the Physical_Object that the Physical_State belongs to. When Physical_State.status is active, it means that the Physical_State represents the current state of the Physical_Object that the Physical_State belongs to. When Physical_State.status is transitioning from, it means that the Physical_State was the current state of the Physical_Object but is currently going through a transition to another state. Once the other Physical_State can be made active, this state will be made inactive.

201.6 Physical_State.reliability

Description: This attribute is used to describe the reliability characteristics of a Physical_Object that is in this Physical_State. The use of this attribute is to allow a Power_Management_Policy to determine if for system reliability reasons it should place a Physical_Object into a Physical_State.

Domain: It may be as simple as a simple measure of Mean-Time-Between-Failures (MTBF). It may allow for some more complex expression of the reliability of the Physical_Object in this Physical_State.

201.7 Physical_State.performance

Description: This attribute is used to describe the performance characteristics of a Physical_State. The use of this attribute is to allow a Power_Management_Policy to determine if the cost of being in a particular Physical_State is warranted. This allows a Power_Management_Policy to computer performance versus power or thermal trade-offs in a meaningful and general way.

五、發明說明 (52)

202. Physical_Transition

```
(starting_state_id,
starting_state_type,
ending_state_id,
ending_state_type,
physical_transition_id,
physical_transition_type,
reliability,
transition_time,
status)
```

Description: Physical_Transitions allow for a general means of describing how a Physical_Object is transitioned from one Physical_State to another. Since it is often the case that the transitions are not of zero cost (i.e. they have characteristics that are distinct from both the starting and ending states) and often do not take zero time, Physical_Transitions have associated with them attributes that are necessary to describe the transition so that a Power_Management_Policy does not have to make assumptions about the costs that may be associated with a particular transition. Physical_Transitions are unidirectional only. That is, they describe a one-way arc from the starting state to the ending state. This was done because it is often the case that going from one state (state A) to another state (state B) often has different costs with it than when it goes from state B to state A. There are also cases where it may be possible to go from state A to state B, but there is no direct way from state B back to state A (i.e. a Physical_Object may have to go from state B to state C and then to state A). A Physical_Object must have a complete set of Physical_Transitions created which describes each transition for each state in the Physical_Object.

202.1 Physical_Transition.starting_state_id

Description: This attribute refers to the Physical_State from which the Physical_Transition is to start from. The type of the Physical_Transition must match the type of the Physical_Object. That is, if the starting Physical_State is a Power_State, then the Physical_Transition must be a Power_Transition.

202.2 Physical_Transition.starting_state_type

Description: This attribute refers to the type of the Physical_State from which the Physical_Transition is to start from. The type of the Physical_Transition must match the type of the Physical_Object. That is, if the starting Physical_State is a Power_State, then the Physical_Transition must be a Power_Transition.

五、發明說明 (53)

202.3 Physical_Transition.ending_state_id

Description: This attribute refers to the Physical_State to which this Physical_Transition will end in. The type of the Physical_Transition must match the type of the ending Physical_State. That is, if the ending Physical_State is a Power_State, then the Physical_Transition must be a Power_Transition.

202.4 Physical_Transition.ending_state_type

Description: This attribute refers to the type of Physical_State to which this Physical_Transitions will end in. The type of the Physical_Transition must match the type of the ending Physical_State. That is, if the ending Physical_State is a Power_State, then the Physical_Transition must be a Power_Transition.

202.5 Physical_Transition.physical_transition_id

Description: This is the attribute that defines the specific instance of a Physical_Transition.

202.6 Physical_Transition.physical_transition_type

Description: This attribute defines the type of the Physical_Transition.

202.7 Physical_Transition.reliability

Description: This attribute is used to describe the reliability characteristics of a Physical_Object as it makes a transition from one Physical_State to another. The use of this attribute is to allow a Power_Management_Policy to determine if for system reliability reasons, it should or should not make the transition from one Physical_State to another. There are a number of physical devices that are very reliable when left in any of a number of states, but can fail prematurely when switched often between those states. This gives a policy additional information that it can use to determine how often it should switch objects from one state to another.

202.8 Physical_Transition.transition_time

Description: This attribute is used to describe the amount of time that it takes for the Physical_Object to

五、發明說明 (54)

make the transition from the starting state to the ending state. There are a number of physical devices where this time is not insignificant. This allows a policy to determine if the expected work load warrants the transition from one state to another.

202.9 Physical_Transition.status

Description: This attribute indicates the status of the Physical_Transition. When the value of Physical_Transition.status is inactive, the Physical_Transition is not being used to transition between Physical_States at this time. When the value of Physical_Transition.status is active, the Physical_Transition is currently being used to transition between one Physical_State and another. Once the transition has been made, the value of Physical_Transition.status is set back to inactive.

203. Power_State

(physical_state_id,
physical_state_type,
power_state_id,
thermal_state_id,
power_object_id,
power_object_type,
power_value,
status)

Description: A Power_State allows the power consumption (or supply) of a Power_Object to be quantified. A Power_Object will have as many Power_States as necessary to represent all of the levels of power consumption (or supply) that may occur in the Power_Object. A Power_State also refers to a Thermal_State so that a Power_Management_Policy can quickly reference the thermal characteristics of a Power_Object in a particular Power_State if that information is required.

203.1 Power_State.physical_state_id

Description: This attribute links an instance of Physical_State to an instance of Power_State.

203.2 Power_State.physical_state_type

Description: This attribute links an instance of Physical_State to an instance of Power_State.

五、發明說明 (55)

203.3 Power_State.power_state_id

Description: This is the attribute that identifies a Power_State. It is composed of two attributes from the Power_State. Both of these fields together define the value of this attribute.

203.4 Power_State.thermal_state_id

Description: This attribute is a reference to the Thermal_State that represents the thermal attributes of a Power_Object being in a Power_State. Different Power_States may cause the Power_Object to be in different Thermal_States (as defined by the Power_Object's related Thermal_Object). The changing from one Power_State to another, may or may not cause a new Thermal_State to be entered. This reference allows for a simple correspondence to exist between a Power_State and a Thermal_State.

203.5 Power_State.power_object_id

Description: This attribute refers to the Power_Object that this Power_State belongs to.

203.6 Power_State.power_object_type

Description: This attribute refers to the type of the Power_Object that this Power_State belongs to.

203.7 Power_State.power_value

Description: This attribute is used to describe the power consumption of a Power_Object in this Power_State. It may be a simple pre-computed value that represents average (expected) power consumption. It may represent a minimum, maximum and average power consumption. It could be as complex as a computed value function where the Power_Object would compute the power consumption based upon some factors that the Power_Object is aware of (such as the current or expected work it is to do or by querying the underlying hardware implementation).

203.8 Power_State.status

Description: This attribute describes the status of an instance of a Power_State.

五、發明說明 (56)

204. Thermal_State

```
(physical_state_id,
physical_state_type,
thermal_state_id,
thermal_object_id,
thermal_object_type,
status,
thermal_value,
time_at_thermal_level)
```

Description: A Thermal_State allows the thermal characteristics of a Thermal_Object to be quantified. A Thermal_Object will have as many Thermal_States as necessary to represent all of the thermal levels that may occur in the Thermal_Object. A Thermal_State also refers to a Power_State so that a Power_Management_Policy may quickly reference the power characteristics of a Thermal_Object in a particular Thermal_State if that information is required.

204.1 Thermal_State.physical_state_id

Description: This attribute provides a link between an instance of a Physical_State and an instance of a Thermal_State.

204.2 Thermal_State.physical_state_type

Description: This attribute provides a link between an instance of a Physical_State and an instance of a Thermal_State.

204.3 Thermal_State.thermal_state_id

Description: This attribute identifies the Thermal_State. It is derived from the attributes Thermal_State.physical_state_id and Thermal_State.physical_state_type.

204.4 Thermal_State.thermal_object_id

Description: This attribute refers to the Thermal_Object to which this Thermal_State belongs.

204.5 Thermal_State.thermal_object_type

Description: This attribute refers to the type of Thermal_Object that this Thermal_State is a part of.

五、發明說明 (57)

204.6 Thermal_State.status

Description: This attribute describes the status of a particular Thermal_State.

204.7 Thermal_State.thermal_value

Description: This attribute describes the thermal load that is placed on the system by the Thermal_Object when it is in this Thermal_State.

204.8 Thermal_State.time_at_thermal_level

Description: This attribute describes the amount of time that the Thermal_Object can remain in this Thermal_State.

205. Power_Transition

(physical_transition_id,
physical_transition_type,
starting_power_state,
ending_power_state,
power_transition_id,
power_value)

Description: A Power_Transition describes the attributes of a transition from one Power_State to another Power_State. In addition to the characteristics described by a Physical_Transition, a Power_Transition contains a description of the power requirements of the Power_Object while it is in transition from one Power_State to another.

205.1 Power_Transition.physical_transition_id

Description: This attribute links an instance of Physical_Transition to an instance of Power_Transition.

205.2 Power_Transition.physical_transition_type

Description: This attribute links an instance of Physical_Transition to an instance of Power_Transition.

205.3 Power_Transition.starting_power_state

Description: This attribute refers to the Power_State to which this Power_Transition starts from.

五、發明說明 (58)

205.4 Power_Transition.ending_power_state

Description: This attribute refers to the Power_State to which this Power_Transition will end in.

205.5 Power_Transition.power_transition_id

Description: This attribute uniquely identifies the Power_Transition. It is composed of two attributes whose values are received from the Physical_Transition.

205.6 Power_Transition.power_value

Description: This attribute describes the power requirements to effect the transition from one Power_State to another. The value described by this attribute applies during the entire transition (i.e. for as long as it actually takes to make the transition).

206. Thermal_Transition

(physical_transition_id,
physical_transition_type,
starting_thermal_state,
ending_thermal_state,
thermal_transition_id,
thermal_value)

Description: A Thermal_Transition describes the attributes of a transition from one Thermal_State to another Thermal_State. In addition to the characteristics that are described by a Physical_Transition, a Thermal_Transition contains a description of the thermal requirements of the Thermal_Object while it is in transition from one Thermal_State to another.

206.1 Thermal_Transition.physical_transition_id

Description: This attribute links an instance of a Physical_Transition to an instance of a Thermal_Transition.

206.2 Thermal_Transition.physical_transition_type

Description: This attribute links an instance of a Physical_Transition to an instance of a Thermal_Transition.

五、發明說明 (⁵⁹)

206.3 Thermal_Transition.starting_thermal_state

Description: This attribute refers to the Thermal_State that this Thermal_Transition starts from.

206.4 Thermal_Transition.ending_thermal_state

Description: This attribute refers to the Thermal_State that this Thermal_Transition will end in.

206.5 Thermal_Transition.thermal_transition_id

Description: This attribute identifies a Thermal_Transition. It is derived from the attributes Thermal_Transition.physical_transition_id and Thermal_Transition.physical_transition_type.

206.6 Thermal_Transition.thermal_value

Description: This attribute describes the thermal load that the Thermal_Object places on the remainder of the system when it is going through this Thermal_Transition.

207. Physical_State_Dependency

(dependent_upon_state_id,
dependent_upon_state_type,
dependent_state_id,
dependent_state_type)

Description: This object is used to formalize the relationship between two Physical_States where one is dependent upon another. The Physical_States must belong to different Physical_Objects. The relationship can be such that a dependent Physical_State can be dependent upon more than one other Physical_State (in different Physical_Objects). A Physical_State that is dependent upon another can itself be depended upon by a third Physical_State.

207.1 Physical_State_Dependency.dependent_upon_state_id

Description: This attribute refers to the Physical_State that the Physical_State is dependent upon.

207.2 Physical_State_Dependency.dependent_upon_state_type

Description: This attribute refers to the Physical_State that the other Physical_State is dependent upon.

五、發明說明 (60)

207.3 Physical_State_Dependency.dependent_state_id

Description: This attribute refers to the Physical_State this is dependent upon the other Physical_State that is identified by this Physical_State_Dependency.

207.4 Physical_State_Dependency.dependent_state_type

Description: This attribute refers to the Physical_State that is dependent upon the other Physical_State that is identified by this Physical_State_Dependency.

Relationship Descriptions for the mk.power_mgmt.states Subsystem

R201. Physical_State (Mc) represents the transitions from Physical_State (Mc)

Physical_State (Mc) represents the transitions to Physical_State (Mc)

R202. Power_State (Mc) represents the transitions from Power_State (Mc)

Power_State (Mc) represents the transitions to Power_State (Mc)

R203. Physical_State is a supertype of Power_State

Power_State is a subtype of Physical_State

Physical_State is a supertype of Thermal_State

Thermal_State is a subtype of Physical_State

R204. Physical_Transition is a supertype of Thermal_Transition

Thermal_Transition is a subtype of Physical_Transition

Physical_Transition is a supertype of Power_Transition

Power_Transition is a subtype of Physical_Transition

R205. Thermal_State (1) represents the transitions to Thermal_State (1)

Thermal_State (1) represents the transitions from Thermal_State (1)

五、發明說明 (61)

R206. Power_State (1) represents power aspects of Thermal_State (1)

Thermal_State (1) represents thermal aspects of Power_State (1)

R212. Physical_State (Mc) is dependent on Physical_State (Mc)

Physical_State (Mc) has dependent states Physical_State (Mc)

R40. Physical_Object (1) contains Physical_State (M)
Physical_State (M) is a state of Physical_Object (1)

R41. Power_Object (1) contains Power_State (M)
Power_State (M) is a state of Power_Object (1)

R42. Thermal_Object (1) contains Thermal_State (M)
Thermal_State (M) is a state of Thermal_Object (1)

R43. Physical_Object (1) is currently in Physical_State (1)
Physical_State (1) represents current state of Physical_Object (1)

R44. Power_Object (1) is currently in Power_State (1)
Power_State (1) represents current state of Power_Object (1)

R45. Thermal_Object (1) is currently in Thermal_State (1)
Thermal_State (1) represents current state of Thermal_Object (1)

上文中對本發明的一種較佳具體實例之敘述係依一物件導向實施方式描述。精於本技術領域者當瞭解本發明可使用異於物件導向之許多種軟體規劃技術來實施。上文所述之物件可利用依本發明所述相同的方法運作及互動之眾

五、發明說明 (62)

多資料組和軟體模組而實現。雖然物件導向具體實例是較佳的，但本發明並不受限於此一具體實例。

根據本發明，包含於電源包封內之各個實體物件、電源物件、和熱量物件將諸受管理實體裝置的各種屬性傳輸以表現電源管理體系正在管理之實際實體系統的模型。電源物件傳送有關一實體裝置的電力消耗或使用情況的資訊。熱量物件傳送有關熱量情況或熱傳輸之資訊。電源物件將資訊提供予電源管理控制器，該資訊包括該實體裝置各可能狀態的電力需求、該裝置可自任何既定狀態轉換往的任何及所有次一可能狀態、及往該次一狀態之轉換所需之轉換電力成本。控制器可自此資訊建立受管理系統之架構。

一種更精緻的電源管理體系會把有關係統中各個實體裝置的額外資訊或屬性列入考量以便設計受管理系統之更複雜架構。可能由電源物件提供之額外屬性可為裝置的信賴性或自一特定狀態轉換至另一狀態所需的時間。電源物件亦能夠判定其對應實體裝置的現正被佔據之狀態或“現行狀態”並接著將該現行狀態通知控制器。控制器根據全部現行狀態的集合即可建立在一特定時間下存在之“系統狀態”的模態。

控制器亦可與事件物件溝通。實體系統中一真實事件將由事件來源物件產生一事件來源信號。實體事件的範例有：CPU 維持停機達一臨限時期、磁碟機接收一臨限量個存取磁碟資料的要求、及一鍵盤按鍵動作。當此類事件發生時，控制器須判定是否要因應於該事件而改變系統狀態。

五、發明說明 (63)

控制器係根據由規則模組提供之規則做此判斷。規則模組的規則是事件、系統狀態、及由電源或熱量物件提供之資訊或屬性的函數。接收到的事件信號引發某些規則。這些規則依該系統狀態在由該電源物件界定之架構內可被容許之可能改變分析系統狀態模式。根據這些被電源管理設計者所組織成的規則，控制器被指揮執行一行動，從而實施電源管理。此行動可能要求不對系統狀態作改變、或要求該等許多個實體裝置中的任何一個之狀態被改變。

當意圖建構一更普及的電源管理體系時，請注意亦應將熱量負載及特性納入考量，因為其會對系統內使用之電源有某種影響。例如當系統之內部溫度上昇時，須打開一個或更多個風扇。由於系統內之電力消耗與熱量產生經常是密切地關聯，故將電源管理的概念擴充以包括熱量管理是很合理的。趨勢的演變使在許多情況下，需要熱量管理的機制類似於需要電源管理的機制，特別是在重要的情況時為然（亦即低電力及超過熱量限制需要類似的機制與規則）。

本發明之電源管理體系旨在夠普及且週密以涵蓋所有要實施電源管理之系統型式。為達此目的，該體系被分割成由實體物件及事件物件構成之機制與包含在一特定系統上實施電源管理體系所需規則之規則模組。該機制對可能使用它們的規則模組沒有概念。電源管理規則模組亦對其下之機制無特定的瞭解。電源管理之控制器藉使用由機制提供之界面根據規則模組之規則及機制的諸物件影響系統之

(請先閱讀背面之注意事項再填寫本頁)

裝

訂

線

五、發明說明 (64)

電力使用改變。

雖然本發明是參照一較佳具體實例而特別顯示並敘述，
精於此技術領域者當瞭解其中可進行許多種形式及細節的
改變而不背離本發明之精神與範疇。

(請先閱讀背面之注意事項再填寫本頁)

裝

訂

線

四、中文發明摘要(發明之名稱: 供一資料處理系統用之電源管理之方法及系統)

在一資料處理系統內之一電源管理架構包括具有至少一種狀態之實體裝置，每一狀態有對應的電源值，且其中一系統狀態被界定為實體裝置的全部現行狀態之集合。各對應於一實體裝置的電源物件及熱量物件包含有關該實體裝置每一可能狀態之電源需求及熱量特性資訊。電源及熱量物件亦描述被容許自各可能狀態至另一狀態的狀態轉換及所有可能狀態轉換之電源需求和熱量特性。各實體裝置的現行狀態亦被傳輸。事件裝置產生代表系統內一事件發生之信號。一規則模組包含有實施電源管理指揮一行動的規則，該等規則為諸事件及電源物件資訊之函數。一與諸實體裝置、熱量和電源事件、事件裝置、及規則模組溝通之控制器因應於一事件而改變諸實體裝置中任一實體裝置的

英文發明摘要(發明之名稱: "METHOD AND SYSTEM OF POWER MANAGEMENT FOR A DATA PROCESSING SYSTEM")

A power management architecture in a data processing system comprising physical devices having at least one state, each state has corresponding power value, and where a system state is defined as the set of all current states of the physical devices. Power objects and thermal objects, each corresponding to a physical device, contain information about the power requirements and thermal characteristics of each possible state for that physical device. The power and thermal objects also describe the allowed state transitions from each possible state to another state, and the power requirements and thermal characteristics of all possible state transitions. Also communicated is the current state of each physical device. Event means generate signals indicating the occurrence of an event in the system. A policy module contains rules, implementing the power management, that direct an action, the rules being a function of events and of power object

四、中文發明摘要（發明之名稱：

狀態。該控制器根據規則模組之規則而決定是否改變一實體裝置狀態。

英文發明摘要（發明之名稱：

information. A controller, in communication with the physical devices, the thermal and power objects, the event means, and the policy module, changes the state of any one of the physical devices in response to an event. The controller determines whether to change a physical device state based on the policy module rules.

六、申請專利範圍

1. 一種在資料處理系統內之電源管理體系，該電源管理體系包括：

許多個實體裝置，每個實體裝置或為電力消耗者或為電力供應者，其中各實體裝置有至少一個狀態，且其中各狀態有一對應電力值，且其中該系統狀態是該等許多個實體裝置的現行狀態之集合；

許多個物件，每個物件對應至一實體裝置，其中一物件包含有關該實體裝置每一可能狀態之電源需求及該實體裝置現行狀態的資訊；

用來產生代表一事件之信號的事件裝置；

一包含指揮一行動之規則的規則模組，該等規則為事件與物件資訊之函數；及

一控制器，該控制器與實體裝置、物件、事件裝置及規則模組溝通以因應於一代表一事件之信號而改變該等許多個實體裝置中任一實體裝置的狀態，該控制器根據規則模組的諸規則、事件信號、及物件資訊而判定是否改變一實體裝置狀態。

2. 根據申請專利範圍第1項之在資料處理系統內的電源管理體系，其中該物件資訊代表實體裝置的實體特性之模型，該模型被控制器在判定是否改變一實體裝置狀態時使用。

3. 根據申請專利範圍第1項之在資料處理系統內的電源管理體系，該電源管理體系進一步包括許多個用來將許多個物件依邏輯分群的包封物件，該包封物件提供表示其

(請先閱讀背面之注意事項再填寫本頁)

裝

訂

線

六、申請專利範圍

所包含之物件及該等物件係何種型式之資訊。

4. 根據申請專利範圍第3項之在資料處理系統內的電源管理體系，該電源管理體系進一步包括一包封規則模組以便管理包含於一包封物件內之諸物件，該包封規則模組包含指揮由諸對應於包括在包封物件內之諸物件的諸實體裝置執行的行動之規則，該等規則是一事件及來自被依邏輯分群之包封物件內的許多個物件之物件資訊的函數。
5. 根據申請專利範圍第3項之在資料處理系統內的電源管理體系，其中至少一包封物件依邏輯方式將諸電源物件分群。
6. 根據申請專利範圍第1項之在資料處理系統內的電源管理體系，其中一物件可產生一代表一事件之信號。
7. 根據申請專利範圍第1項之在資料處理系統內的電源管理體系，其中一物件包含有關於可被容許自各可能狀態至另一狀態之狀態轉換及所有可能狀態轉換之電力需求的資訊。
8. 根據申請專利範圍第7項之在資料處理系統內的電源管理體系，其中一物件包含有關於進行諸可被容許之狀態轉換所需時間的資訊。
9. 根據申請專利範圍第1項之在資料處理系統內的電源管理體系，其中一物件包含有關於對應實體裝置的信賴性之資訊。
10. 根據申請專利範圍第1項之在資料處理系統內的電源管

(請先閱讀背面之注意事項再填寫本頁)

裝

訂

線

六、申請專利範圍

理體系，其中該事件裝置包括至少一事件來源物件，該事件來源物件連接至一實體裝置。

11. 根據申請專利範圍第1項之在資料處理系統內的電源管理體系，其中該事件裝置包括諸物件，且其中一個或更多個物件產生代表系統狀態改變之信號。

12. 根據申請專利範圍第1項之在資料處理系統內的電源管理體系，其中該等實體裝置包括磁碟機、中央處理單元、顯示器、鍵盤、及電池電源供應器。

13. 根據申請專利範圍第1項之在資料處理系統內的電源管理體系，其中一物件包括有關於對應實體裝置的效能之資訊。

14. 一種在資料處理系統內之電源管理方法，該方法包括下列諸步驟：

自許多個物件獲取物件資訊，其中各對應於一實體裝置的一物件包含有關於該實體裝置的各可能狀態之電力需求及該實體裝置現行狀態之資訊，且其中該系統狀態是所有實體裝置現行狀態之集合；

自一規則模組獲取電源管理規則；

接收一代表一事件或系統狀態內一改變之信號；及

因應於該事件或系統狀態之改變而改變至少一實體裝置的狀態，被執行之狀態改變型式是藉應用為事件、系統狀態、及物件資訊之函數的電源管理規則而決定。

15. 根據申請專利範圍第14項之在資料管理系統內的電源管理方法，其中該物件資訊被解釋以形成代表諸裝置實體

(請先閱讀背面之注意事項再填寫本頁)

裝

訂

線

六、申請專利範圍

特性之實體裝置模型，該模型被用於應用諸規則中。

16. 一種在資料處理系統內的電源管理體系，該體系包括：

許多個實體裝置，每個實體裝置或則為熱量來源或則為熱量消散器，其中各實體裝置至少有一狀態，且其中各狀態有一對應熱量值，且其中系統狀態係該等許多個實體裝置現行狀態的集合；

許多個各對應於一實體裝置的物件，其中一物件包含有關於該實體物件各可能狀態之熱量需求及該實體裝置現行狀態之資訊；

用以產生代表一事件之信號的事件裝置；

一包含指揮一行動之規則的規則模組，該等規則為事件及物件資訊的函數；及

一控制器，該控制器與實體裝置、物件、事件裝置及規則模組溝通以因應於一代表一事件之信號而改變該等許多個實體裝置中任一個實體裝置的狀態，該控制器根據規則模組的規則、事件信號及物件資訊而判斷是否改變一實體裝置狀態。

17. 根據申請專利範圍第16項之在資料處理系統內的電源管理體系，其中該物件資訊代表諸實體裝置的實體特性之模型，該模型被控制器在判斷是否改變一實體裝置狀態時使用。

18. 根據申請專利範圍第16項之在資料處理系統內的電源管理體系，進一步包括許多個用來依邏輯方式將許多個物件分群的包封物件，該包封物件提供表示其所包含之物

(請先閱讀背面之注意事項再填寫本頁)

裝

訂

線

六、申請專利範圍

件及該等物件係何種型式的資訊。

19. 根據申請專利範圍第18項之在資料處理系統內的電源管理體系，進一步包括一包封規則模組用來管理包含於一包封物件內之諸物件，該包封規則模組包括指揮由對應於包含在包封物件內之諸物件之實體裝置執行的行動之規則，該等規則為一事件及來自在包封物件內依邏輯方式分群之許多個物件的物件資訊之函數。

20. 根據申請專利範圍第18項之在資料處理系統內的電源管理體系，其中至少一包封物件依邏輯方式將熱量物件集群。

21. 根據申請專利範圍第16項之在資料處理系統內的電源管理體系，其中一物件可產生一事件來源。

22. 根據申請專利範圍第16項之在資料處理系統內的電源管理體系，其中一物件描述自各可能狀態至另一狀態之被容許的狀態轉換及在諸狀態間所有可能的狀態轉換之熱量需求。

23. 根據申請專利範圍第22項之在資料處理系統內的電源管理體系，其中一物件包含有關於進行諸被容許的狀態轉換所需時間之資訊。

24. 根據申請專利範圍第16項之在資料處理系統內的電源管理體系，其中一物件包含有關於對應實體裝置的信賴性之資訊。

25. 根據申請專利範圍第16項之在資料處理系統內的電源管理體系，其中的事件裝置為至少一事件來源物件，該事

(請先閱讀背面之注意事項再填寫本頁)

裝

訂

線

六、申請專利範圍

件來源物件連接至實體裝置。

26. 根據申請專利範圍第16項之在資料處理系統內的電源管理體系，其中該事件裝置包含有物件，且其中一個或更多個物件產生代表系統狀態改變之信號。

27. 根據申請專利範圍第16項之在資料處理系統內的電源管理體系，其中諸實體裝置包括磁碟機、中央處理單元、顯示器、鍵盤、及電池電源供應器。

28. 根據申請專利範圍第16項之在資料處理系統內的電源管理體系，其中一物件包含有關於對應實體裝置的效能之資訊。

29. 一種在資料處理系統內的電源管理體系，該體系包括：
許多個實體裝置，其中每個實體裝置有至少一個狀態，且其中每一狀態有一對應熱量值及一對應電源值，且其中的系統狀態為該等許多個實體裝置的現行狀態之集合；

許多個各對應於一實體裝置的熱量物件，其中一熱量物件包含有關於該實體裝置各可能狀態之熱量需求及該實體裝置的現行狀態之資訊；

許多個各對應於一實體裝置的電源物件，其中一電源物件包含有關於該實體裝置各可能狀態之電源需求及該實體裝置的現行狀態之資訊；

用以產生代表一事件之信號的事件裝置；

一包含指揮一行動之諸規則的規則模組，該等規則為事件、熱量物件資訊及電源物件資訊之函數；及

(請先閱讀背面之注意事項再填寫本頁)

裝

訂

線

六、申請專利範圍

一 控制器，該控制器與實體裝置、熱量物件、電源物件、事件裝置及規則模組溝通以因應於一代表一事件之信號而改變該等許多個實體裝置中任一實體裝置的狀態，該控制器根據規則模組之諸規則、事件信號及物件資訊而判斷是否改變一實體裝置狀態。

30. 根據申請專利範圍第29項之在資料處理系統內的電源管理體系，其中物件資訊代表實體裝置實體特性的模型，該模型由控制器在判斷是否改變一實體裝置狀態時使用。

31. 根據申請專利範圍第29項之在資料處理系統內的電源管理體系，進一步包括許多個包封物件，該等包封物件被用來將許多個實體物件依邏輯方式分群，該包封物件提供表示其所包含之諸實體物件及該等物件屬何種物件型式之資訊。

32. 根據申請專利範圍第31項之在資料處理系統內的電源管理體系，進一步包括一包封規則模組，該包封規則模組被用來管理包含於一包封物件內之物件，該包封規則模組包括指揮由對應於包含在包封物件內諸物件之諸實體裝置執行之行動的規則，該等規則為一事件及來自被依邏輯方式分群於一包封物件內之許多個物件的物件資訊之函數。

33. 根據申請專利範圍第31項之在資料處理系統內的電源管理體系，其中至少一個包封物件依邏輯方式將諸實體物件分群，其中該等實體裝置包括熱量物件及電源物件。

(請先閱讀背面之注意事項再填寫本頁)

裝

訂

線

六、申請專利範圍

34. 根據申請專利範圍第29項之在資料處理系統內的電源管理體系，其中至少一個熱量物件及至少一個電源物件可產生一代表一事件之信號。
35. 根據申請專利範圍第29項之在資料處理系統內的電源管理體系，其中各電源物件描述自各可能狀態至另一狀態之被容許的狀態轉換及諸狀態間所有可能狀態轉換之電源需求，且其中各熱量物件描述各自可能狀態至另一狀態之被容許的狀態轉換及在諸狀態間所有可能狀態轉換之熱量需求。
36. 根據申請專利範圍第29項之在資料處理系統內的電源管理體系，其中諸實體裝置包括磁碟機、中央處理單元、顯示器、鍵盤、及電池電源供應器。
37. 根據申請專利範圍第35項之在資料處理系統內的電源管理體系，其中各熱量物件及各電源物件包含有關於對應進行諸被容許之狀態轉換所需的時間之資訊。
38. 根據申請專利範圍第29項之在資料處理系統內的電源管理體系，其中至少一電源物件及一至少一熱量物件包含有關於對應實體裝置信賴性之資訊。
39. 根據申請專利範圍第29項之在資料處理系統內的電源管理體系，其中該事件裝置包括熱量物件及電源物件，且其中一個或更多個熱量物件產生代表系統狀態改變之信號，且其中一個或更多個電源物件產生代表系統狀態改變之信號。
40. 根據申請專利範圍第29項之在資料處理系統內的電源管

(請先閱讀背面之注意事項再填寫本頁)

裝

訂

泉

六、申請專利範圍

理體系，其中的事件裝置為至少一個事件來源物件，該事件來源物件連接至一實體裝置。

41. 根據申請專利範圍第29項之在資料處理系統內的電源管理體系，其中該等實體裝置包括磁碟機、中央處理單元、顯示器、鍵盤、及電池電源供應器。
42. 根據申請專利範圍第29項之在資料處理系統內的電源管理體系，其中一物件包含有關於對應實體裝置效能之資訊。

(請先閱讀背面之注意事項再填寫本頁)

裝

訂

錄

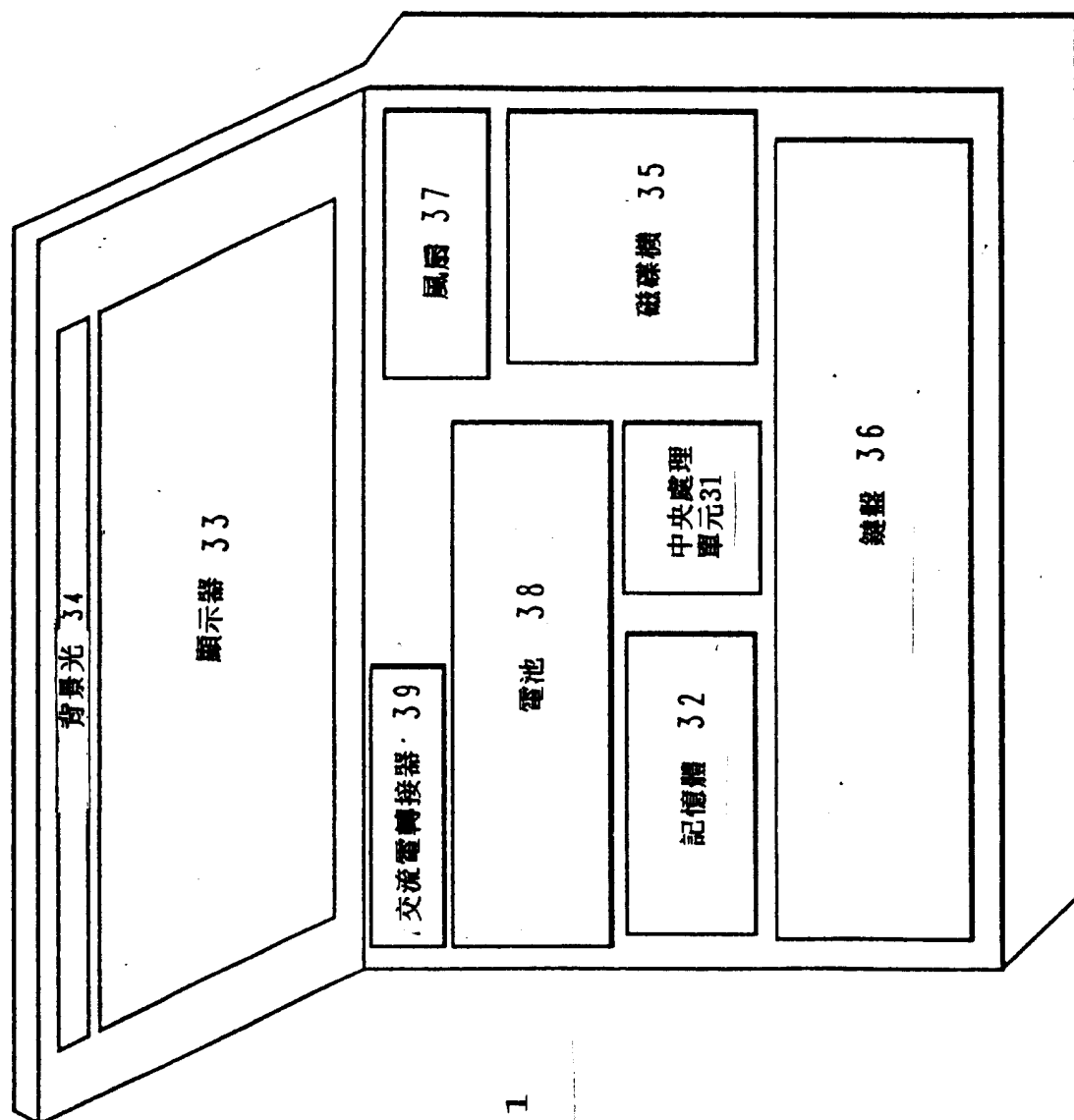


圖 1

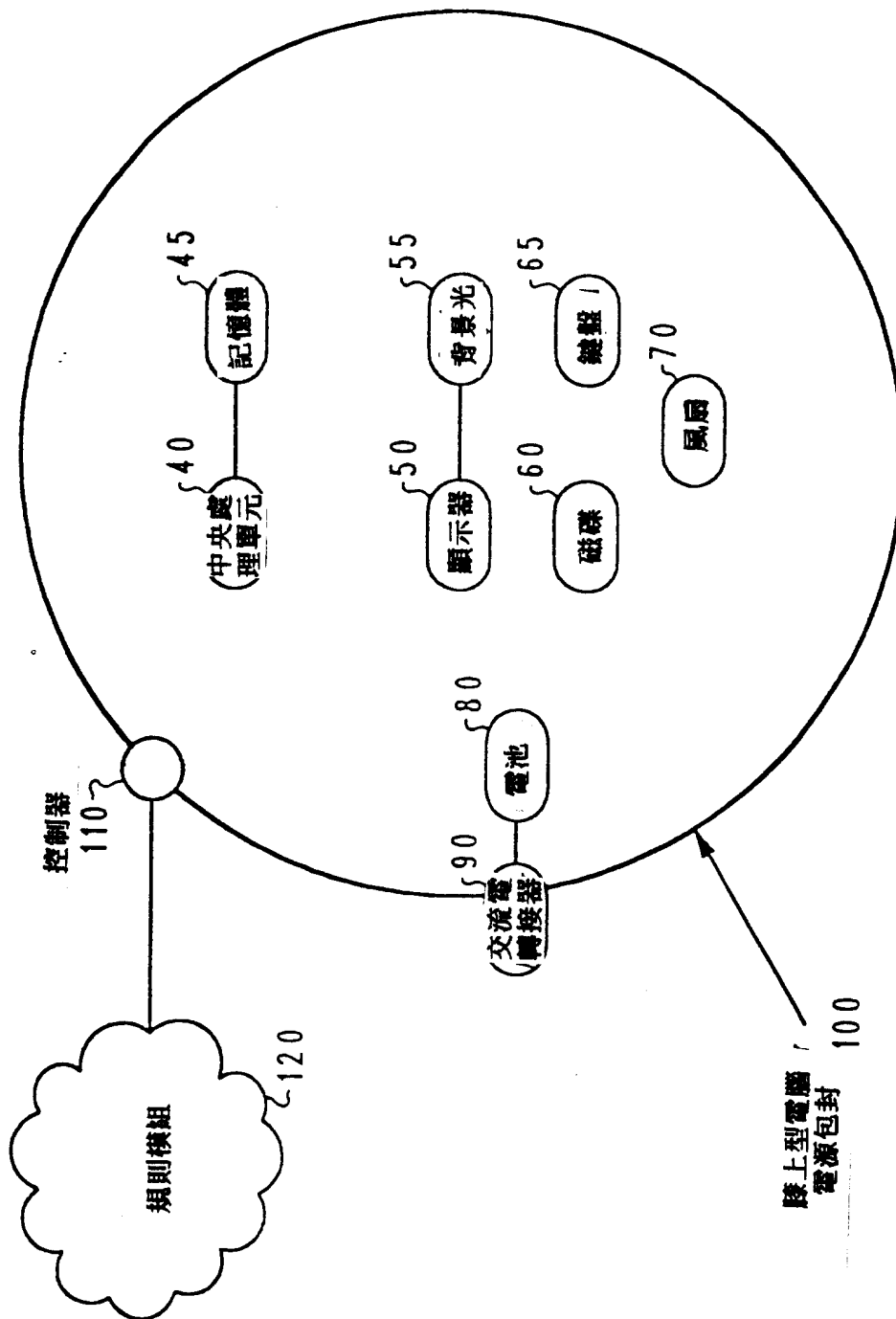
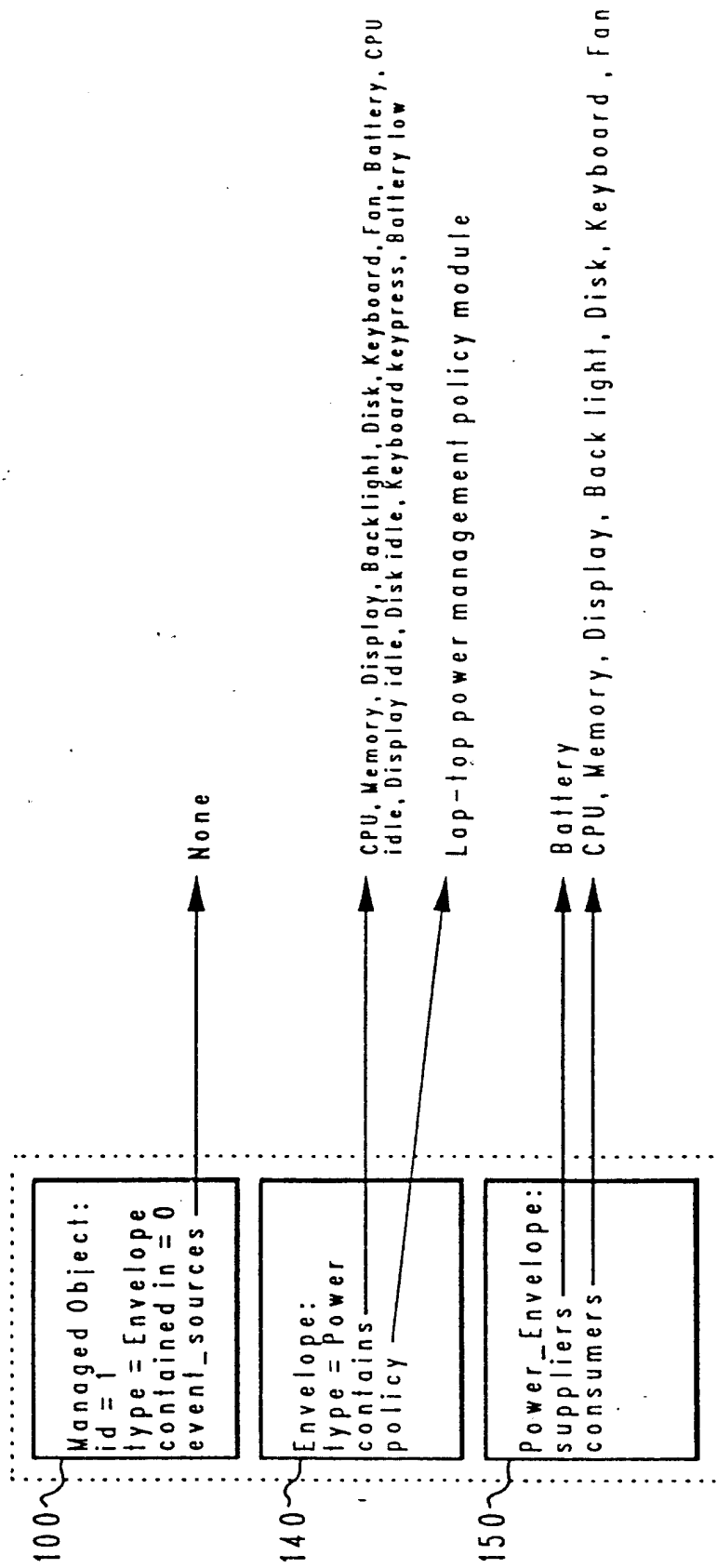
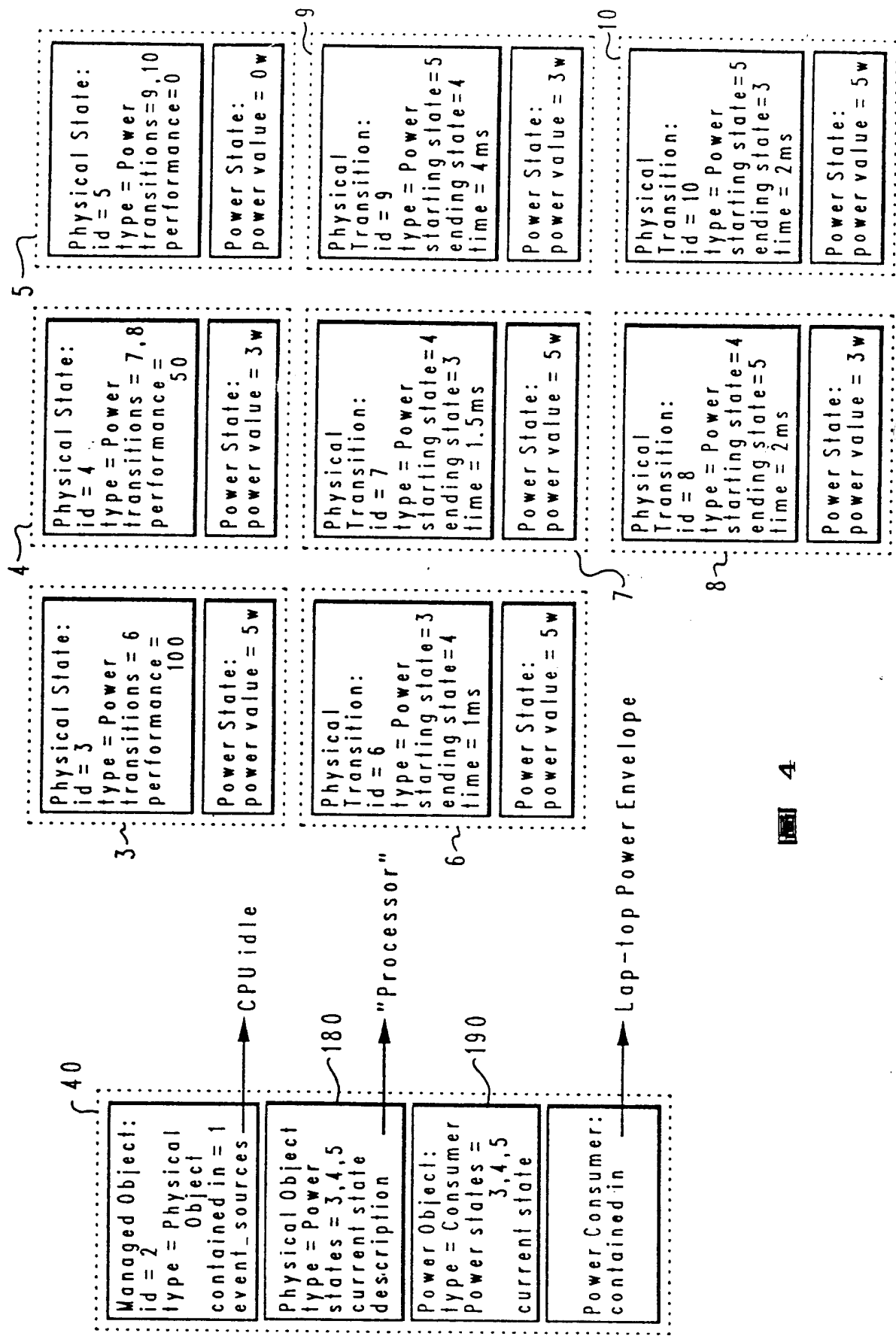
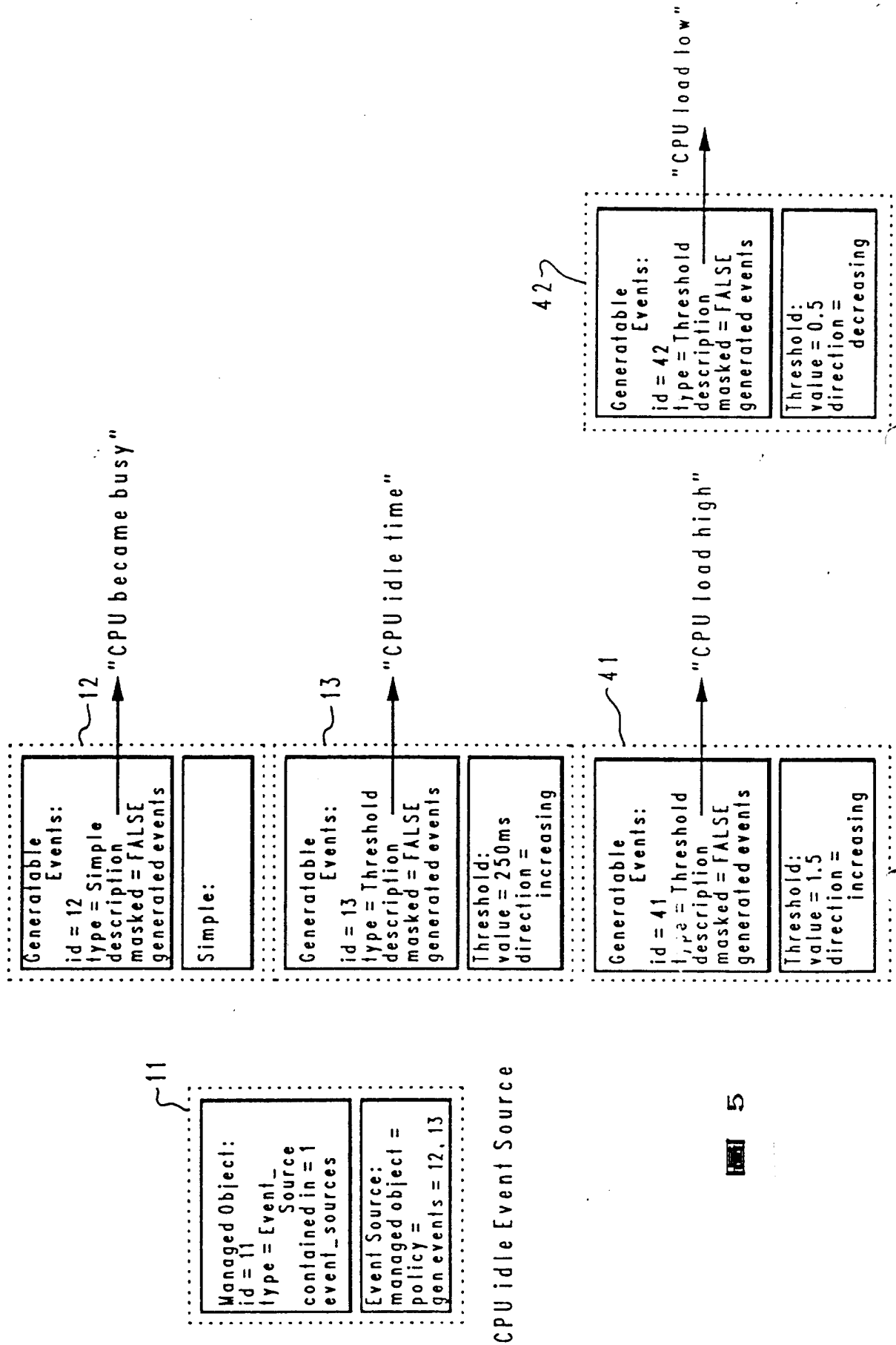
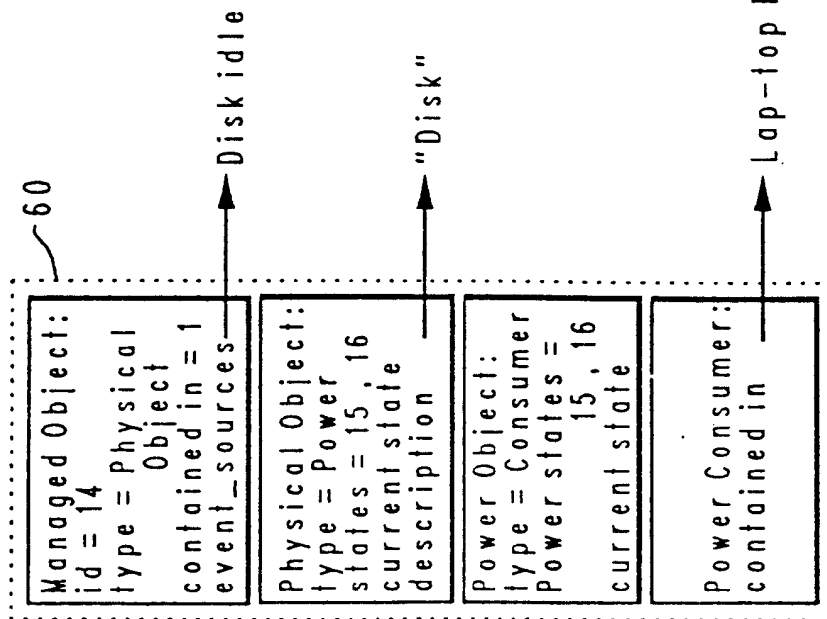


圖 2

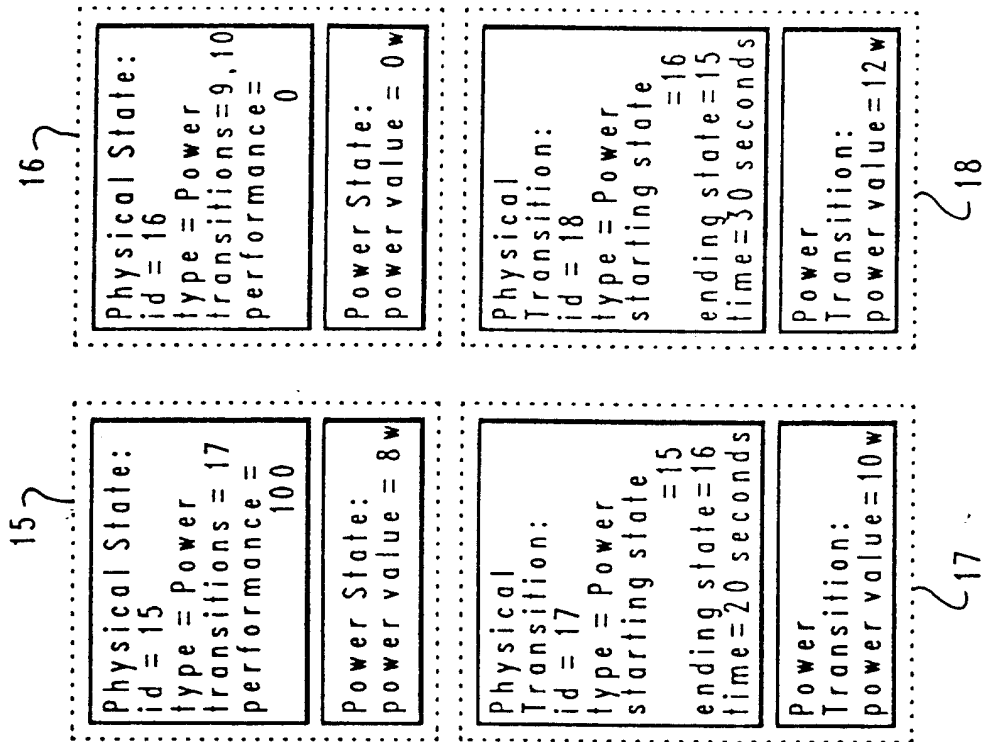


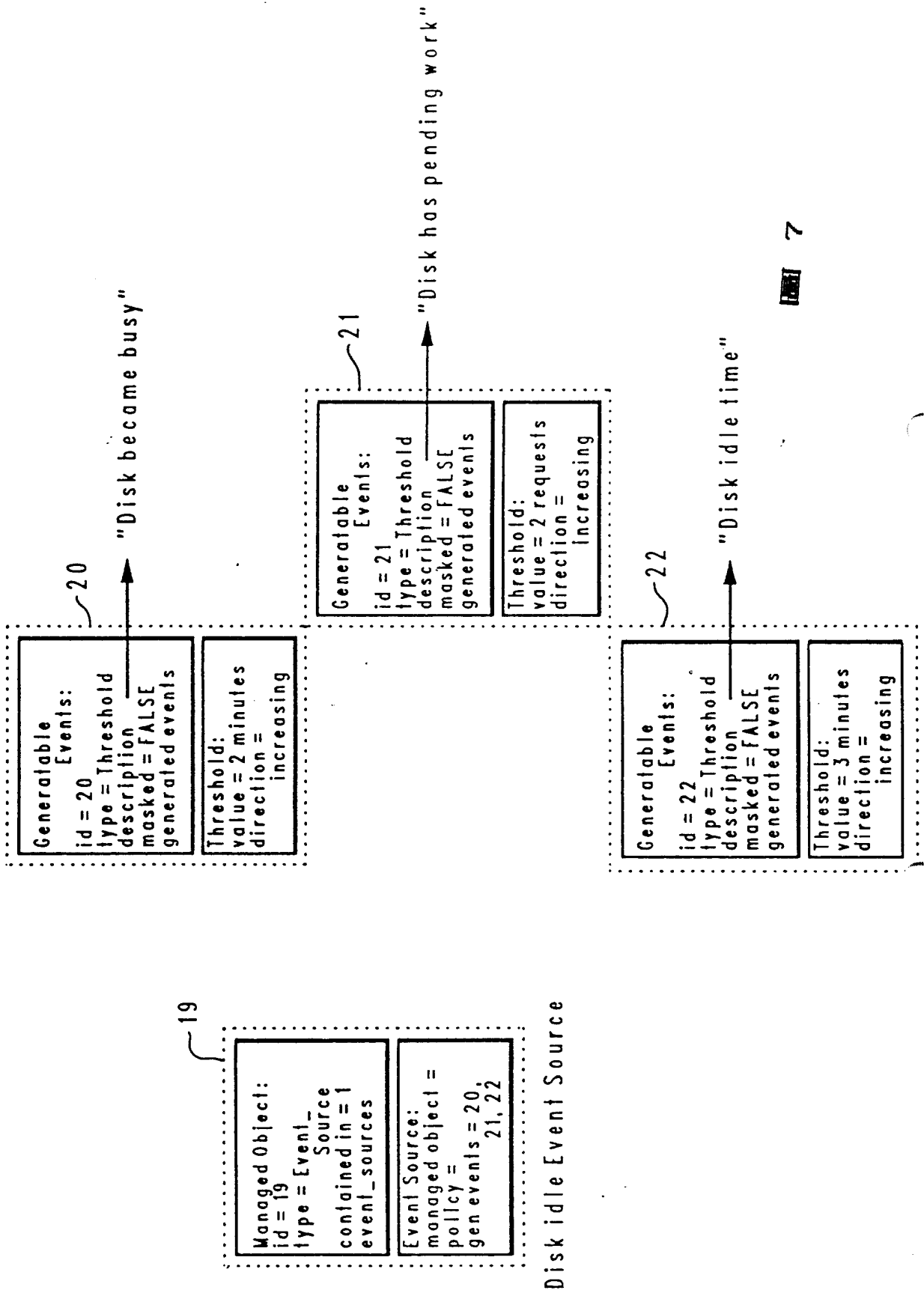


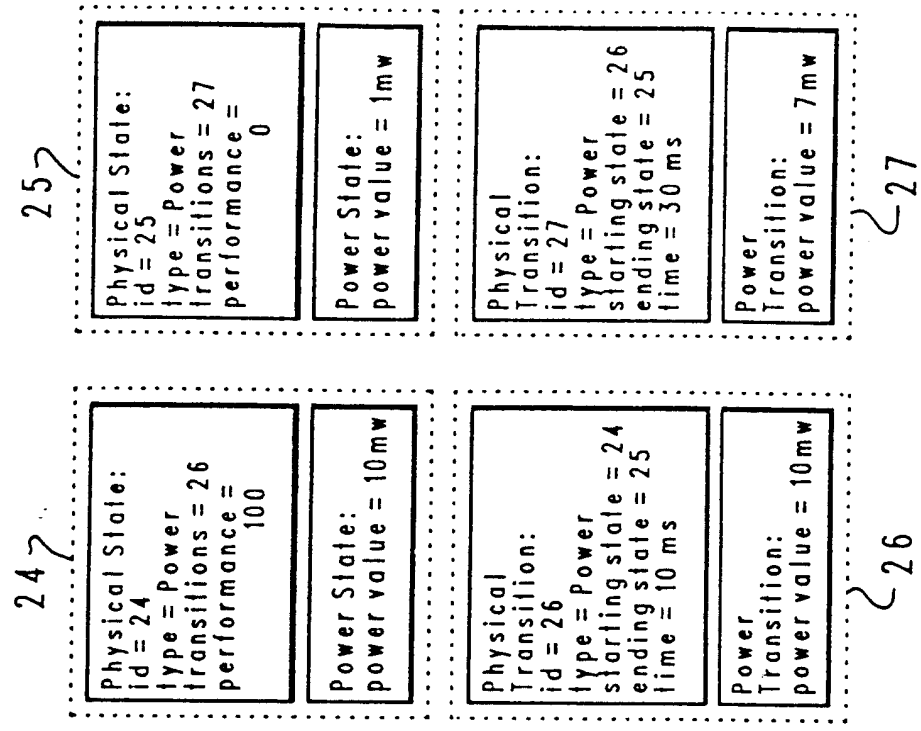
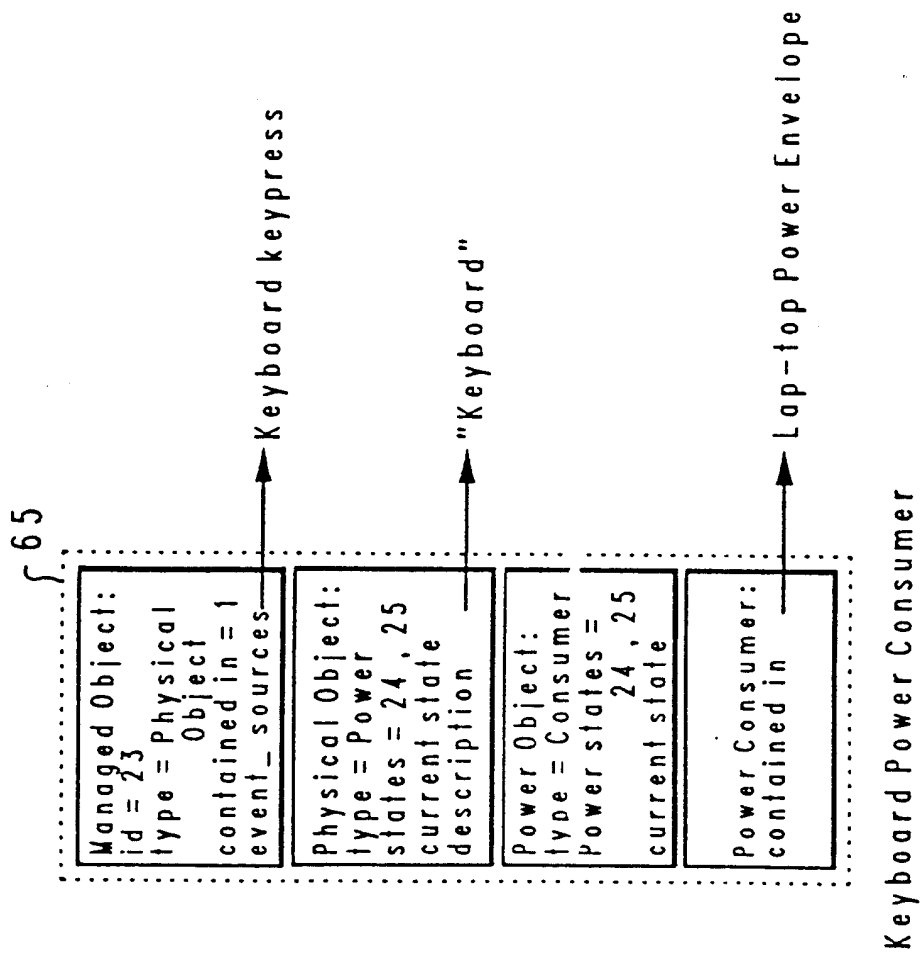




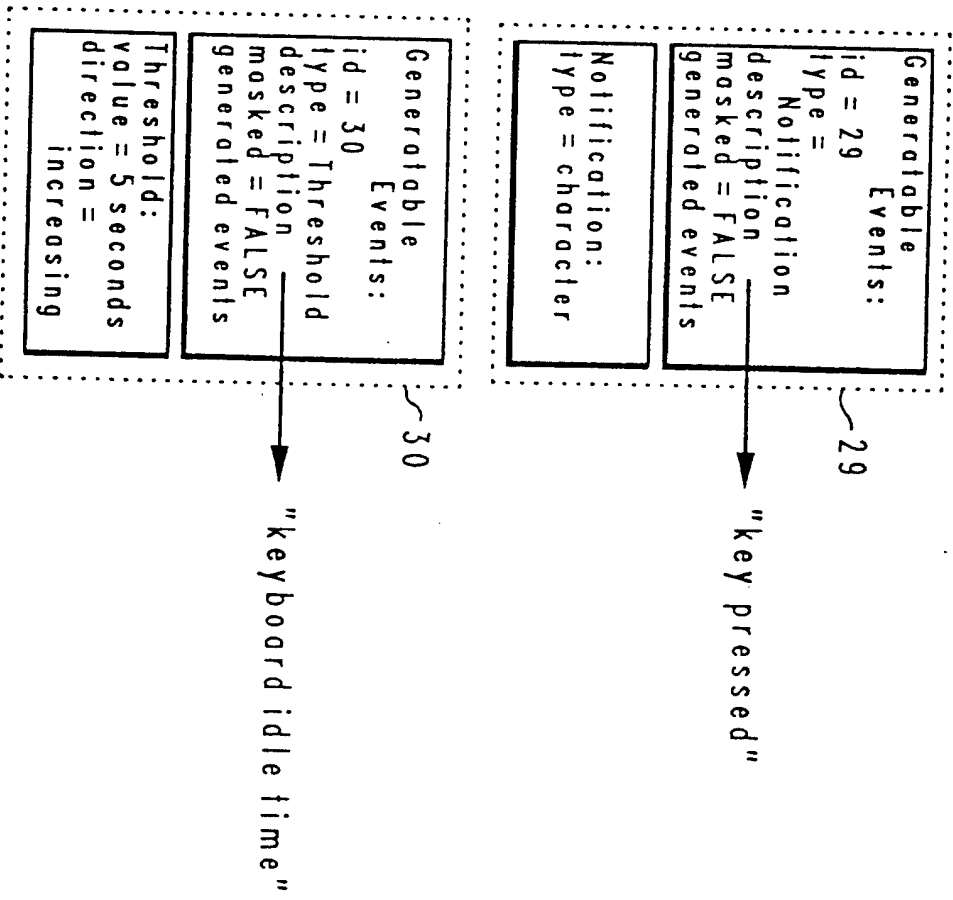
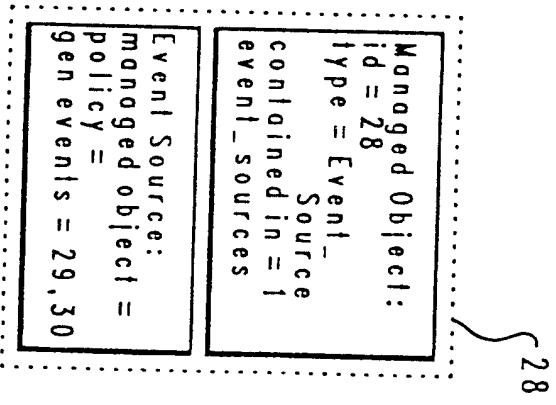
Disk Power Consumer







Keyboard Event Source



事件	情況	行動
1. CPU 在工作中	若電池電源負載為低	將CPU置入狀態#3
2. CPU 在工作中	若電池電源負載為高	將CPU置入狀態#4
3. CPU 停機		將CPU置入狀態#5
4. CPU 負載為低		將CPU置入狀態#4
5. CPU 負載為高	若電池電力負載為低	將CPU置入狀態#3
6. 磁碟機在工作中		將磁碟機置入狀態#15
7. 磁碟機		將磁碟機置入狀態#15
8. 磁碟機停機	若期待磁碟停機 $> (t_{sd} \cdot P_{sd} + t_{su} \cdot P_{su}) / P_s$ 秒	將磁碟機置入狀態#16
9. 已有鍵被按下		將鍵盤置入狀態#24。 若CPU在狀態#5，則將CPU置入狀態#4
10. 鍵盤停機		將鍵盤置入狀態#25

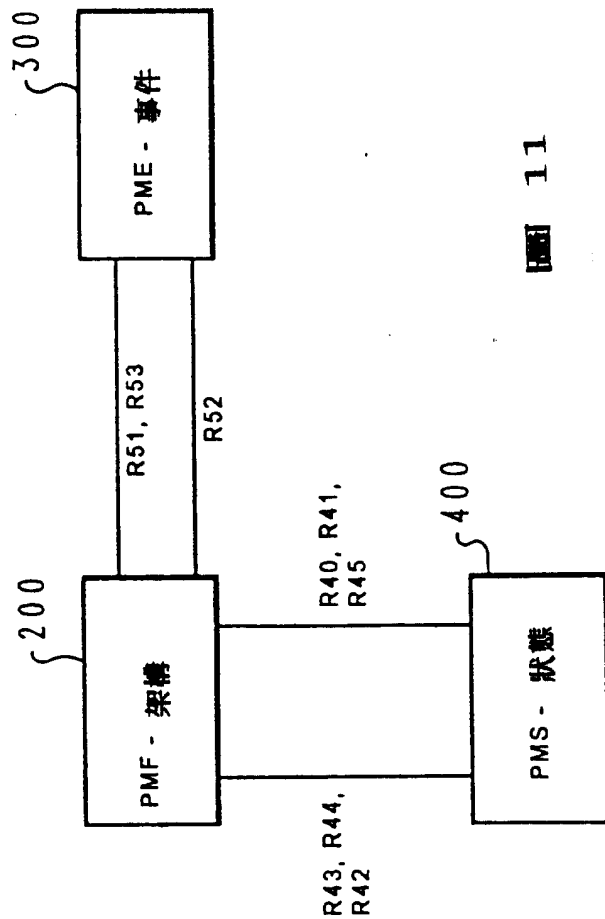


圖 11

12A

