Graph Based Orange Computing Architecture for Cyber-Physical Being

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***Abstract*— In This paper a graph based orange computing architecture for cyber-physical Being (CPB) is proposed. The Physical world is not entirely predictable, thus Cyber Physical Systems (CPS) revitalize traditional computing with a contemporary real-world approach that can touch our day-to-day life. A graph is modeled to tackle the architectural optimization in a CPB's network. These frameworks of assisted method improve the quality of life for functionally locked in individuals. A learning pattern is developed to facilitate wellbeing of the individual. Surveys were performed for multiple CPB's for different state, activities and quality of life scheme are considered.**

I. INTRODUCTION

Cyber-Physical Systems (CPS) is rapidly emerging field, which will touch every aspects of life in the near future. Semiconductor and Internet revolutionized and transformed our lives on how we interact with information and lead to the growth of information technology now we are into a new paradigm of CPS that would transform the way we interact with and manipulate the physical systems. As CPS represents a bold new generation of systems that integrate computing and communication capabilities with the dynamics of physical and engineered systems.

CPS is a revitalized version of traditional computing with a contemporary real-world approach. It integrates convergence of computing, communication, and storage capabilities that can monitor and/or control of entities in the physical world. Since CPS is still an immature field, its full potential can be conceived improving existing technology whether it is C++ like language-object orientation or multithreading behavior model or hiding abstraction layers in computing systems they all fail to express timing properties. The lack of timing in computing abstractions has been exploited heavily in such computer science disciplines as architecture, programming languages, operating systems, and networking. The physical world is concurrent, and our very survival depends on our ability to reason about physical dynamics. The problem is that we have chosen concurrent abstractions for software that do not even vaguely resemble the concurrency of the physical world, so when it comes to reliability and predictability of a system, it is expected that CPS implementation will not be an easy task in application such as robotics, air-traffic control, automotive, healthcare, entertainment, defense, energy and other consumer applications. It has not been realized how the CPS is going to impact economy and social structure as vast major investment are being made worldwide in developing this technology. The economic and societal potential of such systems is vastly greater than what has been realized.

The physical world, however, is not entirely predictable. So we have a wide area open in all area of research to explore and exploit the challenges and immense research opportunities in this Cyber-Physical System arena, and Cyber-Physical Being (CPB).

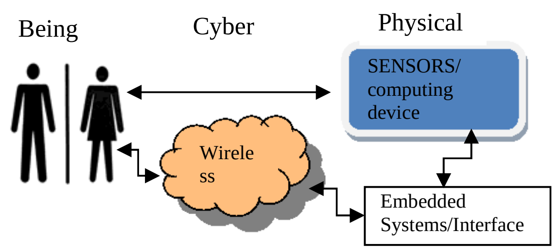


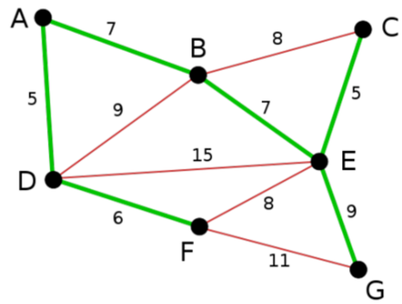
Figure 1. Basic framework of Cyber-Physical Being (CPB)

Figure 1 brings out the framework of automation of cyber-physical system in cyber-physical being level to augment human interaction with complex systems that integrate across computational and physical world.

II. PROBLEM FORMULATION

There have been many combinatorial optimization problems be formulated on a graph where the possible solution be a directed acyclic graph or a spanning tree. The minimum spanning tree (MST) problem is one of these real time optimization problems that finds growing interest in both theoretical and practical aspects. A network or graph problem can be formulated as follows, undirected graph G = (V,E,W) where V represents vertices, E represents edges and W represents weight. For example in telecommunication networks the goal is to provide service to terminal vertex of the network with minimum cost.

The figure 2 shows how a spanning tree of the given graph is constructed as a sub-graph and contains all the vertices together. When it comes to Machine to Machine (M2M) communication network such a spanning tree can yield a reasonable results[4-6]. But for an efficient optimization which include both cost and time consumption constraint we use a directed graph (DG).



A. Graph based Internet of Things (IoT) Modeling

The emerging internet of things (IoT) requires high level of interoperability and hardware-software usability where physical systems would interact with one another, which requires automatic capability and efficiency to accomplish linking resources and synchronization of event[17-20]. For example figure 3 contains 10 elements which are interconnected. If node 1 has sensor, it updates its data as it receives newly sensed information, then the data is communicated to another node say node 9, and a event from node 3 triggers node 9 to forward the data to node 5 which is a destination node.

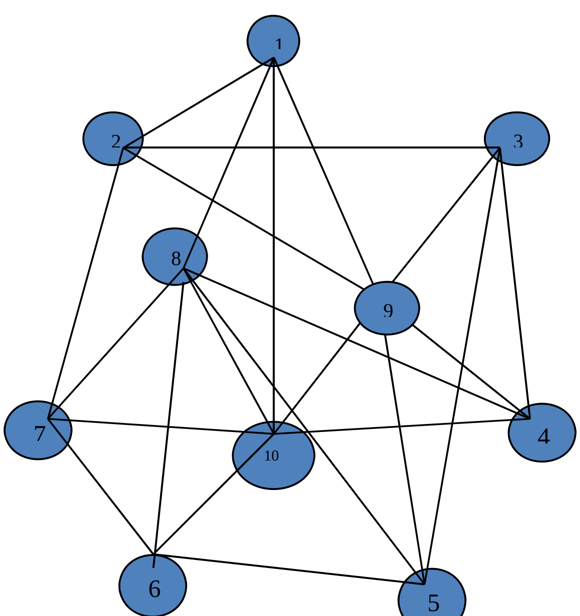


Figure 3. Connected things with in a network

B. Connected M2M and an IoT Senario

As computers become ever-faster and communication bandwidth ever-cheaper, computing and communication capabilities will be embedded in all types of objects and structures in the physical environment. Application with enormous societal impact and economic benefit will be created by harnessing these capabilities in time and across space, thus Cyber-Physical Systems (CPS) are physical and engineered systems whose operations are monitored, coordinated, and controlled and integrated by a computing and communication core. This intimate coupling between the cyber and physical will be manifested from the nano-world to large scale wide-are systems of systems. Yes cyber-physical systems will transform how we interact with the physical world just like the internet transformed how we interact with one another.

But internet on the other hand surpassing its primary function to communicate data and connecting people worldwide to an entity that brings all things together and inter-connects them. As more and more devices are arriving embedded with sensors and the ability to communicate we are moving towards an automated future, thus we move from internet of people to internet of things paradigm[7-9]. Conventional internet includes a server and routers and so on, but they miss the important factor people out of that conventional communication, as humans are imperfect we have limitation to remember things, save information, save data or even pay full attention or accurately calculate. This proves that fact that we are good for nothing in acquiring data from the real world. On the other hand if we have computing machine that has all the information , they gather data from various sensors and computing accordingly and send

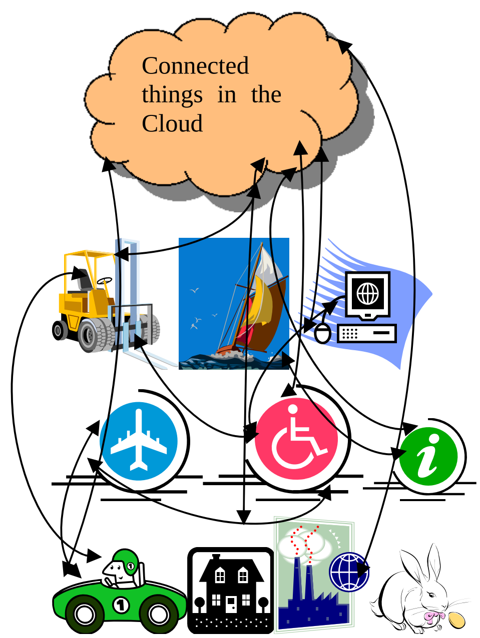


Figure 4. Connected things in an IoT scenario

III. LEARNING PATTER FOR ISOLATED INDIVIDUAL

A. *General Learning Method*

A general model for locked individual management learning agent is shown in figure 5, the accumulation of experience that guides the behavior (action policy) is represented by a cost estimator whose parameters are learned as new experiences are presented to the agent.

The agent is also equipped with sensors that define how observations about the external process are made. These observations may be if necessary combined with past observations or input to a state estimator, defining an information vector or internal state which represents the agent's belief about the real state of the process The cost estimator then maps these internal states and presented reinforcements to associated costs, which are basically expectations about how good or bad these states are, given the experience obtained so far. Finally, these costs guide the action policy. The built-in knowledge may affect the behavior of the agent either directly, altering the action policy or indirectly, influencing the cost estimator or sensors.

The experience accumulation and action taking process is represented by the following sequence. At a certain instant of time, the agent:

1. Makes an observation and perceives any reinforcement signal provided by the
Process.
2. Takes an action based on the former experience associated with the current observation and reinforcement.
3. Makes a new observation and updates its cumulated experience.

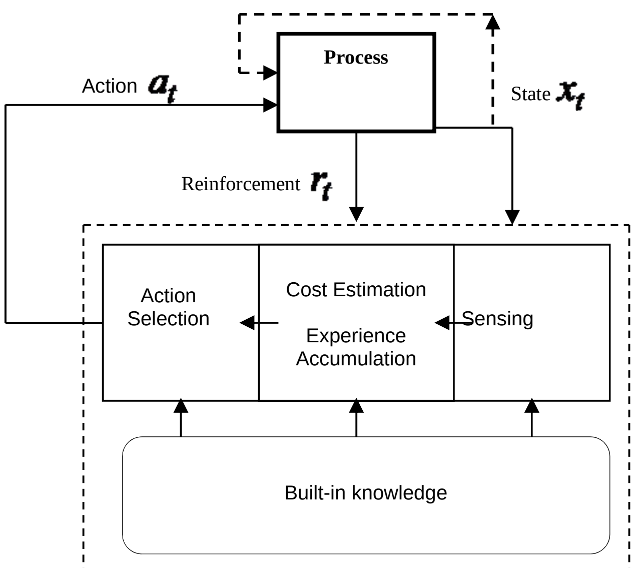


Figure 5 A general model of the learning agent

B. *Intelligent DPM Model*

In this section, Intelligent Individual management(IIM) designed using reinforcement learning agent method which is given In fig 6. This agent learning to predict the best by reinforcement learning method

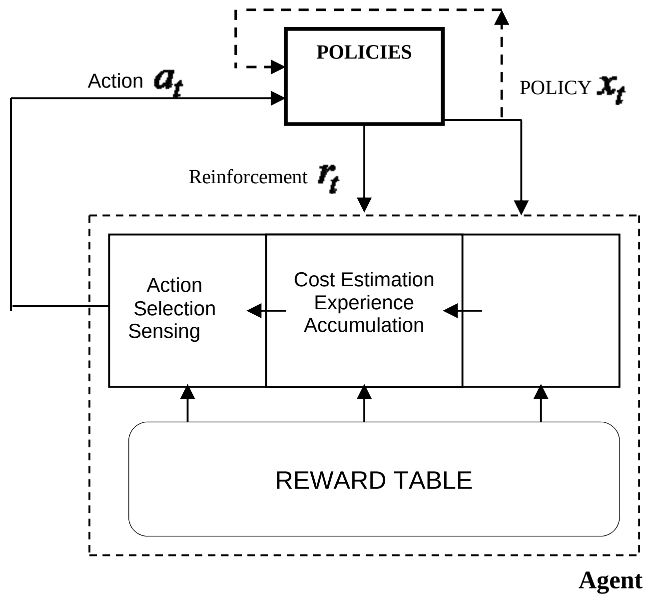


Figure 6. An IDPM model of the learning agent

B. *The Reinforcement Condition of IDPM*

The basic assumption of Markov Decision Processes is the Markov condition: any observation made by the agent must be a function only of its last observation from the state transition and action on select the best policy and change the control to the best (plus some random disturbance)

$$o_{t+1} = f\left(o_t, a_t, w_t\right)$$

Where o_t is the observation at time t, a_t is the action taken to predict best policy and w_t is the reward weight. o_t Provides complete information about x_t . This is equivalent to perfect observability of best policy,

Of particular interest is the discounted infinite horizon formulation of the Markov Decision Process problem. Given

- A finite set of possible actions $a \in A$,
- A finite set of polices $x \in X$,
- A finite set of bounded reinforcements (payoffs $r(x,a) \in \Re$;

The agent gives the reward to which policy minimizes the power consumption. The condition of policies for getting the reward is power saving p_{save} in sleep time should be more than the sum of power consumption at wake up time p_{wake} and power consumption of idle time p_{idle} of embedded system.

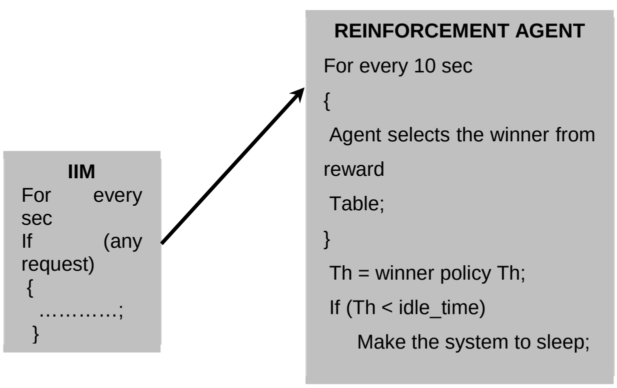
$$T_{th-sleep} \times p_{save} \geq T_{wake\times} p_{wake} + T_{idle\times} p_{idle}$$

To get reward, the policy should make the embedded device to sleep state until the above condition is satisfied. So the threshold time T_{th_sleep} is

$$T_{th-sleep} \geq \frac{T_{wake\times} p_{wake} + T_{idle\times} p_{idle}}{p_{save}}$$

To get reward, the policy should make the system idle state, above or equal to the threshold time T_{th_sleep}.

The pseudo code for the IIM given below



IV. SURVEY RESULTS

A survey was conducted based on learning methods pattern [14] have either under prediction or over prediction by which they pay performance or quality improvement of an functionally locked in individual. Our policy makes sure that server is ON, when there is an event in the Service Requester and Service Queue. Which means that under prediction or over prediction will never occur. Performance penalty will never occur by the proposed scheme.

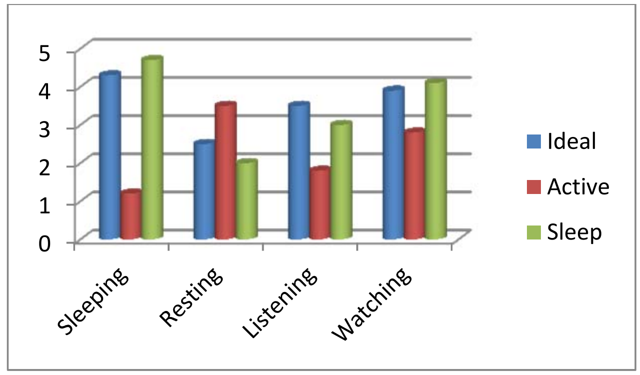


Figure 7. Activity measurement of a CPB

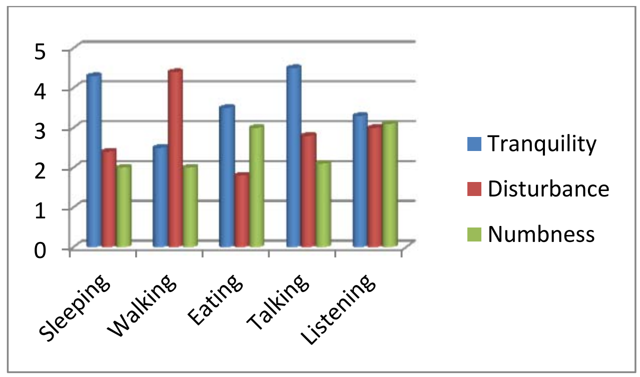


Figure 8. A Measure of quality of life of a CPB

V. CONCLUSIONS

A graph based orange computing architecture with multiple CPB for a CPS was proposed in this paper which uses a directed graph (DAG) to represent the whole enviroment. Parallel M2M establish communication within the network and are partitioned and reconfigured dynamically for large scale network such as IoT is also presented. Survey were performed for multiple CPB's for different state, activities and quality of life scheme are considered.

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