

Ubiquitous Complex Event Processing (U-CEP)

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BRIEF EXPLANATION

Already since a long time when we try to explain the phenomena of the world, philosophers and researchers are referring to a universe based on events (see e.g. the research about synchronicity of events in modern physics or psychology [1]). The nature of 'events' is not the simple concept of current generations of computing systems. It needs new understandings, methods of handling, and most of all computational resources. An emerging discipline of Complex Event Processing (CEP) introduced the concept of events in the computer science as a new paradigm [2, 3, 4, 5, 6, 7]. An enhanced understanding of CEP addresses new concepts as Ubiquitous CEP. U-CEP underpins all computation that addresses *complexity phenomena*. As examples:

- Sequences of happenings across time and space require to be captured to model global phenomena in the natural world.
- The world ecology, the bio-model and mankind expressed through Society evolves over time and space.
- Most of all intentional behavior consists of sequences of responses over time and space.

The above statements presume first some understanding and definition of what topology of time-space seems to be relevant to a particular domain. Even in the physical world this is not simple. In the biological world the evolution of the species is not the whole story. Human behavior and social patterns have been discoursed upon since Plato (or earlier, his mentor Socrates).

In today's world, *Complexity* makes all these aspects very difficult to handle; this is the world of dynamics, interactions, and all the interesting outcomes from emergence including sudden changes in state that forewarn of a need for 'special action'. This is the world of Complex Adaptive Systems (CAS). Three examples show why the ability to compute CAS is important:

- FuturICT [C1] has identified critical applications such as: understanding and predicting societal phenonema and behavior including risk management, counter terrorism, fraud management, epidemic, global emergencies etc.
- INTEGRAL BIOMATHICS [C2] examines the fundamental computational basis of bio- and socio- systems. It anticipates the need for a new breakthrough paradigm change towards *biologically and socially driven* mathematics and computation and the technological challenges of bringing this about. Its goal will be a set of novel mathematical formalisms.

- SOCIONOME-METALOGER[C3] will establish the new science of Computational Socio-geonomics based on the coupling of science and social systems within the new ICT paradigm.
- World Ecology Modeller (S-GAIA) [C4] has identified that Society is a complex adaptive system and processing its events, the product of intentionality, lies at the centre of improving the outcomes of action.
- Computational event processing applies on vast scales to disciplines as different as Bio-sciences, fundamental energy/matter, the brain and physiome. The list is endless.

David Luckham/Stanford University as one of the main inventors of CEP said about the forecast that within the next decades the paradigm of Ubiquitous Complex Event Processing is predicted as the precondition of an execution and simulation platform for a lot of more global and interrelated applications. Current computing methods to handle complex phenomena are not well understood or developed and the ability to handle the scale of event traffic does not exist yet. An IBM sponsored report [.] said:

“ ... the transparency demanded by regulation (such as the Markets in Financial Instruments Directive (MiFID)) requires visibility into the operation of business networks, which again is dependent on electronic information flows. Furthermore, the stresses and strains these forces exert on organisations are changing all the time, and this means that organisations have to be able to sense and respond to internal and external changes... “

This is Global Dynamics, Policy management, dynamics of complex interactions, understanding and management of the world ecology . This is the context of Ubiquitous Complex Event Processing.

Ambition

Vision

Ubiquitous COMPLEX EVENT PROCESSING is an Industry led initiative to exploit the opportunities of the science of CEP into the mainstream of computational practice across diverse fields of science, not just the aspect of computational modelling but the fundamental physical world phenomena exhibited. Elucidation of this discovery will lead to new applications of CEP across the bio-ecological world, and all the artefacts of human involvement and management of this ecology, such as: commerce, industry, government and Society. It will be the ubiquitous applied technology for processing the dynamics of complexity in real world systems. It involves: fundamental science; elucidation of the computational meaning of ‘event’; development of technologies appropriate to the scale of domains of different event patterns; their incorporation into modelling and execution platforms that are useful to their clients – scientific fields, society, the world ecology.

Science of CEP

The fundamental hypothesis of U-CEP is that the pattern of events determines the existence, identity, significance and outcomes of every living entity within the biosphere. The complex interactions this hypothesis involves need to be understood observed and the means found to influence them. This may sound like interfering with our world ecology and very existence. In fact the reverse is the case: currently damage to our biosphere is the result of ignorance; reversing this is a moral quest.

The message of many disparate studies [.] is that complex events in the real world are the triggers of action, or even more profoundly, of identity; identifying, processing, and responding to them is the canvas of U-CEP. Examples show this ubiquity and the enormous variation in scale, that work in combination:

- Chemistry and bio-chemistry are about U-CEP, studies by scientists such as Peter Plath [.]
- The discipline of the New Biology of Epigenetics studies the environment as a global cloud of signals, energies or so called events are at the end responsible for the way of life of a cell [11, 12].
- At the level of basic energy and matter quantum physics and the “Heisenberg uncertainty relation” defines events as eddy of quarks and photons that are a high-end challenge for the CEP-technology [1, 11, 12].
- The human physiome is a united cell structure of 50 trillions of single cells where each cell is doing event processing on the base of its receptors of its cell membrane. So, a human being can allegedly process 120.000 events per second unconsciously (by the right side of the brain), but logically a human can only process a few information units at the same time (by the left side of the brain) [11]. In the sense of CEP this is actually a small number of events and the question is how the human brain works so efficiently and effectively and how a human brain can make predictions as the basic criterion of intelligence [9].

U-CEP researches and mimics the bio-logic, structures, and methods because it is a computational model of the same phenomena. Event Processing Agents (EPA's) are actually cells where event adaptors are the receptors of a cell membrane and the event processing logic based on an Event Processing Language (EPL) are the effectors of a cell. Event Processing Networks (EPN's) are actually a united multicellular structure and so on. The Epigenetics explains how the environmental signals (events) control the activity of the genes. The primacy of the DNA is no longer valid, and the new found information flow is now called the “primacy of the environment”. Recent experiments of The Epigenetics have proved that our beliefs and thinking is energy in the sense of environmental signals. The Epigenetics found that all these kinds of environmental signals influence the regulating proteins which control the activity of the genes and that the global event cloud as environmental signals influences and changes the DNS (so called reverse transcriptase).

In the realm of society in addition to the bio-cellular model, every construct of social system is a newly designed constellation of interacting cells defined to achieve a social/business/organization purpose. The details are the properties defined in the SOCIONOME of Society.

The Technology of U-CEP

The first requirement is to be able to construct a model of the topology and features of the global event cloud; in most cases this is itself evolving and always specific to the scientific field of study. However fundamental features can be abstracted, e.g. in the case of CAS, and top-level normative models used as templates for designing systems to process that event cloud.

As with most systems oriented work, there is a progression to standardized modeling techniques, a language of discourse that can be applied to construct, ‘compile’ processable environments to conduct experiments on the observable phenomena. The entire process is iterative and evolutionary. The learning that takes place is to find meaningful patterns in the dynamics of sets of experiment and action. This always involves the relation between experiment and experimenter.

This proposal will research and devise technological solutions appropriate to the different kinds of entity discussed above, the scale of the cellular interactions that belong to the life of that entity, the specific events and the required response of the entity. In the business/organization world this is the total set of events arising from the conduct of the business/organization at every level from everyday activity to the highest levels of governance within the world ecology. It will position this research in the context of extreme complexity and the tools required to deal with this in the life-cycle of each 'species' of bio-socio life. This can be envisaged as the potential interactions of the entire set of competing and cooperating species and their members, living out their purpose and consuming the resources of the ecology in doing so. This requires processing the dynamics of multi-layered complex events. It requires the relation of multiple ontologies to be constructed and modeled. The technology has to integrate on a scale required to deal with this complexity, involving identification and responses to events in huge numbers of concurrency. The technology involves continuous re-configuring since all facets of the processing are themselves complex adaptive systems.

Impact

The fundamental importance of U-CEP is that it reveals the dynamics of the environment of a bio- or socio- entity which condition that entity to behave in particular ways and to construct and execute strategies to deal with that environment. The question U-CEP answers is how to achieve sufficient mastery of the environment and the events that permeate it, the 'global event cloud', to influence the otherwise chaotic outcomes, or the outcomes determined by alien perturbations.

Ultimately such experimentation across the universe of observable phenomena will lead to new and novel understandings of how anything and everything becomes instantiated, lives out a life, and gives way to some other phenomenological pattern. The most interesting question is that of quantum experimentation: who decides what is really happening?

This would seem to be of immediate import in the social sciences field where the questions of goals, influence, behaviours and outcomes for the world ecology are determined by the models that are designed, but still influenced by clouds of events not obviously triggered by designed models. Resolving such conundrums is of crucial importance.

The outcome of this work will be progressive compilation of ordered views of the model topology and complex event changes to instantiations of this, which are then translated into inferences about what is happening, its significance, and even ultimately its 'meaning'. The latter takes U-CEP into the important realms of human intelligence and consciousness, the paradigms of meaning already constructed, and paradigmatic shifts to new models.

Integration

U-CEP requires the twin worlds of domain behaviour and computational advances to be combined in order to design and execute experiments and operational environments that process complex events. The reality of CAS is there is no deterministic solution in advance or ever. As the IBM Paper [.] said:

“ Although event processing technology is not trivial to understand, you need to find ways to get IT specialists working with business domain experts.... Domain experts have the most useful insights into significant events and patterns, decisioning rules and actions – the “content” for event processing systems – “

U-CEP research concerns fundamental questions that are both universal and specific to each area, typified by the following example areas that is a conceptual canvas of the required research:

1. David Luckham’s forecast 2008 – from Simple CEP to Ubiquitous CEP in an event-driven world
 - 1.1. Which are the applications of Ubiquitous CEP of the next decades? Neuroscience, Epigenetics, Brain Research, CERN Large Hadron Collider, Higgs Boson, ...
2. Ray Kurzweil’s understanding of CEP – “Singularity is Near” [8]
 - 2.1. Mapping of Ray’s and David’s forecast until 2050 and beyond
3. Enhancing human intelligence and cognitive or physical abilities
 - 3.1. Jeff Hawkins’s understanding of CEP – “On Intelligence” [9]
 - 3.2. Memory-prediction framework
 - 3.3. Prediction and (event) patterns
 - 3.4. Intelligent machines – based on a layered CEP like human brain’s cortex
 - 3.5. The Blue Brain project – Henry Markram (EPFL Lausanne) [10]
 - 3.6. Brain Computer Interface – Kevin Warwick (Reading University) [21, 22, 13, 14, 15]
4. Epigenetics and CEP – Bruce Lipton’s “Biology of Belief” [11]
 - 4.1. Cell membrane as an organic information processor, receptors, effectors, protein machinery, reverse transcriptase and event processing, an individual as a combination of fifty trillion of collaborating event processing cells
 - 4.2. Event adapters, Event Processing Agents, Event Processing Networks as the analogy of CEP
 - 4.3. Epigenetics-research-portal for Germany, Austria, Switzerland
 - 4.4. Rationale of EU FET-program: Biological cells are highly sophisticated, chemical information processing systems, capable of responding to changing conditions. The information processing capabilities of such systems could be exploited by future information technologies if this ‘information chemistry’ could be ‘programmed’.
 - 4.5. General objective of EU FET-program: Develop the foundations for a radically new kind of information processing technology inspired by chemical processes in living systems. Enable the development of ICT systems and devices that utilize interactions between components to assemble complex functional information processing materials. The research should enable a new generation of systems capable of interfacing with conventional IT systems that are self-replicating, selfrepairing and/or capable of rapid adaptation/evolution as well as flexible reconfiguration in response to changing conditions
5. Brain research and CEP – the long and the most recent discussion about “Free Will”
 - 5.1. The position of the brain researchers Wolf Singer, Gerhard Roth et al. [13]
 - 5.2. The world as a deterministic whole based on Event Processing
 - 5.3. Concerns, e.g. of Jürgen Habermas
 - 5.4. The Blue Brain project – Henry Markram (EPFL Lausanne) [10]
 - 5.5. Brain Computer Interface – Kevin Warwick (Reading University) [21, 22]
6. Consciousness and memory technology – Storing, modifying, transferring of consciousness and the relation with CEP
 - 6.1. Theory of Hans Moravec, Otto E. Rössler, Ray Kurzweil [15, 16]
 - 6.2. Concerns, e.g. of Klaus Heinerth, University of Munich [18]
 - 6.3. Individual consciousness, consciousness of groups, cosmic consciousness – what would we store, modify, transfer? [17]
7. Universe and Events – Large Hadron Collider of CERN [19]

- 7.1. Higgs Boson, Higgs Field, Big Bang, From energy to matter
- 7.2. Event processing at CERN means:
- 600 millions events per second, a lot of sensors for different event types
 - event filtering, event enrichment, event processing as cloud computing by more than 100.000 computers, at present C++ coded
 - goal: find the Higgs boson
- Questions to be discussed could be:
- strategy for the detection of Higgs boson
 - can be solved by a CEP approach?
 - what kind of EPL would be appropriate?
 - is there a need for a flexible and fast changing EP-logic?
- Etc.
8. Computational Socio-Geonomics [20]
- 8.1. Concept of Weak and Strong Emergences → to be mapped on Complex Events
- 8.2. An ICT platform for Social Simulation means:
- around 10 billion human agents in future
 - millions or even billions and trillions of events per second,
 - a lot of sensors for different event types (“smart dust”, foglets)
 - appropriate modeling approach for simulation scenarios
 - easily to use and domain-appropriate Event Programming Language
9. A list of use cases and scenarios from the Zurich workshop “European FET Flagship Initiative”:
- interdisciplinary and systems thinking to advise private and public organizations on such matters as diverse global trends, plausible scenarios, emerging market opportunities, and risk management
10. Discussion about future interdisciplinary CEP-based projects:
- 10.1. SmartHealthcare and Diabetes: Simple CEP/ed(B)PM?
- 10.2. SmartHealthcare and Depression: Depression - A defect of Event Processing?
- 10.3. SmartEmergencyManagement: City/Location specific emergencies as Simple CEP/ed(B)PM versus global emergencies taking the example of Solar Storm 2012
- 10.4. Brain Research: A new Libet experiment regarding Free Will based on CEP?

The application of U-CEP thinking has been accepted as a relevant discipline in the FutureICT project Virtual World Modeller (VWM) where it will lead the focus on complex events and the technologies to handle them.

Thus this project will provide insight into the fundamental questions to be asked, and hopefully reach some conclusions leading to processable constructs, that term applying to both the modeling framework and its computational representation.

Plausibility

As stated above, computing has always addressed ‘events’. The new work envisaged in this project is to raise the level of this to the ability to deal with the phenomena of complex events, occurring in vast numbers and scales.

Progress Beyond the Current State of the Art

The drivers for this research are the growing recognition across every field of science that their phenomena are rooted in the basic questions regarding what determines their existence and how is this manifest in observable, measurable, and predictable collections of entities and events.

The above definition is a blueprint for the construction of a model, also termed a hypothesis, that relates to existing Frames of reference in our world, and that can be translated into a computational form. Since it is now becoming clear that complexity is the nature of all phenomena even where limited abstractions are amenable to deterministic rules, a convenience to support bounded reality, there is no alternative game in town. The pursuit of modeling in both domains and computers is ubiquitously directed to addressing indeterministic systems.

Road Map

The outcome of this effort is leading both real-world experimentation and computational representation to new fundamental methods and solutions. The experimental means are the focus ahead of its application to derive insights, answers and real world action.

The infrastructure for this is a combination of pure science, applied science, technology and engineering, and the application of all these fields of research in real world applications. The practical signs of progress and achievement are the formation of institutions to oversee the progress, consolidate the research, and command the resources and funding to deliver results. The following are specific examples:

- The Complex Systems Society is spearheading the drive to bring the science into the mainstream of practical application, especially science and computational methods
- The Event Processing Technical Society has been formed to spearhead and consolidate the many disparate efforts to deliver practical computational approaches by industry. It is leading the required drive for standards and methods that will avoid the Tower of Babel syndrome
- Events, Conferences, practical applications and pure science are underway in many fields.

Aspirational dates, forecasts until 2020 and Beyond, e.g.:

- See the forecast of David Luckham [2]
- See the forecast of Ray Kurzweil [8]

All these are the real signs of a new branch of science moving from theory to practical use.

Implementation

The following is a list of typical active partners; it is only a sample:

- The World Ecology Modelling (S-GAIA) Consortium
- The Event Processing Technical Society (EP-TS)

The most of the FET proposals are based on some features of the Future Internet (FI).

- European Future Internet Initiative (EFII)
- Networked European Software & Services Initiative (NESSI).

Although we will and have to cooperate with the organisations around FI (e.g. providing an event streaming interface to FI), the research topics of FI and U-CEP will be carefully separated.

Benefits

This project will bring the science and technologies of Ubiquitous Complex Event Processing into the mainstream of ICT and all the real-world applications dealing with complexity.

Conclusions

U-CEP is a critical new field of pure and applied science and engineering that will deliver ICT capability that can support the solving of practical problems involving critical time and space based dynamics (where these dimensions also include further levels of abstract ontological entities). It is thus a critical component of many fields of enquiry involving real-world complex adaptive systems

References

1. F. David Peat: Synchronicity - The Bridge Between Matter and Mind. Bantam Doubleday Dell Publications. 1987
2. David Luckham: The Power of Events: An Introduction to Complex Event Processing in Distributed Enterprise Systems. Addison-Wesley 2002
3. Opher Etzion, Peter Niblett: Event Processing in Action. Manning 2010
<http://www.citt-online.com/downloads/EPIA%20for%20experts%20meeting.ppt>
4. K. Chandy, W. Schulte: Event Processing: Designing IT Systems for Agile Companies. McGraw-Hill 2009
5. von Ammon, R. 2009 Event Driven Business Process Management. In Encyclopedia of Database Systems, Ling Liu and M. Tamer Özsu (Eds.), Springer
6. von Ammon, R., Ertlmaier, Th., Etzion, O., Kofman, A. and Paulus, Th. 2009 Integrating Complex Events for Collaborating and Dynamically Changing Business Processes, ICSOC/ServiceWave 2009, Mona+ workshop, Nov 23-24, 2009 Stockholm, Sweden, DOI= http://www.citt-online.com/downloads/Integrating_Complex_Events_for_Collaborating_and_Dynamically_Changing_Business_Processes_MONA_Final.pdf
7. von Ammon, R., Ertlmaier, Th., Etzion, O. and Paulus, Th. 2009 Existing and future standards for event-driven business process management, Proceedings of the Third ACM International Conference on Distributed Event-Based Systems DEBS 2009, July Nashville, USA, DOI= <http://portal.acm.org/citation.cfm?id=1619258.1619290>
8. Ray Kurzweil: The Singularity Is Near: When Humans Transcend Biology. Viking Adult 2005
9. Jeff Hawkins: On Intelligence. Times Books 2004
10. Blue Brain Project http://en.wikipedia.org/wiki/Blue_Brain_Project
Henry Markram: <http://www.youtube.com/watch?v=LS3wMC2BpxU>
11. Bruce H. Lipton: The Biology of Belief. Mountain of Love 2005
12. Dennis Bray: Wetware: A Computer in Every Living Cell. Yale University Press 2009
13. Wolf Singer: Der Beobachter im Gehirn: Essays zur Hirnforschung. Suhrkamp 2009
14. John Morgan Allman: Evolving Brains. W.H. Freeman & Company 1999
15. Hans Moravec: When will computer hardware match the human brain? Robotics Institute, Carnegie Mellon University, Pittsburgh 1997, <http://www.transhumanist.com/volume1/moravec.htm>
16. Hans Moravec: Die Wirklichkeit ist ein Konstrukt des Bewußtseins.
<http://www.heise.de/tp/r4/artikel/6/6038/1.html>
17. Jörg Starkmuth: Die Entstehung der Realität. Bonn 2008

18. Klaus Heinerth: Können Computer Bewußtsein entwickeln? 1998,
<http://www.heinerth.de/Computerbew.htm>
19. Rolf Landua: Am Rand der Dimensionen: Gespräche über die Physik am CERN. Suhrkamp 2009
20. R. Sun, Cognition and Multi-Agent Interaction: From Cognitive Modeling to Social Simulation. Cambridge University Press, New York. 2006.
21. <http://www.reading.ac.uk/sse/about/staff/publications/k-warwick-publications.aspx>
22. <http://www.nature.com/nature/focus/brain/index.html>

CONTRIBUTIONS to the ONLINE FET FLAGSHIP CONSULTATION 2010

- [C1] Dirk Helbing Proposal for a Socio-technic project titled The futurICT knowledge Accelerator Unleashing the Power of Information for a Sustainable Future
- [C2] Integral Biomathics: a New Era of Biological Computation Simeonov, P. L. *Integral Biomathics: A Post-Newtonian View into the Logos of Bios. J. Progress in Biophysics & Molecular Biology*, Elsevier, 2010, Article in Press, ISSN: 0079-6107, DOI:10.1016/j.pbiomolbio.2010.01.005.
<http://dx.doi.org/10.1016/j.pbiomolbio.2010.01.005>.
- [C3] Sutcliffe-Braithwaite, J 2010. Proposal for a Socio-technic project titled SOCIONOME-METALOGER
- [C4] Atta Badii. 2010 Proposal for a Socio-technic project titled WORLD SOCIETY MODELLER (S-GAIA)

http://cordis.europa.eu/fp7/ict/fet-proactive/docs/flagshipcons09-01_en.pdf

Some more information:

<http://www.citt-online.com/downloads/FET-F-CITT-v3.ppt>

<http://www.citt-online.com/downloads/Beyond%20Simple%20CEP.pdf>