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Part 3. What Lays Ahead – 'Crystal ball gazing…'

I think there is a world market for maybe five computers.
- Thomas Watson, IBM Chairman, 1943

640K ought to be enough for anybody.
- Bill Gates, Microsoft Chairman, 1981

There is no reason for any individual to have a computer in their home.
- Ken Olson (President of Digital Equipment Corporation) at the Convention of the World Future Society in Boston in 1977

Get your feet off my desk, get out of here, you stink, and we're not going to buy your product.
- Joe Keenan, President of Atari, in 1976 responding to Steve Job's offer to sell him rights to the new personal computer he and Steve Wozniak developed

Computers in the future may have only 1,000 vacuum tubes and perhaps only weight 1.5 tons.
- Popular Mechanics, 1949

Everything that can be invented has been invented.
- Charles H. Duell, Commissioner, U.S. Office of Patents, 1899

If history repeats itself, I shall think we can expect the same thing again.
- Terry Venables, ex-England and Australia soccer team manager

To be fair, we must admit that quotations in the beginning of this part are probably taken out of context (found on [WWW WhatIs] in 'favourite technology quotations'). But don't they sound good from the position of our current knowledge? We could not resist reminding them to you. Revisiting the old predictions and failed insights present a good lesson in itself.
Surely, these people could qualify their statements better at the time, and to find a good explanation now. However, as Russian proverb goes – "word is not a sparrow – it flies away and you won't get it back".

This Part is the smallest in the book; just a placeholder really, but surely deserves a special attention. After all, whatever we do in any human activity is being done for the future. Software Architecture, as largely forward-looking activity, is not an exception in this sense.

We outline main developments in Information Technology that will have an immediate impact on Software Architecture in short- to mid-term.
This part does not attempt the comprehensive analysis of trends and acting forces, but serves as a catalyst towards consolidating your own judgement on where our industry is going.

Chapter 13. Are We There Yet? …

Bart Simpson probably would not appreciate the fact that Enterprise and Software Architecture is not a *state* that can be studied like a still image, but rather an evolving *process* with no end in sight.
On the other hand, Enterprise Architect would greatly benefit from the street-smart wisdom and the ability to grasp the simple persistent truths behind the smokescreen of some self-serving promotions.

Methodologies

Methodologies introduce discipline and predictability into otherwise largely unstructured and un-deterministic processes.
Methodologies digest and summarise knowledge and previous experience of successes or failures into re-useable guidelines that can be applied to ensure the success the next time, or to maximise our chances for success by managing risks and expectations.

Let us offer you a heretic thought: natural intent of improving the discipline and manageability of your design and development processes firmly places you on the right track already, whatever the supporting methodology you may decide to adopt, adjust, or invent.

Studying methodologies and gauging their benefits for the specific challenges you are facing will be an intrinsic and rewarding part of building the Enterprise Architecture.

However, risking attracting the wrath of methodologists, we wholeheartedly subscribe to the opinion expressed by Robert Glass [Glass 2003] when he introduced the Fallacy #5 of the Software Engineering: “Software needs more methodologies”.
And further *ibid*: “We have more methodologies than we know what to do with already”.

Standards and Protocols

Ever since the humble beginnings of the Information Technology, its consumers craved for commonly accepted standards and seamless inter-operability.

Probably, very first concerted effort to deliver the inter-operable software platform was the attempt to standardize on the single Operating System – Unix. Initial expectations were to get an agreement on the common set of commands and utilities, and, if possible, to ensure portability of binaries across different machines.
Technology was not mature enough to deliver such a bold vision without stifling the new developments in IT. In addition, conflicting agendas of consortiums and companies made reaching the broad agreement very difficult in late 1970s and 1980s. As a result, Unix initiative lost the momentum at a crucial time of the Operating Systems war in the commercial market, and had to claw its way back in the next market shakeout in 1990s.
Let’s be frank. Unix and its Linux incarnation are as good an Operating System platform as any other. But market just had to pull the rabbit out of the hat, so to speak, and to create the competition for the dominant platforms from IBM and Microsoft. If not for Unix, market would pull out from obscurity any other solution that overwise would be “also in the running” niche proposition at best.

As a general trend, suppliers of the Information Technology also see the openness and compliance with standards as a strong positive feature.
However, in the past, limited spread and restricted variety of IT offerings unleashed the business forces encouraging the self-contained proprietary solutions. Until 1980s, IT solutions did not have to communicate much with external and, god forbid, different components. Due to the localized and well-defined boundaries of IT services, suppliers of IT could get away with closed, server-based monolithic product architectures, especially when they owned the market.

Middleware solutions of 1980s and 1990s raised the lowest level denominator for inter-operability significantly.
Middleware enabled the collaboration of components and services on larger variety of platforms, with broader geographical distribution. Still, different middleware architectures like DCOM, DCE and CORBA, as well as different implementations of CORBA, had very limited inter-operability in practice.

Here comes the XML and Web Services.
To continue previous line of thought, Web Services, as the ubiquitous middleware inter-operability platform, raises the lowest level denominator even higher (likely, as high as it is going to get).

Web Services comprise the suite of evolving standards that makes a point of ***not*** being dependent on any underlying technology platforms or transport protocols.

If Web Services succeed in delivery to this vision, what could be more generic and portable than the Web Service?
(If history of IT is anything to go by, the tragic answer to this rhetoric question could be: other Web Services standard, or other non-compliant implementation of Web Services. This may happen yet! Let's make sure this does not happen).

Fundamental Web Services standards – SOAP, WSDL and UDDI – establish a basic communication platform for locating and invocation of the Web Service. This is a very good start towards cross-platform application. However, enterprise business processes and distributed workflows require much more than that.

Ability to reach the greater base of customers and business partners in real-time, often over the public networks, comes with additional challenges and exposures.
Dependable commercial Web Service must deal with:

- Security and Privacy of participating customers and business partners, including Identity Management, Authentication, Authorization and Access Control. The more valuable the business or infotainment content of the Web Service is, or it is more visible on the public Internet – the greater the chance of attracting the hacker or other abuser
- Transactional integrity of complex long running and distributed transactions or workflows, possibly requiring response from many separate distributed Web Services in the process
- Guaranteed and predictable high availability of the Web Service. Ability to enforce and track the Service Level Agreement (SLA) for availability and performance of service. This challenge is even more complicated by the need to combat spam and Denial of Service (DoS) attacks
- Rating and billing of the services rendered
- Audit, non-repudiation and reporting
- Legal and ethical issues, both within the single contry and internationally. Local regulations and customs may vary in different countries. Web Service may be liable to comply with local regulations either where the service is run from, or where the service is delivered to

Web Services standards rapidly evolve to address these requirements of the distributed enterprise. We have to watch closely the early warning signs of the fragmentation and duplication in the standardisation efforts.
Prominent organizations that influence Web Services standards are [WWW W3C, OASIS, WS-I].

Probably, one of the best tale-telling signs that Web Services can deliver on the promise of ubiquitous portability is the fact that Web Services pull together new alliances, and bring together companies that not so long ago would be considered strange bedfellows, like IBM and Microsoft.

Next wave of Web Services standards address issues of Security, Transactions, Business Process Execution Language (BPEL), or 'choreography' and 'orchestration' of Web Services.

Technologies and Platforms

Mobility and Pervasiveness

Mobile and wireless capabilities give enterprises new opportunities for delivery of services to employees, partners and customers.

First, mobile and wireless technology unleashes the user, literally. LAN wires sticking from the wall limited the mobility of Information Technology users.
User is being returned in his or hers 'natural habitat', i.e. where actual business and infotainment activities happen. User will not have to interrupt his business just to get back to the office and record the business transaction, or get some information required to close the deal.

Second, mobile and wireless technology potentially expands the customer base beyond traditional commited and computer literate customers who were prepared to sacrifice their usual routine for the privilege of using the IT gadgets.

And *third* but not the least – customer may have a full-time online connection, or just-in-time connectivity to enable responsiveness sufficient for the Real-Time Enterprise, or just for up-to-date news and weather reports.

Apart from technological and useability advances, mobility delivers IT to the mass customer in non-intimidating and accessible way. Combined with delivery of common and sought-after services, mobile and wireless channels become a very appealing and feasible proposition for the mass market.

Major arenas where mobile and wireless technology will deliver most tangible impacts:

- ***Wireless Office***. Un-wiring the office LANs and WANs will provide opportunities for more flexible and agile office solutions. Re-location and re-deployment of staff in response to rapidly changing business will be greatly facilitated, even for the staff with desktop PCs. Rigid office space will evolve into the *Virtual Office* for some more dynamic and mobile enterprises. Radio connections to the communication hub like Wi-Fi (802.11x) and Bluetooth will replace LAN wiring. After the initial setup costs and upon reaching maturity of technology in the short term, wireless connections in the office will drive deployment, maintenance and support costs down
- ***Wireless Home***. Personal computing devices at private home or *Home Office* will multiply, and will require ability to communicate with each other and with servers on Internet. These devices will include not just PCs and PDAs, but 'smart' TV, fridges, watches, spas, toilet seats etc. as well. Smartness of our home appliances will be limited only by our imagination and perceived usefulness of provided services (although, 'usefullness' could be a big stretch in some cases as far as hungry and disadvantaged people are concerned)
- ***Customer on the road***. Private consumers and enterprise 'road warriors' will remain connected to the services and information providers. Mobile phones, Portable PCs and PDAs will evolve, converge and improve, and will become a commodity. Useability requirements for personal compuiting devices will drive them towards further miniaturisation, long battery life, smartness, reliability of device and connection, resilience to rought handling and hostile environment, simplicity of use, price cut. Until personal computing device may become a part of our body (scary thought, isn't it!), we may have to settle for wearable computer that does its job of helping us in doing whatever we are doing, and minimises our distraction from the task at hand in the process. Delivery of services to mobile channels will require special efforts and infrastructure on the server side of the Enterprise while implementing the presentation layer

Easy and broad access to enterprise resources will highlight the security vulnerabilities even further. Threat of misuse, hacking, spam and DoS attacks from the mobile computing device may far outweigh the benefits to the enterprise and to the customer of truly distributed business model.

Hardware Platforms and Networking

Enterprise Architecture benefits from well-performing and reliable underlying hardware platform, but becoming less dependent on it in making architectural decisions.
Hardware (especially when software layers becoming highly portable) has become a replaceable commodity for most enterprise applications.

Operating systems insulate running application from intricacies of multi-processor computer architectures. We can throw in more boards with CPUs and memory, possibly without re-booting the computer.
Clusters of computers also transparent to the software layers above the Operating System.

Storage Area Networks (SAN) is logically to the application is the same old magnetic disk, only bigger and more reliable. However, SAN makes a big difference in the Enterprise Architecture in the storage management.

In addition to providing connections, network infrastructure takes on the tasks of load balancing, high availability, coarse-granular access control and filtering, data protection, caching.

Arguably the most painful limitation of the Internet platform from the point of view of the Enterprise Architecture is the obsolete architecture of Internet itself.
Internet was not designed and built with high volume and guaranteed service levels Enterprise applications in mind. Now we pay for the extreme simplicity of communications by increased complexity of the server-side and network infrastructure, and by inherently weak security and state management.
Like it or not, HTTP and HTML has become entrenched legacy of 21st century, not unlike Cobol until our days. Some new internetworking paradigms, possibly Internet2, may gradually find its way into the Internet and the Enterprise Architecture mainstream.

Application Servers

Two main Application Server platforms that will attract most of attention of application developers are J2EE and .NET.
These Application Servers will continue to evolve and mature, and provide a foundation for portals and enterprise integration suites.

All Application Servers will implement Web Services framework as a major enabler for cross-platform integration.
Web Services implementation in Application Servers will happen competitively as soon as specification standard is ratified, or even ahead of formal ratification, especially if the Application Server vendor happened to be a major player in Web Services standardization efforts.

Despite the good intention of building components compliant to J2EE specification, urgent demands for portals and enterprise suites will exceed the pace of standardization efforts in the Application Server arena.
Deployment of the J2EE-compliant Application Server likely will constitute only fraction of the overall need of the Enterprise. Additions and 'extensions' of the J2EE functionality may exhibit limited portability and be vendor-specific, especially if extension provided by the J2EE Application Server vendor, e.g. IBM, BEA, Oracle and etc.

Also, some gaps in the J2EE specifications will be filled in by proprietary solutions on the Application Server implementations.
For instance, load balancing and high availability is under-specified in J2EE, and vendors are forced to seek their own solutions in building industrial-strength scalable Application Servers.

Human-Computer Interfaces

Advances in how we interact with computers will fittingly complement the mobility of computing devices and pervasiveness of computing services.

We are used to receive the output from computers on the display of our personal computing device (workstation, PC, PDA, mobile phone). In addition to visual input, we can receive voice or vibrating messages on our mobile phones or pagers. Voice messages may be recorded by human voice, or synthesised.
We convey commands and information to computers by typing letters and symbols on the keyboard, by manipulating the mouse or joystick, or, increasingly, by handwriting or speaking into microphone.

As old saying goes, picture worth thousand words. Good old monitor based on the Cathode Ray Tube (CRT) technology will become increasingly obsolete. More portable and energy-efficient solutions poised to replace CRT.
Flat (or, rather, flatter than CRT) Liquid Crystal Displays (LCD) already found their way into Portable PCs and PDAs.

Displays will follow us wherever and whatever we do, and will become a convenient, cheap, resistant to harsh conditions, commonplace commodity. Cardboard displays in retail outlets and gauges with moving parts will become obsolete within decade.

Paper-thin flexible displays will deliver visual images of high quality. Emerging new display technologies include Digital Paper or E-Ink, Organic Light-Emitting Diodes (OLED) and Light-Emitting Polymers (LEP).

Voice recognition and synthesised voice response (including ability to handle different languages other than English) will become an important part of pervasive customer service.

Handwriting recognition will improve, and will become a reliable and viable alternative for consumers using Tablet PCs or PDAs.

Security and Identity Management

Information Technology dramatically increased the number of stakeholders in the customer base for the enterprise solutions. Business bets the farm on smooth and reliable Enterprise Architecture.
In addition, mobility and pervasive computing makes a mass commodity of the enterprise services.

User-friendliness and easy accessibility aggravate serious concerns for privacy of individuals and the security of access to valuable information assets of the Enterprise. This is ever-present and increasing challenge.

Before we even attempt implementing and enforcing access control rules, we better be sure whom we are dealing with in the first place.
Problem of reliable authentication has become more important and, at the same time, more difficult with the advent of mobility. And not just in a technical sense.

We have to realise that *person* who uses the service, and the *device* that is used to access the service provider – are two different entities.
Every mobile phone may be recognised by its unique built-in id on the CIM card, every Digital Certificate on PC or the smartcard is unique, every thing may be reliably tagged by Radio Frequency Identification (RFID), but it does not guarantee that unauthorised person has got the device in his or her possession wrongfully and uses it to gain access in the name of some other person.
For instance, you would be unpleasantly surprised if someone was using your mobile phone without your knowledge and run up the sizeable bill. As far as mobile services provider concerned, this was you, and you should pay.

Let's assume that all authentication hurdles behind us and we successfully resolved issue of *person* vs *device*. (We ignore for the moment the scenario where user of service is not necessarily a *person*, but possibly some other business or service).
Successful authentication provides enterprise with some unique *id* by which the enterprise knows the person. All access control and business rules are built against this person's *id*, or group he or she belongs to.

Mobility and pervasiveness strongly challenges this simple model of Identity Management.
Mobile user is likely to be registered in many places with different service providers, likely under different *ids*.
Think about how many *ids* and *passwords* you have to remember while moving from one service to another. This proliferation of *ids* and different namespaces may get only worse, and can become completely unmanageable, if we do not do something about it.

Evolving standards for *Federated Identity* aim to consolidate and co-ordinate identity and access policy stores in different namespaces. This co-ordination will enable SSO between enterprises or separate parts of the enterprise where user *id* may be different.
SSO mechanisms will involve establishing *circles of trust* between loosely coupled domains and applications, delegation and enforcement of access control rules based on security checks performed in another domain.
Project Liberty [WWW LibertyAlliance] promises to devise standards for *Federated Identity* and access control.

Enterprise Computing

Service-Oriented Architecture

Service-Oriented Architecture (SOA), as opposed to monolithic architecture, is yet another industry buzzword for modular and component-based Enterprise Architecture.

Web Services, as a great enabler and ultimate enterprise middleware, are in the core of the SOA.

SOA is not something that may be delivered to the enterprise in one big bang, but rather an on-going approach in building the Enterprise Architecture.
Likely, enterprises will prime themselves for SOA by componentising their existing architecture, encapsulating and presenting parts of the legacy Enterprise Architecture as re-useable services and facilities. As soon as that is done, service may be packaged as the Web Service in no time.

SOA concept aligns very well with multi-channel delivery and re-purposing of content and services.

Real-Time Enterprise

Real-Time Enterprise (RTE) concept may have two connotations: agility of the Enterprise Architecture in responding rapidly to the changing business demands, and responsiveness of the Enterprise Architecture at run-time in delivering requested services and content.

Arguably, SOA will deliver greater benefit for RTE in the former sense, where SOA modularity ensures better structural agility of the Enterprise Architecture.
Impact of SOA on responsiveness of RTE in the latter sense is less obvious, but we are satisfied that better built and managed Enterprise Architecture will find the way to manifest its benefits at the run-time too.

Note that by RTE we do not necessarily mean instantaneous response, or ‘zero latency’. This is not theoretically possible, and actually is not required. ‘Just-in-time’ response will do just fine, where ‘just-in-time‘ in the context of the enterprise business processes may mean seconds, hours, days etc.

Expect to get more pressure on Enterprise Architecture from the business to deliver RTE.

Enterprise Suites

Market will continue to struggle with temptations of getting the comprehensive monolithic enterprise solution from the single vendor.
This is not a bad idea, provided your enterprise can determine and comfortably predict the scope and boundaries of your business, now in the foreseeable future. Modern enterprise hardly will be presented with such a luxury, especially in such application domains like Customer Relationships Management (CRM), Supply Chain Management (SCM) and Business Intelligence.
Agility of the Enterprise Architecture has become an imperative feature of the modern enterprise.

Proven comprehensive solutions from such vendors like SAP and Siebel will deliver expected and predictable benefits to your enterprise for the advertised functions and components.

Additional challenges and issues for your enterprise may arise when you decide to embark on sizeable customisation and application development outside the box of the enterprise suite. Apart from the significant configuration and development challenges and costs, you are likely to make your life more difficult when vendor upgrades the suite to the new version.
Ask yourself: may be we could be better off in the long run if we gauge our true business requirements and temper our appetite a little. Sometimes it is worth adjusting your own business processes and expectations, and not the product features. It just may happen that enterprise may benefit from the

implementation of the enterprise suite just as well without butchering the off-the-shelf product beyond recognition.

Another harsh reality is that enterprise suite is not the whole world of your Enterprise anyway. Likely, you will have to make great efforts in integrating the enterprise suite with existing and future other suites, applications, platforms, data repositories and business processes, outside the immediate scope of the given enterprise suite.

Skills and Professional Services

IT departments of Enterprises are facing increasingly conflicting demands on the set of in-house skills and human resources.

Complex and comprehensive enterprise suites require great deal of specialized knowledge and expertise, in addition to good grasp of industry-wide standards and technologies like Java, .NET or Web Services.
Enterprises need an outside professional help to close unavoidable gaps, at least in some components, tiers or silos, and at least on some stages of the application life cycle, at least temporarily.

Due to the combination of human, technological and business factors, the dynamicity and ability to adjust is lower in the bogy of in-house human resources than in the agile Enterprise Architecture that feverishly tries to follow and pre-empt changing demands of the core business.

Arguably, in-house Enterprise Architects remain most resilient constant in the body of Enterprise IT human resources (after IT managers, of course).
If nothing else, manager must have a local technical expert who will verify the suitability and sanity of proposed solution and quotes, and keep Professional Services consultants honest, figuratively speaking (we do not question here professional honesty of external consultants, but they certainly may have different business or professional agendas).

Narrow technical skills will make position of permanent employee vulnerable in the envirinment of agile enterprise. Technical staff must react by making conscious efforts towards:

- Expanding and diversifying their technical expertise across various hot technologies and products by getting involved in different projects and by assuming different responsibilities. In addition, strive to improve own competence by making individual efforts outside your immediate job or project, be prepared to do this on your own time and money if necessary
- Seeking opportunities for technical management, mentoring, leadership and higher accountability and visibility
- Increased understanding of business management and business drivers
- Assessing the value and visibility of your contribution to the business of the enterprise. Make sure you are in position to articulate the value of your contribution
- Building and nurturing good professional and social relationships with network of peers and co-workers. Formal organisational hierarchies not necessarily determine who will influence opportunities for new openings and future plum projects

Technical aspects of application development and implementation of the cutting edge solution will expose gaps in available in-house skills in the enterprise.
Likely, there will be insufficient time to acquire new skills locally to ensure the high quality application development. Either way, risk minimisation requires wealth of existing proven expertise before the project started, and the in-house team is not going to get this proven expertise in time.
Also, Enterprise may not require constant use of these skills on on-going basis, and the expense of re-training or permanent hiring will not be justified in the long run.

Maintenance and support of diverse platforms and enterprise suites may also necessitate enlisting the help of external Professional Services providers.

In addition to consulting services, and independent on them, Enterprise may decide on outsourcing of some of its platforms, applications or functions.

For instance, networks and application platforms becoming a commodity to such an extent that Enterprise presented with many viable options for outsourcing of all or part of IT services and platforms. Enterprises may use VPN on a public network to implement their intranets, or use data centres for hosting of their computing resources, databases, or applications.

Professional Services providers will continue to enjoy large footprint in the Enterprises.

Grid Computing

Another concept that received a lot of attention in academic circles and in the specialized high-volume computing applications is *Grid Computing*.

Grid is a technology for parallel computing by combining the power of loosely coupled computational and data resources, possibly owned by different organizations. Single application on the *Grid* can draw on resources of many individual computers and databases, possibly running on different platforms. Note that *Grid* is markedly different from the computer cluster or from the multi-processor computing device.
As a result, depending on what type of combined resource is being pulled together for sharing the workload, grid types could be *Computational Grid* or *Data Grid*.

Grid Computing is an over-hyped concept, and is not well defined. We need to seek clarity of what exactly the grid proponents mean by grid. We must assess suitability of the *Grid* for the particular enterprise applications carefully.
Specifically, as with any highly distributed application running on heterogeneous dynamic platform, Enterprise Architect must look carefully into service levels, metering and managing resources usage, billing, security, transactional and data integrity. This list of possible concerns in running the enterprise application on the grid is by no means complete. Depending on the context of your application, you may have to revise this list and priorities of the issues in it.

Having alerted you to the need of cutting through the hype, there is no denial that *Grid Computing* already found glorious implementation in such collaboration and massive computation projects as Search for Extraterrestrial Intelligence (SETI), as well as complex modelling and number-crunching in aero-dynamics, weather forecasting, seismology and geological exploration.

Virtual Society

Pace of the technology progress makes the predictions in the old sci-fi books look naïve and outdated. However, the biggest qualitative changes occurred in our society as a whole.

Information Technology penetrated every aspect of our existence and wellbeing, the way we conduct our business, entertain ourselves, build our daily lives.
Here is the scary thought for you: we rely on the Information Technology so much that the single day without it may seam unthinkable – our world as we know it will collapse.

IT is the catalyst and enabler of vital services and facilities that we begin to take for granted.
At the same time, IT has become a ruthless differentianting factor between power and weakness, modernity and backwardness, privilege and disadvantage, wealth and abject poverty, security and exposure (although, jury is out on that one, i.e. which way the impact of IT affects security and privacy in the society).

Advent of pervasive computing will make us even more reliant on readily available services and information of any kind – whenever, wherever and however we request it.
Furthermore, human being is becoming a slave of his tools, an extension of the end-user device on a far-reaching network. Customer is becoming a commodity, always available online to request and consume multitude of services, and to pay for them without delays.
Even better, as soon as customer is available for the delivery of service over the network, all bets are off for the type of service that may be potentially offered. Service providers will try to reach the person with business or infotainment services on the available mobile devices even if person did not initially

consider those services at all.

Personal devices will increasingly consolidate capabilities for delivery of all or most sought after services (both for business and infotainment) on the same customer device that is always in the possession of the person.
Enterprises may think about themselves as service-oriented. However, consumers of services strive to consolidate and streamline their access channels to the services across all types of services on offer. Consumers do not wish to be monopolised by the single service provider.

In order to strengthen the grip on the customer, enterprises will consider offering integrated and bundled services, so that customer does not have to stray for the additional services elsewhere.
This business strategy is old as the world. The big difference in the context of the modern technology is that finally we are able to reach all the customers in existence out there, and to have them online full-time.
The battle for the limited number of tollbooths on the information super-highway is well and truly began.

Let's not get carried away though. Hopefully, we should be able to balance the unstoppable technology race with the understanding that resources of the mother Earth are limited. With current and future technology advances we can easily pull the rag from under our own feet, so to speak.
We (mankind) will have to re-think our use of the energy sources and our impact on the environment, if we are to stay on this planet. Information Technology can assist greatly in the rational use and recovery of resources, or accelerate the degradation of the environment. Choice is ours.

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