

Smart environment of connected things and applications

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The *smart* environment of connected things and applications that is now emerging, e.g., smart cities, can be viewed as an integration of multi-layer segments that are integrated seamlessly both organically (green field) and as modified overlays (brown field). The basic essential building blocks in both cases are given below in the order that they will or have emerged:

- A very-high-bandwidth physical layer consisting of optical, copper and wireless networks duly integrated utilizing multi-protocol switching and routing equipment. This will of necessity include OFC, copper, 5G, 4G, IBS, and related protocol and standards-based technologies that are interoperable. This is well established with internet protocol being the binding protocol of choice. Software-defined devices, CoS, QoS, and IPv6 will now become essential rather than optional and may have to be relooked at for expansions as newer requirements emerge – QoS/CoS proxies raising their heads.
- More and more embedded networks, which may be software-defined or hardware-derived or may be hybrid will form a sub-layer of the networks, making it more complex and exciting.
- Since demand for applications will outrun deployment of the requisite grade due to cost and prioritizations, we are likely to see emergence and utilization of more and more sophisticated peer-to-peer integrated networks as another sub-layer.
- An array of sensors that seamlessly integrate on the physical layer and thus make an array of a sensor-based network, which when exploited becomes Internet of Things or IOT. The standards for these devices are under formulation and should be promulgated soon. This will enable standards-based devices to be produced leading to compatibility and interoperability amongst them.
- A huge quantity of structured standards-based digital data will be produced by the above interconnected devices. There are the connected existing non-structured data sets in existence that need to be factored in. This leads to newer challenges/dimensions for handling the data streams. These are listed (but not limited to) below:
 - Timely transmission and storage with redundancies – data centers, which have the requisite physical and electronics prerequisites and can be cloud-based.
 - Newer ways of making data available to limited user sets beyond the cloud to ensure technical/financial cost effectiveness. Solutions will also have to cater to poor availability of Wide Area Networks as also user timelines and security requirements. Emergence of concepts of Fog and peer-to-peer caching protocols like Squirrel and Pastry, if used innovatively, cater for all these requirements.
 - A new and much more encompassing paradigm of cyber security (which has to be end-to-end and will include inter- and intra-communications among users, devices, and networks will have mind-boggling permutations and combinations) will have to be defined as the earlier concepts may not be able to fit the bill of an emerging class of networks, devices, and applications.
 - Identity management, data tagging, NAC protocols, and multi-dimensional firewalls will see an upsurge in development to cater for the complexities that are emerging. Traditional LDAP, OLAP, and OLTP will come in for review in view of the gigantic and multifarious applications with dynamic rapidly changing requirements.
 - Physical security will rapidly change its dimensions into a blended IOT-assisted flavor with guards becoming more and more akin to cyber warriors.
 - Data sovereignty and data privacy will need to be physically provided and technically utilized for optimization and cost effectiveness within multiple cross-functional and cross-national legal frameworks.
- The data so stored and secured will also require to be manipulated securely and within legal frameworks, in an acceptable timeframe and with outcomes/outputs,

which may have the following flavors or combinations of these and other options as they emerge:

- Traditional structured outputs employing tools like bi.
- Unstructured manipulations employing big data prescriptions. Trigger to control systems in an automated or semi-automated manner to initiate a set of pre-defined or dynamically defined on the fly actions. This suits IOT and MIOT. This will of necessity sometimes incorporate results from and at other times feed into embedded or overlaid AI and ML functions.
- Top-level senior management will require effect-based visualizations of this data sets in a multitude of predictive and statistical formulations derived for again a permutation and combination-based array of relevant variables. Many strategic decisions will depend on these decision-support systems MIS-based visualizations. Technologies like predictive analysis, deep learning, machine learning, expert systems, artificial intelligence, augmented reality, virtual reality, and more will interact and enmesh to provide the outputs that can be as perfect as possible to suggest and help in sound strategic decision-making based on data.
- Today there are many applications and services, which mostly run standalone. More aspirational applications either must cater for or be provided with their technical requirements through virtualizations on closed networks or at best through cloud services. They may aspire for becoming fully *smart* securely and cost effectively, but imperatives stop them from that goal. However, in the emerging environment, the owners of these applications, be it a government department or an entrepreneur, will have the option of doing what they are best at doing and ride on a standards/protocols-based resilient, secure, interoperable, scalable, adaptable, and technically updated system of systems provided by a collaboration of public-private partnerships as outlined above. We will soon see multifarious *smart* sectoral applications ride on this integrated system of systems, having tailored and appropriately segmented subsets of all the above offerings as required by the user for delivery of his offering enterprise-wide. Technology isolations within the system can even provide secure vaulted enterprise-wide applications with user-defined security/QoS/CoS in near real time. Users of this *smart* infrastructure can be, but is not limited to, any application requiring *smart* operations over a large geography. While traditional uses are generally well known, some emerging areas are listed below:
 - *Smart* governance and *smart* applications/monitoring of utilities in city administration.
 - Block chain applications like peer-to-peer uber communities-based offerings using the trust and graduation factor of block chain technology.

- AR/VR-based teaching on a hub-and-spoke model to overcome cultural, geographical, and economic barriers and disparities.
- Record keeping of all types.
- Just-in-time allocation of scarce resources including skilled humans.
- Adding a dynamic dimension to applications like job portals/property search, and more.
- Routine and hazardous tasks relegated to autonomous technical agents.
- Real-time IOT monitoring of convoys with drones capable of IOT-based reactions.
- Weapon inventory and its use.
- Augmenting communication and surveillance facilities in war/disaster management without physical movement of resources.
- Optimizing multitude of similar resources without losing ownership, autonomy, and effect.
- Predictive data visualizations of all hues and adaptations.
- Image enhancement and its integration.
- Isolating deliberate trojans and bugs in foreign-made equipment.

With new technologies mentioned above will come a system of systems that will offer a unified access to users, tailoring their requirements to a unique managed bouquet. Backend will be a collaboration of extremely complex technologies that collaborate based on standards and protocols. With this will also emerge newer risks and opportunities, both technical (like security, collaboration, integration) and human related.

Many of the traditional roles of today will be taken over by robots using AI, ML, and DL. Many functions will be subsumed by robotics, IOT, AR, VR, and software-defined components. A larger number of newer roles will, however, emerge. These very technologies, which will take over traditional roles, will create jobs for workers in a different realm that will primarily be based on data. Multi-tasking and multi-skilling will raise its head, integrators and aggregators will be a new stream. Skills based on knowledge will be of paramount importance. Decisions and actions will be increasingly based on near real time DSS and data visualizations. They will be much faster and have massive effects over larger geographies. Since data will become the currency and weaponry of choice (along with water), statecraft, strategy, and method of conducting business at all levels will change. In fact, change is already visible in some measure. The crescendo will continue till saturation and then a new paradigm will again emerge. However, human mind will remain supreme. But we too must change and adapt in an informed manner so that we remain current and relevant. Therefore, let us embrace the change and prepare ourselves adequately for the inevitable. ●