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Knowledge
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The Internet-of-Autonomous-Things (IoAT)

Compsim White Paper

The Internet-of-Things (IoT), first introduced in the late '90s[1], recognizes that the Internet facilitates linking "a large number" of addressable connected devices. IPv6 opens the door to a larger address space, thus enabling even more connected devices. For example: IPv4 provides 4,294,967,296 possible addresses, and IPv6 provides 340,282,366,920,938,463,463,374,607,431,768,211,456 possible addresses.[2] So there is a significant potential about to be released. But (hypothetically) if all those devices were implemented and started talking at once!!!! This would be a real challenge to systems relegated to Moore's Law and Guilder's Law. Stated differently: it will be hard for your personal computer and your 1000GB network interface to handle all of the data, not to mention the memory issues you would have to deal with - even if you do upgrade your computer every year. So what will change? This paper proposes that it will not be practical to network all of the simple sensors that might be added to the Internet and also hope that your system can make sense of it all. What will be "connected"; however; will be an abundance of devices that operate autonomously: The "Internet-of-Autonomous-Things" (IoAT).

So what is an Autonomous-Thing? It will be an information source that has the intelligence (judgment and reasoning skills) to operate autonomously and communicate / collaborate when appropriate or necessary, and act on its own. Some of the "Things" will be fixed or stationary. Some will be mobile. Unlike devices of today that are "programmed" to manipulate information, the next generation of these devices will told *how* to think and how to act on the problems themselves. Tasks might include functions like "protect", "detect and adjust", "track", "control", "evade", "hide", "act", "proceed", "retreat"; all with relativity (apply a relative amount of selected resources). Some of the devices will support multiple objectives simultaneously. In other words, some of the knowledge they accumulate will have multiple uses and might be shared with other information interpretation points (other Autonomous-Things) so they can accomplish their tasks.

The key differentiator between the "Things" of today and the "Things" of the future is that future systems ***will be able to apply judgment and reasoning, and they will be given the responsibility to act accordingly***. These judgmental problems commonly need to be addressed by balancing alternatives, as there will be no one perfect answer to address all of the "sometimes conflicting objectives". Today's Things are mostly programmed with conventional IF | THEN | ELSE sequential programming techniques, because these systems are calculating answers to relatively simple problems. They are primarily "manipulating and transforming" information according to static rules. To understand the difference, consider when you call in an expert for help. You go to a doctor because you expect (hope) the doctor

[1] Internet of Things: http://en.wikipedia.org/wiki/Internet_of_Things
[2] The Sheer Size of IPV6: https://pthree.org/2009/03/08/the-sheer-size-of-ipv6/

can accurately evaluate your symptoms and recommend the best treatment. The doctor may give you several treatment options, where each has its associated costs, risks, success factors, and impact on quality of life. Together you match your financial situation, life style choices, etc in order to choose how to proceed. In this example, alternatives are considered and evaluated to make a decision. Alternatives are balanced to select the best approach for you. The choices cannot be evaluated in isolation; they have to be evaluated together to make the best choice. The situation needs to be re-evaluated and the treatment adjusted as the situation evolves. You can see this evolution (at the high level) in the military space with the deployment of robotic weapons, and in the transportation space with self-driving cars. But it will also take place at a low level (at the source of information) where complex behaviors can be introduced to act when changes are first detected. Subassemblies of systems will include webs of connected Autonomous-Things, each with its own set of responsibilities; operating independently and collaborating with other Autonomous-Things when necessary. Humans and Autonomous-Things will work together as both providers-of-information and as actors-on-information.

Compsim's Knowledge Enhanced Electronic Logic (KEEL®) Technology[3] was developed to capture and package this *adaptive expertise* for deployment into the next generation "Things". Therefore it will stimulate the transformation from just a population of connected things to the "Internet-of-Autonomous-(Expert)-Things". While there may be some initial trust concerns with the "Autonomous-Things", KEEL Technology allows the "Things" to "explain" their decisions and actions in a user-friendly way (without having to consult mathematicians or the software engineers that wrote the code). This will make the IoAT far more transparent than their human counterparts. Ultimately, the human population that uses and benefits from the Autonomous-Things will demand and expect that level of transparency. The Autonomous-Things will work as extensions to human organizations to deliver a better quality of service - at lower costs.

[3] About KEEL Technology: http://www.compsim.com/AboutKEEL.htm