Hardware for Industrial IoT fog and mist computing

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The latest industrial Intel Atom processors are empowering new, small form factor systems for industrial applications. IIoT hardware optimization using a bottom-up approach gathers momentum and the ecosystem of providers of fog and mist-computing solutions gets new hardware.

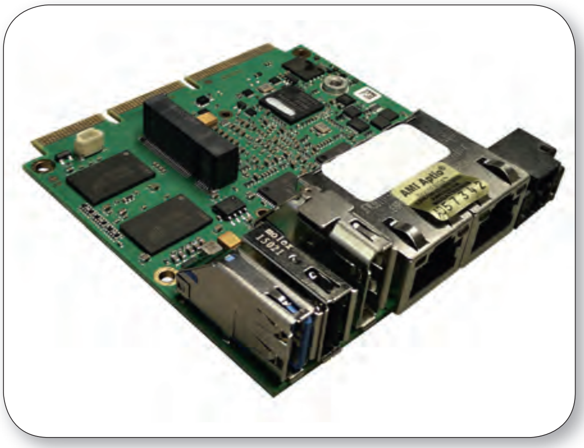

Figure 1. With the ADLE-3800SEC a Microsoft Azure certified 75 mm x 75 mm Edge Connect SBC with Intel E3800 ATOM processor is offered.

■ Industrial IoT (IIoT) continues to expand into the far reaches of the industrial and commercial environment. In many of these environments (think smart grid, wind farms, oil and gas, autonomous vehicles, etc) reliable connectivity to the cloud is plagued by intermittent connectivity, latency and security issues. Add to that the fragmented reality of trying to build a cohesive IIoT cloud solution from the vast array of legacy and modern equipment, machinery, control software, and disparate databases, and the task begins to take on monumental costs and time proportions. To address some of these issues, recent attention has turned to pushing IIoT hardware, data storage, data analytics and communication resources nearer to the IIoT edge in close proximity to the things being controlled. First and foremost, this helps address intermittent connectivity and latency issues resulting in better uptimes and overall efficiency, but it also provides more optimal distribution of resources and helps limit the scope of the security task.

Social media conversation and many recent articles have centered on these new IoT/IIoT computing strategies. Extending the analogy of the IoT/IIoT cloud in the meteorological sense, this idea of moving IIoT resources closer to the things being controlled is often referred to as fog or mist computing. If fog computing defines IIoT resources in close proximity to things, mist computing defines IIoT resources directly on or in things. Promoted by the Open Fog Consortium with founding members including Intel, ARM, Cisco, and Dell, fog computing is defined as, "...a system-level horizontal architecture that distributes resources and services of computing, storage, control and networking anywhere along the continuum from cloud to things." Fog computing addresses the needs of IIoT at a local level providing distributed data and control resources for increased efficiency and reliability. Fog computing makes use of new software-designed automation elements like software-PLC controllers and digitization of equipment and processes with sufficient detail as to be termed, digital twins. These virtual and digitization strategies are a key component in addressing the fragmented state of communication and control at the lowest hardware levels.

Extending this analogy one step further, the term mist computing is used to refer to those compute, communication, and storage elements integrated directly into or onto machinery and equipment thus extending IIoT computing to the hardware level. According to industry expert Angelo Corsaro, Ph.D. one of the primary objectives for mist computing is "...enabling resource harvesting by exploiting the computation, storage, and communication capabilities available on the things." Table 1 lists the typical hardware necessary at the various IIoT computing layers. At the cloud level, the hardware elements revolve around server farms, immense in some cases, and sophisticated enterprise-scale control centers designed to store and analyze truly massive amounts of data for management, control, and monitoring of the enterprise down to the factory floor. At the fog computing level, the scale of the equipment takes on smaller proportions via server rooms and local storage supported by an array of smaller networking elements including gateways, routers, and industrial PCs with local databases enabling local data analytics, monitoring and control of things. Mist computing completes the resource migration picture by extending key hardware elements of fog computing directly onto or into things albeit in much smaller embedded form factors. Beyond providing the equipment control and monitoring function, this hardware must also support fog and mist computing sharing of resources.

The reality of close proximity or direct physical integration onto/into things is no small feat. From an environmental standpoint, the hardware must be able to survive the same environmental conditions (temperature, humidity, mechanical stress, etc) as the things

IIoT Layers	Hardware Resources
Cloud	Remote server farms and control centers for data analytics, monitoring and control.
Fog	Local computing hardware for data storage, analytics and networking
Mist	Embedded systems and hardware on or in "things"

Table 1. Hardware requirements according to Industrial IoT (IIoT) layers.

Figure 2. Microsoft Azure certified, ADLEPC-1500 embedded PC.

into which it is integrated. Increasingly, these things are in exposed or remote locations making the choice of mist computing hardware a critical design element. As well, the product lifetime and quality of mist computing hardware cannot degrade in any way the overall quality and product lifetime of the machinery or equipment which it is controlling. From a vendor standpoint, this translates into a careful selection of hardware BOM components that optimizes product lifetime and quality. As well, the circuit architecture must be such that operation over all temperatures and voltage conditions is guaranteed - all while maintaining a compact form factor suitable for embedded integration.

From a functional standpoint, fog and mist computing hardware must support multiple cores with virtualization technology to support software-defined automation and digitization requirements. This hardware must also provide the necessary performance for on-machine data analytics, control, monitoring and communication with other elements of the mist or fog computing network. Addressing many of these needs are new, small form factor embedded CPUs and system offerings from companies like ADL Embedded Solutions and others, which are bringing full-featured compact CPUs and industrial embedded PC designs to market.

A good illustration of this is new ADLE3800SEC designed with the latest industrial Intel Atom processors with extended junction temperatures of -40 °C to 110 °C. This compact (75mm x 75mm) edge-connected SBC is a full-featured, standalone SBC for rugged, embedded applications. The **edge-connect architecture** allows for added I/O expansion and connectors in a variety of baseboard/breakout board configurations (flat, vertical, odd-shapes, etc) for rugged, portable/mobile applications such as unmanned systems, robotics, remote data logging, wearable computing or portable medical devices. The ADLE3800SEC is suited for rugged, extended temperature intelligent systems with stringent size, weight, and power (SWAP) requirements. It boasts a wide input voltage (20-30VDC), DisplayPort, USB2.0, USB3.0, and two GLAN ports with support for DirectX 11, Open GL 4.0, and full HD video playback. The SBC is capable of standalone operation or easy integration with expansion I/O boards, which helps provide a single computing board across equipment and product profiles for consistency of hardware, firmware and BIOS.

Compact solutions like the ADLE3800SEC or the derivative mini ADLEPC-1500 also ease the task of IIoT deployment by maintaining compatibility with IoT development platforms like Microsoft Azure and others to help optimize security and overall stability. Their substantial functionality and performance at generally lower cost helps reduce the cost of fog and mist fabric creation - necessary for efficient distribution of data storage and data analytics for fog and mist communication, monitoring, and control.

The ADLEPC-1500 is a full-featured embedded PC with dimensions of 86mm x 81mm x 33mm (W x D x H). It is based on the compact ADLE3800SEC SBC and is characterized by a wide input voltage range of 20 to 30 VDC (optionally up to 36 VDC) as well as a large temperature range of -40°C to + 85°C. This makes it a solution for a variety of applications and environments, such as unmanned systems (UAV), industrial controls, robotics, traffic management and monitoring.

The embedded PC is housed in an industrial CE/FCC-compliant housing with mounting options for DIN Rail, VESA and direct mounting. The SBC EdgeConnect architecture allows the embedded PC to be easily extended by additional interfaces and functions according to customer-specific requirements. This makes it possible, for example, to use customer-specific expansion cards over several generations of processors without requiring a lot of redesign or development. Significant savings and less risk in development and design are immediate advantages. As this bottom-up approach to IIoT hardware optimization continues to gain momentum, and the ecosystem of hardware vendors providing fog and mist computing solutions grows, we can expect to take a giant step forward in the near future toward making the promise of IIoT a reality. ■