ADLINK
Leading EDGE COMPUTING

Technical Article

High Performance HEVC Codec Opens a New Chapter for the 4K UHD Era

Leverage Intel® Media Server Studio and Intel® Iris™ Pro Graphics P580 to make hardware video processing more efficient



www.adlinktech.com

LRI Distribuída no Brasil pela LRI | vendas@lri.com.br | 51 2129-3000

High Performance HEVC Codec Opens a New Chapter for the 4K UHD Era



Table of Contents

Introduction P1
Why do we need 4K? P2
Why do we need HEVC? P3
ADLINK hardware solutions P5
Conclusion P7
Appendix: Open Compute Carrier-grade Edge Reference Architecture (OCCERA) P7

Introduction

For the last 30 years, the rapid developments in electronics and computer technology have continually improved people's visual enjoyment of video from VCD, DVD, Full HD (1080p) up to the development of the current standard, 4K UHD. The efficiency of video encoding algorithms has also advanced significantly from MPEG-1, MPEG-2 to H.264, and now HEVC (also known as H.265), helping to advance generation after generation of video industries. Currently we are entering the Ultra High Definition (UHD) era with 4K resolution and HEVC encoding. This article will discuss why 4K/HEVC will become a stringent requirement and change the encoding algorithms used in video-related industries. It will also introduce ADLINK Technology's MCS-2080 cloud media server and how it uses the highly efficient HEVC codec to help video service providers address the challenges of providing 4K video to their customers.

LRI Distribuída no Brasil pela LRI | vendas@lri.com.br | 51 2129-3000

Why do we need 4K?

The name “4K” originates from the number of horizontal pixels in an image, with two common resolution specifications: 4096 x 2160 and 3840 x 2160. The resolution of 4K is 4 times that of 1080p with the number of pixels increasing from 2 million to 8 million. This means that 4K can display images with finer details and more realistic textures. Television manufacturers are continually developing new growth markets and have successfully transformed 4K UHD into a current trend in the consumer electronics industry. In addition, 4K has also started to be widely applied in commercial applications such as video conferencing and video surveillance.

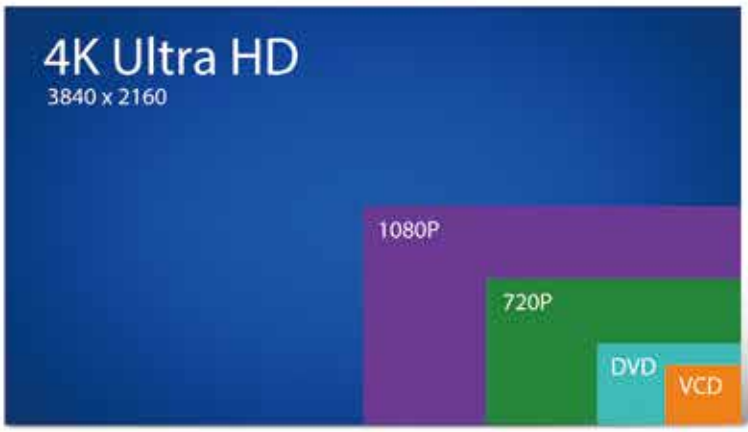


Figure 1
Comparison of different resolution sizes, from VCD to 4K

4K brings a visual feast

According to the market research agency WitsView, 4K TV panels exceeded 30% of TV panel shipments for the first time in Q1 of 2017*1. As 4K becomes mainstream, it brings huge opportunities for TV manufacturers, video program makers and broadband service providers. Video is increasingly the dominant traffic of the wired and mobile Internet, with users’ interests having shifted towards higher quality viewing experiences and live streaming of events and tournaments. 4K technology will drive the development of the entire video industry chain, including video recording, production, transmission and playback. Many companies participate at each of these stages and there are even mid/high end mobile phones on the market that support 4K video recording. Today, most major video websites have begun providing 4K video on demand, hoping to get and stay ahead of the competition. Many IPTV set-top boxes on the market also support 4K and major domestic Internet TV operators are using free 4K content as means of converting non-paying users into paying customers. Although the widespread adoption of live and on demand 4K video broadcasts will not happen overnight, the availability of 4K video will become increasingly commonplace.

Video conferencing: 4K immersion gives a sense of being on-site

With the arrival of the Industry 4.0 era and a further step towards economic globalization, video conferencing and its related applications are being used more and more widely. In addition to traditional multi-party video conferencing, it now encompasses remote education, remote medical treatment, remote recruitment, and integrated command and dispatch systems. Video conferencing applications focus on cross-region, face-to-face communication with resolutions ranging from standard to high definition. 4K UHD video conferencing systems provide improved clarity, color reproduction and smoothness to let participants feel more immersed in the conference setting. In application scenarios such as remote medical treatment and integrated command and dispatch systems, 4K brings quantitative to qualitative enhancements for improved collaboration. During remote consultations, the high-resolution medical imaging provided by 4K allows doctors to make more accurate judgments, and the ability to clearly display patient vital signs and data on the same monitor enables greater efficiency. In integrated command and dispatch systems, the ultra-high resolution of 4K makes the splicing of large screen systems more efficient, providing powerful on-site situational awareness to decision makers.

*1: 4K Penetration Surpassed 30% for First Time in 1Q17 LCD TV Panel Shipments, Says TrendForce. http://press.trendforce.com/press/20170424-2829.html

Distribuída no Brasil pela LRI | vendas@lri.com.br | 51 2129-3000

Video surveillance: 4K makes surveillance more secure

For the video surveillance industry, the biggest values brought by 4K UHD are clearer images and richer details. Since its resolution is 4 times that of 1080p, 4K images can be enlarged up to 4 times with the same detail retrieval of 1080p, enabling security system providers to better meet customer needs and discover new areas for profit growth. For example, the high resolution of 4K allows the use of cameras with an ultra-wide video surveillance area in applications such as freeways and public areas, with fewer cameras required to provide the same level of surveillance. This results in savings on deployment costs and also allows more efficient visual management and response coordination. In urban areas, the need for 4K video surveillance is even more crucial. When an anomalous event occurs, smart video analysis systems can acquire more details from a 4K image. Taking facial recognition as an example, having facial data with four times the resolution of 1080p allows for a significant increase in speed and accuracy. In large-scale monitoring of spliced video from multiple cameras, use of 1080p resolution source video can result in difficulties when there's the need to enlarge the image to perform detail tracing. But if 4K video is used to perform the splicing, clear detailed images can be acquired even after being enlarged several times.

In general, whether watching video for entertainment, video conferencing or video surveillance, the need for 4K applications is growing quickly. The greatest challenge currently facing 4K UHD video implementation is the high bandwidth requirement. When dealing with encoding of 4K, the current mainstream H.264 encoding technology is inadequate.



Why do we need HEVC?

The High Efficiency Video Coding (HEVC, also known as H.265) is a video compression format standardized by the ISO/IEC MPEG and ITU-T VCEG. Its goal is to achieve higher quality video stream transmissions with existing available bandwidths. HEVC is in many ways an extension of H.264, having similar encoding architectures, but it provides many new tools to lower the bit rate. For example, in the encoding unit every macroblock in H.264 is 16x16 pixels whereas the coding unit of HEVC ranges from a minimum of 8x8 to the maximum of 64x64. HEVC also provides more "intra" prediction modes as well as better motion compensation processing and vector prediction methods. Subjective tests show that HEVC provides video playback with the same quality as H.264 using roughly half the bandwidth.

LRI Distribuída no Brasil pela LRI | vendas@lri.com.br | 51 2129-3000

HEVC: the best codec for 4K video

A main obstacle with providing 4K video on demand services is the bandwidth required for video transmission. The H.264 codec currently used for 1080p video would require a bandwidth 4 times higher for 4K UHD, going from 4Mbps up to 16Mbps respectively. According to the "China Broadband Rate Status Report" issued by the Broadband Development Alliance, the average download speed of China's public fixed wireless broadband network reached 10.47Mb/s in the second quarter of 2016. But this is still insufficient for stable 4K video transmission. When HEVC encoding is used, the bandwidth required for transmission can be reduced to 8Mb/s and therefore can be transmitted on most domestic broadband networks.



The same video transmission problems exist for 4K video conferencing and video surveillance. Using H.264 encoding for 4K video conferencing over a wide area network will make it difficult to achieve smooth video transmission, and even more problematic to achieve 60 fps frame rates. HEVC can reduce the bandwidth required for transmission by one half, allowing 4K video conferencing to be realized earlier without having to wait for available bandwidth to increase. As video surveillance is frequently deployed over private networks, transmission bandwidths are not necessarily a bottleneck. But using the HEVC codec can greatly reduce the bandwidth and infrastructure requirements for private networks. The HEVC codec is currently the only practical choice for 4K video transmission, and the popularization of HEVC codec equipment will significantly promote the use of 4K applications.

HEVC: powerful, but resource intensive

The HEVC video coding standard still follows the block-based hybrid coding framework, but when compared to H.264, it has many technical innovations such as the expanded coding size, flexible block-based inter-/intra-picture prediction modes, sample adaptive offset, adaptive loop filter and parallel design (Table 1). HEVC provides double the compression efficiency of H.264, but also brings a significant increase in processing requirements. The computational demands have been a problem for the promotion of HEVC applications. According to Intel tests*2 , although the compression efficiency of HEVC is only double that of H.264, the necessary compute power to encode at the same speed can be more than 10 times as high.

Technical module	H.264	HEVC
Coding block size	16x16, 8x8, 4x4	64x64, 32x32, 16x16, 8x8
Intra prediction	Maximum of 9 modes	Maximum of 35 prediction modes
Prediction size	16x16, 16x8, 8x16, 8x8, 8x4, 4x8, 4x4	2Nx2N, Nx2N, 2NxN, nLx2N, nRx2N, 2NxnD, 2NxnU, NxN (N=4, 8, 16, 32)
Inter-picture prediction	Space-based motion vector prediction	Time and space-based Advanced Motion Vector Prediction, Merge, Skip
Transform block size	4x4, 8x8	4x4, 8x8, 16x16, 32x32
Loop filter	De-blocking filter	De-blocking filter, sample adaptive offset
Parallel architecture	Frame, Slice	Slice, Title, WPP

In order to guarantee the compression rate and video encoding quality, reducing the complexity of the HEVC codec is the key to promoting HEVC technology. Current mainstream practices include the use of hardware assisted HEVC encoding and performing software optimization so as not to adversely affect HEVC decoding.

*2: Presented at Intel ISTEP Seminar, May 27th, 2015, Shanghai China

LRI Distribuída no Brasil pela LRI | vendas@lri.com.br | 51 2129-3000

ADLINK hardware solutions

The ADLINK MCS-2080 Media Cloud Server is designed specifically for video processing, making it extremely suitable for next generation video services that utilize HEVC encoding, including video on demand/live broadcast services, smart video analysis, high definition video conferencing and WebRTC-based internet video applications.



Product introduction

The MCS-2080 is the next generation Open Compute Carrier-grade Edge Reference Architecture (OCCERA*3) -based Media Cloud Server. Powered by the Intel® Xeon® Processor E3 v5 Family with integrated Intel® Iris™ Pro Graphics P580 supporting Intel® Quick Sync Video, the MCS-2080 is especially suitable for video processing tasks such as video transcoding, video analysis and video conferencing.

Key features of the MCS-2080 are listed below:

1. Supports 16 Intel® Xeon® processor E3-1585 v5 in eight dual-system compute nodes. The Intel® Xeon® processor E3-1500 v5 family, manufactured on Intel's latest 14 nm technology, offers dramatically higher CPU and graphics performance compared to the previous generation and provides a broad range of power options and new advanced features that boost edge-to-cloud performance.
2. Utilizes the latest Intel® Quick Sync Video technology and supports HEVC/VP9 hardware encode/decode to efficiently decode video streams, freeing the processor to complete other tasks.
3. Dual-redundant switches; each switch provides 1G bandwidth for each compute node and 4x 10G interfaces for uplink
4. Provides 8 PCIe x8 slots for scalable expansion
5. Supports intelligent system management based on IPMI with web-based interface to reset, power on and power off the system as well as Serial Over LAN
6. Uses adaptive smart fan speed control to reduce fan noise and power consumption as much as possible
7. Dual-redundant power supplies provide power health status monitoring and warning
8. ADLINK MediaManager software provides reference source codes for frequently used end-to-end video applications to speed up the customer's application development



*3: See the introduction to OCCERA in the appendix.

Figure 2 ADLINK Media Cloud Server MCS-2080

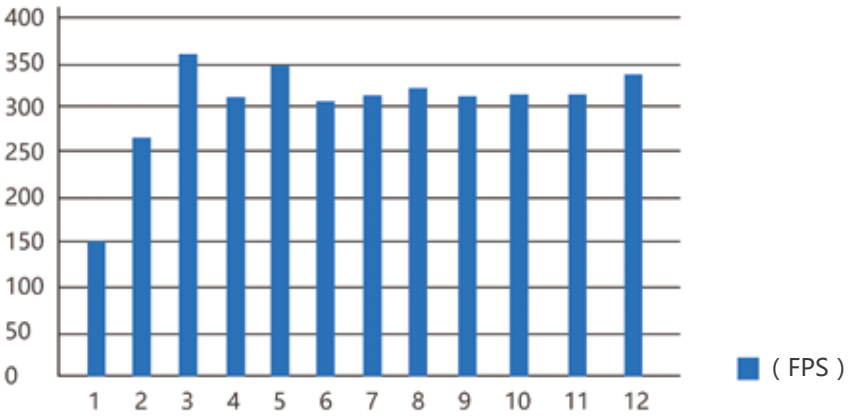
LRI Distribuída no Brasil pela LRI | vendas@lri.com.br | 51 2129-3000

Ultimate HEVC codec performance

As an illustration of the MCS-2080's video transcoding performance, tests were performed by executing Intel® Media Server Studio on a single system to transcode 10 seconds of MPEG2 1080p 30fps video to HEVC 1080p 30fps. The results are shown in the table below.

Video transcode performance: MPEG2 1080p 30fps to HEVC 1080p 30fps, single system

Number of parallel transcoding channels	Transcoding time (seconds)	Total number of video frames	Transcoding frame rate (fps)
1	1.95	300	153.8
2	2.18	600	275.2
3	2.48	900	362.9
4	3.83	1200	313.3
5	4.30	1500	348.8
6	5.97	1800	310.5
7	6.61	2100	317.7
8	7.22	2400	332.4
9	8.34	2700	323.7
10	9.08	3000	330.4
11	9.98	3300	330.7
12	10.44	3600	344.8



The figure below shows a graph of the number of channels transcoded in parallel vs. the transcoding frame rate for a single system on the MCS-2080. We can see that when three or more channels are transcoded in parallel, the processing capabilities of the processor are maximized and that the video transcoding frame rate does not change appreciably as the number of parallel tasks processed increases, remaining at approximately 350fps. Therefore, when running real-time transcoding tasks, the transcoding frame rate should not exceed this value. For 1080p 30fps video, a single system of the MCS-2080 is able to transcode approximately 11 channels to HEVC as can be seen in the transcoding times in the table above. When the number of channels transcoded in parallel is less than or equal to 11 channels, transcoding to HEVC of all 10 second video files can be completed within 10 seconds and can therefore be supported in real-time. The transcoding performance required for HEVC 4K 60fps video is eight times that of HEVC 1080p 30fps video, meaning that each system on the MCS-2080 can transcode one channel of HEVC 4K 60fps transcoding task in real-time (total of 16 channels for the entire platform).

In video surveillance systems, the video decoding capability is often the main bottleneck of system performance. Test results for the MCS-2080 show that the maximum frame rate for decoding HEVC 1080p 30fps video on a single system and saving it to the system memory is approximately 580fps. Or in other words, each single system is capable of performing real-time decoding of 19 channels of HEVC 1080p 30fps video. For HEVC 4K 60fps video, the MCS-2080 can decode two channels of HEVC 4K 60fps in real-time on each system.

LRI Distribuída no Brasil pela LRI | vendas@lri.com.br | 51 2129-3000

Conclusion

The development of 4K UHD applications is a definite trend in the entire video and graphics industry ecosystem. HEVC codec technology can double the efficiency of video compression and therefore reduce by half the required transmission bandwidth and storage space, making it a key element for the popularization of 4K applications. The ADLINK MCS-2080 has integrated the latest Intel graphics processing technology in a high density modular design to maximize its HEVC codec processing capabilities. Each platform can achieve 16 channels of 4K 60fps real-time HEVC transcoding within a 2U form factor, and support up to 176 channels of real-time 1080p 30fps HEVC transcoding. The extreme HEVC processing capability of MCS-2080 makes it a ideal choice for next generation video infrastructures, accelerating the time-to-market of 4K video applications.

Open Compute Carrier-grade Edge Reference Architecture (OCCERA)

OCCERA, the new industrial IOT architecture for commercial off-the-shelf (COTS) platforms features a design aimed atoptimizing performance, cost and space requirements for the next generation of industrial IOT solutions. ADLINK's OCCERA industrial-grade platform is designed to support the native virtualization requirements for software-defined networking (SDN) and network function virtualization (NFV), while integrating a wide range of the latest hardware acceleration technologies to boost the processing of network packets and video streams. All this functionality is offered on an open, modular computing architecture, allowing users to redefine resource allocation for cloud computing applications.

The strategy behind OCCERA platforms is to introduce the latest data center technology to industrial telecom computing. The OCCERA implies the main characteristics of the platform: modular design, industrial carrier-grade features, and cloud-oriented design.

OCCERA adopts an innovative modular design for upgraded scalability and flexibility. Customers can choose from different functional modules (compute, switch, storage, and IO modules) depending on their specific application requirements to build a highly tailored computing platform. The hybrid design allows customers to mix and match between 1/4 and 1/2-width slot compute nodes in order to scale the number of independent systems with different processing capacities in the platform, as needed.

OCCERA adopts industrial-grade design for higher density, rich I/O capacity, PCIe backplane throughput, and lower latency. All modules offer redundancy and hot-plugging. In addition, IO modules support advanced LAN bypass features, and – in order to meet the high bandwidth requirements of future 5G networks – each computing module is designed to support dual 64G bandwidth, with even higher bandwidth support available through expansion IO cards.

OCCERA is designed for industrial cloud computing with native virtualization for SDN/NFV. For SDN, OCCERA switch modules use larger TCAM tables to implement L2/L3/L4 fast packet forwarding using OpenFlow. For NFV, OCCERA switch modules and network cards support hardware-accelerated processing for NVGRE and VXLAN tunnel protocols. OCCERA designs also integrate a wide range of the latest hardware acceleration technologies to boost the processing of network packets and video streams.

ADLINK's OCCERA is a delivery system for the latest telecom, networking security, and intelligent video surveillance services. The platform offers a complete solution, with optimized stacks, high throughput, and an expanding partner ecosystem for mix-and-match hardware and software configurations. OCCERA provides computing modules based on Intel® Core™/Xeon® and other processor-based boards, switch modules, storage modules and IO modules, and can be easily customized and scaled based on customer needs. OCCERA platforms provide variety of rack-mount form factors, like 2U, 4U and many others, truly scalable from rack mount to rack scale, enabling different computing capacity for different stages of a project.



Distribuída no Brasil pela LRI | vendas@lri.com.br | 51 2129-3000

About ADLINK

ADLINK Technology is leading edge computing with solutions that drive data-to-decision applications across industries. ADLINK offers a variety of building blocks and both generic and market-specific Industrial Internet of Things (IIoT) platforms to serve the automation, communications, medical, transportation, and defense/government verticals.

Our products include motherboards, blades, chassis, modules, gateways, systems, and end-to-end solutions based on industry standard form factors, as well as an extensive line of test & measurement products and smart touch computers, displays, and handhelds that support the global transition to always connected systems. Many products are Extreme Rugged, supporting extended temperature ranges, shock and vibration.

ADLINK is a Premier Member of the Intel® Internet of Things Solutions Alliance and is active in several standards organizations and interoperability initiatives, including European Telecommunications Standards Institute (ETSI), Telecom Infra Project (TIP), Open Network Automation Platform (ONAP – The Linux Foundation Projects) and Open Compute Project (OCP).

About the Intel® Internet of Things Solutions Alliance

ADLINK Technology is a Premier member of the IntelR Internet of Things Solutions Alliance. From modular components to market-ready systems, Intel and the 400+ global member companies of the IntelR Internet of Things Solutions Alliance provide scalable, interoperable solutions that accelerate deployment of intelligent devices and end-to-end analytics. Close collaboration with Intel and each other enables Alliance members to innovate with the latest technologies, helping developers deliver first-in-market solutions.

Learn more at: intel.com/iotsolutionsalliance

LRI Distribuída no Brasil pela LRI | vendas@lri.com.br | 51 2129-3000

WORLDWIDE OFFICES

ADLINK Technology, Inc.

9F, No.166 Jian Yi Road, Zhonghe District
New Taipei City 235, Taiwan
新北市中和區建一路166號9樓
Tel: +886-2-8226-5877
Fax: +886-2-8226-5717
Email: service@adlinktech.com

Ampro ADLINK Technology, Inc.

5215 Hellyer Avenue, #110 San Jose, CA 95138, USA
Tel: +1-408-360-0200
Toll Free: +1-800-966-5200 (USA only)
Fax: +1-408-360-0222
Email: info@adlinktech.com

ADLINK Technology Singapore Pte. Ltd.

84 Genting Lane #07-02A, Cityneon Design Centre,
Singapore 349584
Tel: +65-6844-2261
Fax: +65-6844-2263
Email: singapore@adlinktech.com

ADLINK Technology Singapore Pte Ltd. (Indian Liaison Office)

#50-56, First Floor, Spearhead Towers
Margosa Main Road (between 16th/17th Cross)
Malleswaram, Bangalore - 560 055, India
Tel: +91-80-65605817, +91-80-42246107
Fax: +91-80-23464606
Email: india@adlinktech.com

ADLINK Technology Japan Corporation

〒101-0045 東京都千代田区神田鍛冶町3-7-4
神田374ビル4F
KANDA374 Bldg. 4F, 3-7-4 Kanda Kajicho,
Chiyoda-ku, Tokyo 101-0045, Japan
Tel: +81-3-4455-3722
Fax: +81-3-5209-6013
Email: japan@adlinktech.com

ADLINK Technology, Inc. (Korean Liaison Office)

경기도 성남시 분당구 수내로46번길4 경동빌딩 2층
(수내동 4-4번지) (우) 13595
2F, Kyungdong B/D, 4 Sunae-ro 46beon-gil, Bundang-gu,
Seongnam-si, Gyeonggi-do, Korea, 13595
Toll Free: +82-80-800-0585
Tel: +82-31-786-0585
Fax: +82-31-786-0583
Email: korea@adlinktech.com

ADLINK Technology, Inc. (Israel Liaison Office)

27 Maskit St., Corex Building PO Box 12777
Herzliya 4673300, Israel
Tel: +972-54-632-5251
Fax: +972-77-208-0230
Email: israel@adlinktech.com

ADLINK Technology (China) Co., Ltd.

上海市浦东新区张江高科技园区芳春路300号 (201203)
300 Fang Chun Rd., Zhangjiang Hi-Tech Park
Pudong New Area, Shanghai, 201203 China
Tel: +86-21-5132-8988
Fax: +86-21-5192-3588
Email: market@adlinktech.com

ADLINK Technology Beijing

北京市海淀区上地东路1号盈创动力大厦E座801室(100085)
Rm. 801, Power Creative E, No. 1 Shang Di East Rd.
Beijing, 100085 China
Tel: +86-10-5885-8666
Fax: +86-10-5885-8626
Email: market@adlinktech.com

ADLINK Technology Shenzhen

深圳市南山区科技园南区高新南七道数字技术园
A1栋2楼C区 (518057)
2F, C Block, Bldg. A1, Cyber-Tech Zone, Gao Xin Ave. Sec. 7
High-Tech Industrial Park S., Shenzhen, 518054 China
Tel: +86-755-2643-4858
Fax: +86-755-2664-6353
Email: market@adlinktech.com

ADLINK Technology GmbH

(Mannheim) Hans-Thoma-Strasse 11, D-68163,
Mannheim, Germany
Tel: +49 621 43214-0
Fax: +49 621 43214-30
Email:emea@adlinktech.com

(Deggendorf) Ulrichsbergerstrasse 17, 94469
Deggendorf, Germany
Tel: +49 (0) 991 290 94 – 10
Tel: +49 (0) 991 290 94 - 29
Email: emea@adlinktech.com

ADLINK Technology, Inc. (French Liaison Office)

6 allée de Londres, Immeuble Ceylan 91940
Les Ulis, France
Tel: +33 (0) 1 60 12 35 66
Fax: +33 (0) 1 60 12 35 66
Email: france@adlinktech.com

ADLINK Technology, Inc. (UK Liaison Office)

First Floor West Exeter House, Chichester Fields
Business Park Tangmere, West Sussex,
PO20 2FU, United Kingdom
Tel: +44-1243-859677
Email: UK@adlinktech.com

ADLINK® Leading EDGE COMPUTING

intel IoT Solutions Alliance Premier

All products and company names listed are trademarks or trade names of their respective companies.
All specifications are subject to change without further notice.

LRI Distribuída no Brasil pela LRI | vendas@lri.com.br | 51 2129-3000