Solution Brief

Rise to the Indy Autonomous Challenge

ADLINK provides AI-focused processing platforms and open source software support for the world’s first head-to-head self-driving race challenge

Race to the Finish Line with Edge AI

On October 23, 2021, somebody is going to win USD 1,000,000.

On that date, a host of colleges and universities will unleash their specially equipped Dallara AV-21 racecars onto the Indianapolis Motor Speedway, home to the famous Indianapolis 500 event. But in this race, the cars must complete 20 laps (totaling roughly 50 miles) in 25 minutes or less, requiring an average speed of at least 120 miles per hour.

Without a driver.

Like the DARPA Grand Challenge before it, the Indy Autonomous Challenge (IAC) aims to help spur the evolution of autonomous vehicle (AV) development. Self-driving cars generate massive amounts of sensor data that must be processed with ultra-low latencies. Platform performance is literally a matter of life or death. Thus, if the software and systems governing an AV can maintain safety and reliability at 200 MPH, many lessons should emerge that can help inform AV operation under everyday road conditions.

The IAC, in tandem with the Clemson University International Center for Automotive Research (CU-ICAR), aims to merge academic research groups from around the world with private technology developers and manufacturers. The IAC is the twelfth project by Deep Orange, CU-ICAR's vehicle prototyping program. The DO12 racecar (a Dallara AV-21 retrofitted with hardware and controls to enable automation) is made available to all participating teams. From this platform, organizers' vision is that participating students will imagine and invent the next generation of vehicle software able to outperform anything currently available — and just maybe help steer AVs deeper into mainstream adoption.

As the official edge computing sponsor of the IAC, ADLINK Technology will supply every qualifying race team with an ADLINK AVA-3501 series robot controller for in-vehicle computing. This compact workstation faces a range of challenges unlike any traditional embedded deployment. To cope with the massive data load of high-speed, autonomous driving, the AVA-3501 must employ artificial intelligence (AI), working through gigabytes of image analysis in real time. There are no extra milliseconds to communicate with a pit crew, much less the cloud. This AI work must be done in-car, at the network edge, and showcases just one example of why today's edge AI market is growing at over 20% annually. The IAC is, in some ways, a test of whether edge AI, and specifically ADLINK's AVA-3501, is ready for this level of next-generation performance.

The stakes are massive and the road ahead uncertain, but the AVA-3501 can help even these most daring AVs cross the finish line.

The Most Advanced Autonomous Car Ever Built

IAC Challenges

In-car vibrations during racing often exceed +/-3g, which is severe enough to cause human vision impairment. Temperatures in the vehicles range from 120 to 160 degrees Fahrenheit (49°C to 71°C), with no option for air conditioning. Having a high-performance, real-time computing system remain reliable under such conditions is a serious request, which is why hardware selection is so critical.

The autonomous aspect of this race imposes an entirely different set of challenges and requires the implementation of a wide array of technologies.

Vehicle-to-vehicle communications

AV safety benefits from cars being able to share data about their current conditions, such as location, acceleration, and braking rate (sharing this information in a race situation won't give away the competitors' intentions). This data helps to avoid collisions, but only if data is transmitted, received and processed in real time.

Perception systems

AVs can use conventional cameras, radar, LiDAR, and many other types of sensor to "see" their surroundings. To date, there is no accepted "best" approach to perception, either for sensors or the algorithms used to interpret the data, and research is proliferating in this space. Implementing these sensors on racecars only escalates the challenge due to the high vibration environment and strong wind forces on equipment.

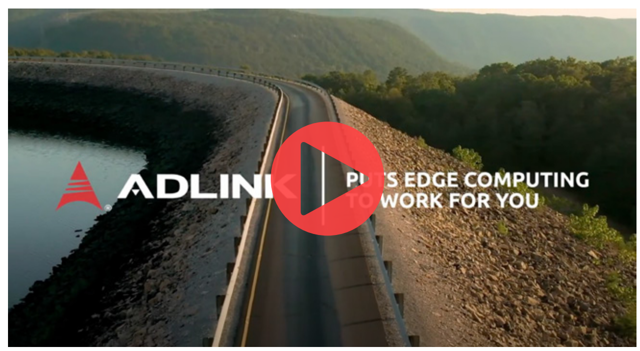
Onboard computing

Every AV has onboard embedded computing capabilities, as there is no time for communication to the cloud or even nearby edge networks. The embedded system performs autonomous decision making, as well as vehicle control and condition monitoring. All decisions from collision avoidance to drive-by-wire controls (throttle control, shifting, clutch operation, braking, etc.) to pit stop parking must be handled in-vehicle. The magnitude of these compute tasks requires GPU acceleration on top of server-class CPU resources.

Vehicle-to-infrastructure communications

There may not be humans in the cars, but these Indy AVs still require careful condition monitoring by pit crews. Telemetry data keeps teams current on systems status, and close-range communications allow for remote-controlled vehicle shutdown if necessary.

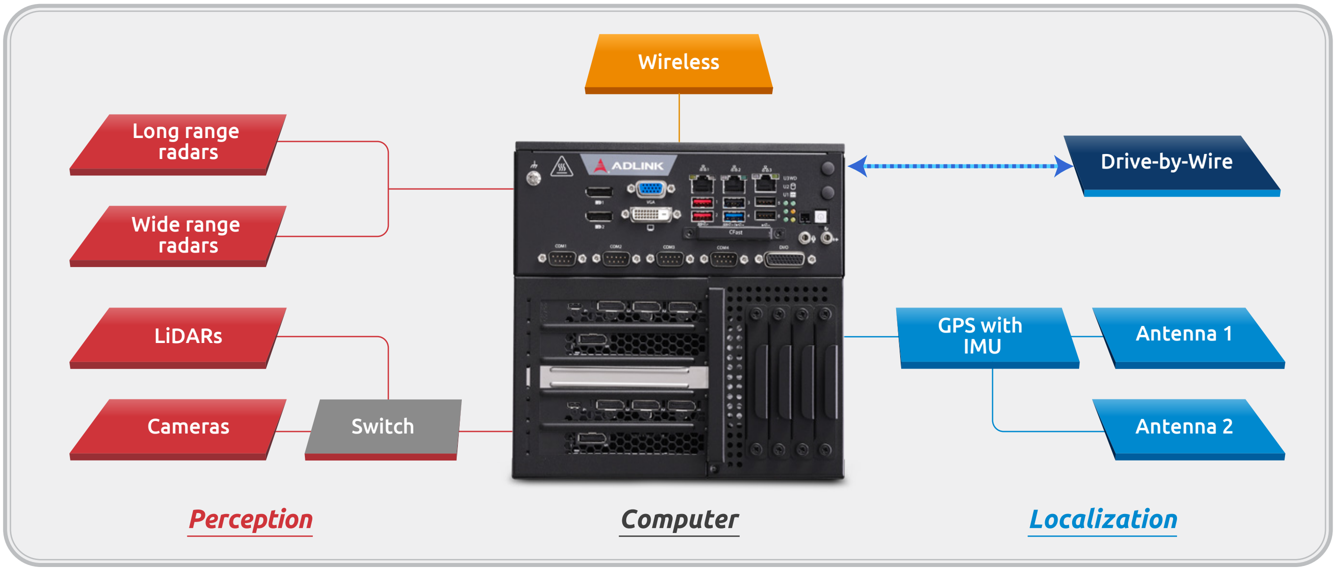
All these challenges require a stringent selection of hardware linked through a robust, high-bandwidth I/O architecture. Data must flow at peak levels continuously, with maximum precision and multiple forms of connectivity that must operate in unison without the risk of bottlenecking.



How to Engineer an IAC-Style Autonomous Racecar

ADLINK’s Solution

In a self-driving racecar, every device matters. From a data perspective, none may be more critical than the server at the vehicle’s core. ADLINK’s AVA-3501 series workstations offer the right mix of ruggedness, compute performance, and GPU-based accelerated processing to handle the rigorous demands of this most demanding AV implementation.



IAC Competition Team Computer Architecture

Each type of sensor on the AV carries its own data burden for the system. As examples, industry estimates offer these bandwidth ranges:

- Cameras: 20-40 Mbps
- Radar: 10-100 Kbps
- LiDAR: 20-100 Mbps
- GPS: 50 Kbps

In addition to these examples, an AV can have dozens of other sensor types. Former Intel CEO Brian Krzanich estimated in 2016 that AVs will “generate and consume roughly 40 terabytes of data for every eight hours of driving.” The number and resolution of sensors has only increased since then.

Again, the data demands on these racecars are even more strenuous than on road cars. As the IAC detailed on its blog, “If we assume 180 mph (290 km/h) on the straightaway, that equates to 80 meters per second. For a 20Hz LiDAR, that means it must calculate four meters per point cloud (a 3D model of the area surrounding the racecar), that can include distortion due to movement during capture. Cameras must capture 60 images per second, which is greater than 1 meter per image.” Any latency added during processing only increases the risk of the AV not having enough time to respond to the rapidly oncoming situations.

ADLINK excels in creating highly rugged, application-ready computing platforms bolstered by industry-leading CPU and GPU components. The AVA-3501 combines late-model Intel® Core™ and Xeon® processor options with dual-slot full-length NVIDIA RTX graphics for AI acceleration.

Factors that set the AVA-3501 apart from other graphics-oriented workstations include its remarkably compact size — 210 x 210 x 350 mm (8.3 x 8.3 x 13.8 inch) — which is far more suited to a space-constrained AV than conventional workstations. Depending on the configuration, the system can also provide two NVMe M.2 SSDs, two hot-swappable 2.5” SATA bays, dual 40 GbE QSFP connectivity, and six CAN channels. This is in addition to a standard I/O set including DP++, DVI-I, GbE, 8-ch DI, 8-ch DO, and USB ports.

Building Ecosystem to Accelerate Autonomous Driving Innovation

The IAC is about much more than hardware. To allow the components of the AV solution operate at peak capabilities, teams and suppliers alike must demonstrate deep knowledge of AV open-source software and middleware platforms. For example, ADLINK has validated its robotic control system on Autoware.Auto, Open Robotics ROS 2, Apex.OS, Eclipse iceoryx, Eclipse Zenoh, and Eclipse Cyclone DDS. (ADLINK's Eclipse Cyclone DDS is a tier 1 ROS 2 middleware.) These extensive validations have contributed to the IAC racecar software support, enabling IAC university teams to race using Open Robotics ROS 2 with Autoware.Auto autonomous driving packages, Eclipse Zenoh V2X and Eclipse Cyclone DDS with iceoryx zero-copy built-in.

The same ADLINK hardware platform, in tandem with Tier IV, ITRI and AutoCore, is now a pivotal part of the autonomous driving system within Foxconn's MIH Alliance, an electric vehicle open platform with over 200 global partners. Further, ADLINK helped to integrate its workstation with the IAC vehicle sensor suite and Ansys' VREXPERIENCE simulation to assist in race platform training and refinement. This required close partnership with Autoware Foundation, Open Robotics, OpenCV, and Eclipse Foundation. With a project as complex as the IAC, it really does require a full industry ecosystem to achieve outstanding results.

The IAC marks an expansion of ADLINK's commitment to high-opportunity areas within edge computing, as well as strengthening the bridges between computing hardware, open-source efforts in AI, and academic research. About ten racecars will go through qualification and compete in the final race on the track, but 39 universities will bring their best and brightest to the competition. (The competing teams are required to meet minimum thresholds imposed by the IAC to advance to the final race.) Organizers encourage teams to collaborate, and ADLINK will be there to assist. ADLINK is helping teams meet the IAC's tight schedule demands through technical support that leverages 25 years of experience across edge computing, partnership with AI centric companies like NVIDIA, IoT integration, heterogeneous computing, and networking. ADLINK also brings its extensive experience in system integration and validation/verification.

ADLINK believes that partnerships and ecosystem development — connecting people, places, and things with AI — will be vital to the coming autonomous technologies revolution. The IAC is a perfect example of disparate groups working together to solve the field's most complex technological challenges. In being a part of the IAC and similar efforts, and through participation in key AI industry groups with Intel, NVIDIA, Arm, and many open computing consortia, ADLINK is helping to drive the AI field toward the finish line and into its maturity.

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: +1-408-600-1189
Email: info@adlinktech.com

ADLINK Technology Singapore Pte. Ltd.

84 Genting Lane #07-02A, Axxel Innovation 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: +91-80-42246107, +91-80-23464606
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
ユニゾ神田鍛冶町三丁目ビル4F
Unizo Kanda Kaji-cho 3 Chome 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 Korea Ltd.

경기도 용인시 수지구 신수로 767 A동 1503호
(동천동, 분당수지유타워) (우) 16827
A-1503, U-TOWER, 767 Sinsu-ro, Suji-gu,
Yongin-si, Gyeonggi-do, Republic of Korea, 16827
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)

SPACES OXYGEN, 62 Medinat, Ha-yehudim st
4673300, Herzliya, Israel, P.O.Box – 12960
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

Hans-Thoma-Straße 11
D-68163 Mannheim, Germany
Tel: +49 621 43214-0
Fax: +49 621 43214-30
Email: germany@adlinktech.com

Ulrichsbergerstraße 17
D-94469 Deggendorf, Germany
Tel: +49 991 290 94–10
Fax: +49 991 290 94–29
Email: germany@adlinktech.com

ADLINK Technology, Inc. (French Liaison Office)

Bâtiment Thalès - Parc des Algorithmes,
Route de l'Orme des Merisiers,
91190 SAINT AUBIN, 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 partner Titanium

NVIDIA ELITE PARTNER