ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

| Impact Factor: 7.186| A Monthly Peer Reviewed & Referred Journal |

Vol. 4, Issue 9, September 2016

The Convergence of Internet of Things and Artificial Intelligence: Synergies and Opportunities

MS. SONAL BORDIA JAIN

ASSOCIATE PROFESSOR, DEPT. OF COMPUTER SCIENCE, SS JAIN SUBODH PG COLLEGE, JAIPUR, RAJASTHAN, INDIA

ABSTRACT: AIoT, the confluence of AI and Industrial IoT technological forces, gives rise to a new digital solution category – the Artificial Intelligence of Things (AIoT). AIoT is built for industrial companies looking for better ways to connect their evolving workforce to data-driven decision tools and digitally augment work and business processes and make better use of industrial data already collected. ARC Advisory Group has observed that the convergence and overlap of IT and OT groups, driven largely by the digital transformation of industry in recent years has created organizational confusion and a significant "gray-space" of common technologies between each area, one area being AI.

However, leveraging AI requires data science capability, which adds additional complexity to an already complex environment. While engineering roles are skilled in analyzing large amounts of data, setting up and creating production grade machine learning environments is not easily accomplished. Unlocking the value of industrial data through AI requires a hybrid approach. This is where we get to the paradigm of Industrial AI, which combines data science and AI with software and domain expertise to deliver measurable business outcomes for capital-intensive industries.

KEYWORDS-IoT, AI, convergence, synergies, opportunities, engineering, industries

I. INTRODUCTION

At one time, this manufacturing digital nervous system was primarily based solely on legacy systems and architectures. But today, the industry is borrowing from IT approaches and architectures developed for enterprise systems with a focus on speed and scale. These next generation of Industrial AI solutions make it easier for the industry to embed and deploy AI into industrial systems and allow users to solve industrial problems without retraining or adding data science capabilities to industrial organizations.[1,2,3]

Key drivers for AI-IoT convergence include:

- The overlap of IT and OT groups driven largely by the digital transformation and significant "gray-space" of common technologies between each area.
- Interest in the democratization of the application of AI in the industrial domain by converging data science with IT systems and OT domain expertise.
- Aspen Technology announced the Aspen AIoT Hub that provides production-grade integrated data management, edge, and cloud infrastructure to build, deploy and host industrial AI applications and unlock the business value from industrial data assets at enterprise speed and scale.

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

| Impact Factor: 7.186| A Monthly Peer Reviewed & Referred Journal |

Vol. 4, Issue 9, September 2016

IT/OT Organizations Leave an Abundance of Gray Space

Information technology or "IT" commonly provides the applications and infrastructure that enables business functions to run their respective business processes. Operational technology or "OT," in turn, executes the physical value-add via real-time systems.

Historically, the scope and ownership of IT covers the spectrum of systems that support centralized corporate functions like finance, HR, supply chain, order management, sales, etc. These functions and their processes tend to have commonality across industries. However, OT involves the spectrum of systems that deal with the physical transformation of products and services. These task-specific and often mission-critical systems are highly customized for individual industries. They typically fall under the domain of a centralized (global) engineering services group or de-centralized (plant-level) engineering group.

ARC has observed that the convergence and overlap of IT and OT groups, driven largely by the digital transformation of industry in recent years, has created organizational confusion around ownership and responsibility. This historical view is somewhat clouded by technology change and convergence, centralization versus decentralization, and the prevalence of significant "gray-space" of common technologies between each area.

Convergence of AI and Industrial IoT

Industrial companies are looking for better ways to connect their workforce to decision tools and digitally enhance or augment work and business processes. At the center of industrial technology strategies, leaders are looking to make better use of industrial data already collected and help diverse persons within the organization make better decisions that improve business performance. We see this dynamic across all aspects of manufacturing, from design engineering to operations and maintenance to supply chain and human resources.

However, leveraging AI requires data science capability, adding additional complexity to an already complex environment. An AI system built for industrial processes without adequate knowledge of a plant or process or without appropriate controls and systems could create a potentially dangerous situation by introducing serious errors and impacting plant decision making.

Industrial manufacturing has not typically built organizational competency in data science. While engineering roles are skilled in analyzing large amounts of data, setting up and creating production-grade machine learning environments is not easily accomplished.

AIoT is the convergence of AI and the IoT, bringing intelligence from the edge to the cloud in industrial environments, transforming the data into useful information for an improved decision-making process, with processing done in a location where it is most needed. The foundation of Industrial IoT is the ability to collect massive quantities of data at high frequency and making these integrated datasets mobile and accessible across the organization for strategic decision making. AIoT is the democratization of AI and machine learning in the industrial domain by converging data science with IT providing software at scale and OT domain expertise.[4,5,6]

In an era marked by rapid technological advancements, two giants have emerged at the forefront: Artificial Intelligence (AI) and the Internet of Things (IoT). Together, they're forging a new paradigm, often referred to as AIoT.

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

| Impact Factor: 7.186| A Monthly Peer Reviewed & Referred Journal |

Vol. 4, Issue 9, September 2016

IoT: The World Gets Connected
IoT represents the network of physical objects embedded with sensors, software, and other technologies to connect and exchange data with other devices and systems. Think smart homes, connected cars, and smart cities – it's about the world communicating seamlessly through billions of devices.

How AI Empowers IoT
While IoT provides the infrastructure of connected devices, it's AI that brings intelligence to this network. AI algorithms can process the vast amounts of data generated by IoT devices, make sense of it, and even act upon it in real-time. This can be in the form of making decisions, identifying patterns, or optimizing processes.

Applications: Where AI Meets IoT

- Healthcare: Wearables tracking vital statistics and notifying professionals of abnormalities.
- Agriculture: Smart farming solutions like drones analyzing field conditions and predicting crop diseases.
- Retail: Smart shelves detecting inventory levels and automating restocking processes.
- Transportation: Connected vehicles predicting maintenance needs or optimizing traffic flow in smart cities.

Challenges at the Intersection
AIoT, while promising, isn't without challenges. Data security and privacy concerns dominate the landscape, with billions of devices transmitting data continuously. Additionally, there's the challenge of integrating diverse systems and ensuring interoperability.

Looking Ahead: The Future of AIoT
With advancements in edge computing, we're seeing a trend where AI processes data closer to where it's generated (i.e., on the device) rather than in a centralized cloud. This can lead to faster decision-making and reduces data transmission costs. As 5G networks roll out globally, the potential for AIoT applications becomes even more staggering.

The Dawn of Intelligent Connectivity
The merging of AI and IoT heralds a new age of intelligent connectivity. As devices get smarter and more connected, our world becomes more responsive, efficient, and, ultimately, more human-centric.

II. DISCUSSION

Artificial Intelligence is the brain of a system, [7,8,9]while the Industrial IoT (Internet of Things) functions like the digital nervous system. At one time, this digital nervous system was primarily based solely on legacy systems and architectures, such as control systems, networks, and process historian infrastructure. But today, the industry is borrowing again from IT and approaches and architectures developed for enterprise systems including the cloud. These systems make it easier for the industry to embed AI into operational technologies by leveraging a scalable data infrastructure to power Industrial AI models from training to productization and allow users to solve industrial problems without significantly adding data science capabilities to industrial organizations.

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

| Impact Factor: 7.186| A Monthly Peer Reviewed & Referred Journal |

Vol. 4, Issue 9, September 2016

AspenTech Industrial AI Infrastructure: Aspen AIoT Hub

To help embed data science, Aspen Technology announced the Aspen AIoT Hub -- a fit-for-purpose, cloud-ready and built-for-industry Industrial AI infrastructure solution. The AIoT Hub provides the integrated data management, edge and cloud infrastructure and production-grade AI environment to build, deploy and host industrial AI applications at enterprise speed and scale.

The Aspen AIoT Hub consists of several well-established and innovative technologies. At its core is Aspen InfoPlus.21, which integrates cloud-native connectivity, capabilities providing the ability to assemble and deploy AI-driven IoT applications, and the advanced enterprise workflows, analytics, and governance that is designed for industrial companies. Key capabilities of the Aspen AIoT Hub include:

Data Integration & Mobility

Through the Aspen AIoT Hub, organizations will be able to access and leverage fully integrated data, from sensors to the edge and cloud, across the enterprise.

Cloud-ready Infrastructure

Scaling AI requires providing the tools, infrastructure, and workflows for broader collaboration between development, data science, and infrastructure capabilities such as CloudOps, DevOps, MLOps and others.

Enterprise-wide Visualization

The Aspen AIoT Hub enables enterprise users access to real-time data and analytics to do all of this – improving collaboration, project efficiency and operations by tapping into the power of accelerated insights and enhanced visualizations.

Industrial AI Applications Ecosystem

Provides an embedded workbench for feature engineering, training, and rapidly productizing machine learning (ML) models, as well as supports versioning and collaboration. It empowers data scientists, at customers and partners, to collaborate with domain experts on data-rich AI apps.

III. RESULTS

ARC Advisory Group research finds interest in AI in manufacturing to be strong; however, a recent digital transformation study of 157 process manufacturers finds barriers to organizational accountability, change leadership, and competency. This disconnect between ambition and ability is cause for industrial companies to seek ways to democratize application of AI through Industrial AI, just as Industrial IoT has democratized the access to data.

The confluence of AI and Industrial IoT technological forces gives rise to a new digital solution category -- the Artificial Intelligence of Things (AIoT) -- that centers on unlocking the untapped business value in industrial data. This category describes the combination of AI technologies with the Industrial IoT to enable the next generation of Industrial AI infrastructure, allowing organizations to enable seamless human-machine workflows, harmonize industrial data management, and rapidly transform raw data into tangible business outcomes.

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

| Impact Factor: 7.186| A Monthly Peer Reviewed & Referred Journal |

Vol. 4, Issue 9, September 2016

Today, the industry stands at a tipping point – they must tap into the disruptive power of these technologies to transform their business operations and redefine their sustainable competitive advantage or else risk obsolescence. As AI and Industrial IoT converge into AIoT, the information technology (IT) and operations technology (OT) functions are also converging -- unlocking additional opportunities and challenges.

Drivers for AI and Industrial IoT convergence place an emphasis on using data already gathered. ARC Advisory Group recommends industrial users consider the following business drivers to justify an AIoT strategy.

Driver	Benefit
Improve the capability of IT and OT organizations	Address acceleration of digital transformation and Industrial IoT while avoiding duplication of effort
Implement new technologies and AI	Improve business performance, margin optimization and operational excellence
Developing skills and competency	Address technology change, micro-learning
Extracting more value from systems	Leverage data and infrastructure already being gathered
Improve the capacity for internal customers	Better absorb technology and accelerate work process change

Drivers for AIoT Convergence

From fictional characters like Joey and Phoebe in Friends to the hamburger & fries combo for foodies, the greatest and most powerful duos have existed throughout the history of mankind. They may have a unique individuality but when clubbed together boom! Together, says Dinesh Soundararajan of Contus, they create an awesome and wonderful impact.[10,11,12]

Similarly, the perfect amalgamation of the Internet of Things (IoT) with Artificial Intelligence (AI), together known as AIoT, is all geared up to give enterprises the best of both worlds! This is backed up with recent research from researchandmarkets.com which states that by 2013, the global value of IoT in embedded IoT devices market will grow to US$26.2 billion (€23.9 b illion)

1. AIoT gives a competitive edge to IoT technologies

"AIoT in simple terms means to make the Internet of Things perform intelligence tasks with the help of integrating Artificial Intelligence."

The Artificial Internet of Things helps to connect IoT devices with sensors that are integrated

with AI capabilities – all of these with no human intervention.

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

| Impact Factor: 7.186| A Monthly Peer Reviewed & Referred Journal |

Vol. 4, Issue 9, September 2016

2. Key factors of Artificial Internet of Things

That being said, let's see how these Artificial Internet of Things actually help the business world move towards a next-gen transformation.

3. How does AIoT differ from IoT?

Are you wondering why we need AIoT when the Internet of Things market is doing well across several industries? Well, here is a quick look at the differences between these two technologies. We can call AIoT the next version of IoT.

Benefits of AIoT to shape the future of your business model

" In this era of 5G, the AIoT technology will only be enhanced further where it will connect every object, people, and machines in a more meaningful way."

Having an intertwined relationship between IoT and AI will help organisations move to the next level. Now that AI and IoT have individually marked their presence in the digital world, many IoT app development companies are moving towards AIoT for managing Internet of Things connected devices with artificial intelligence techniques.

AIoT based on the business perspective

Let's look at the advantages of AIoT for business:

1. Intelligent business decisions

The data collected from millions of IoT devices is so massive it makes it difficult to segregate and extract useful information from it. To organise these unstructured data into a meaningful chuck of data, AI-based algorithms are used to eliminate junk data and leverage any business model.

Now the chief technology officers (CTOs) and other decision-makers can make firm business decisions based on the valuable insights retrieved from this data.

2. Enhanced operational efficiency

Smart automation surpasses the traditional approach by streamlining the organisation's processes. Several industries have implemented these AIoT technologies to save on resources. For example, in office buildings, smart environmental sensors provide data on how many people are safe inside the premises. This includes fire, theft or any other warnings.

The integration of human facial recognition software and other biometric access devices all facilitate remote monitoring of the physical security of office buildings. Any unidentified personnel or abnormal activities are swiftly recorded and alerts or notifications can be sent automatically to the central hub.

AIoT based on the customer perspective

Let's briefly look into the advantages of AIoT for customers:

1. Delightful customer experiences

Understand your customer's behaviour and their challenges more precisely with Artificial Internet of Things technology. For instance, the surveillance camera is not only used to detect any thefts or crime, it also helps to read the customer's shopping pattern.

AIoT collects and correlates inventory data, such as which aisle needs re-filling fast or where goods are fast-moving, and which aisle has seen no customer visits at all. Hence, large organisations are able to predict the customer's habits more accurately and make it a more personalised experience for them.

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

| Impact Factor: 7.186| A Monthly Peer Reviewed & Referred Journal |

Vol. 4, Issue 9, September 2016

2. Accurate predictions

Artificial Internet of Things provides next-level predictions to get accurate results. One of the powerful use cases of AIoT is the autonomous robot used for delivery. The robots have in-built sensors that collect and store data retrieved from the IoT devices. It stores data like physical addresses, direction details, and traffic information.

After collecting the data, the AI fed into the robot system detects less congested routes and makes a smart decision by detouring to routes where there is less traffic. Then, it delivers the package to the relevant address.

Several other industries have been implementing IoT data visualisation techniques. These include office buildings with smart environmental sensors and facial recognition software to get real-time data and behavioural analysis.

Practical applications of AIoT[13,14,15]

1. DHL – A leading global logistics company

"By 2028, DHL aims to build 10,000 IoT-enabled truck transportation vehicles. It says AIoT has reduced 50% of their transit time with 90% reliability of real-time tracking."

DHL leverages the innovative IoT solutions along with artificial intelligence through Smart Trucking operations teams using an agile model where it streamlines the businesses by creating a transportation model that decreases the fatigue among the drivers, and helps them to spend less time on the road and provide a better work-life balance.

Board member of DHL, Juergen Gerdes said in an interview, "We expect to transport 100,000 tonnes of cargo and plan to cover 4 million kilometres daily worldwide."

2. WalMart – The largest retail chain in North America

With more than 11,000 brick and mortar models with equally numerous online stores for each county or state, Walmart was able to pull it off effortlessly with the help of AI and machine learning (ML) integrated with the Internet of Things.

Facial recognition software, voice-based search by Google Assistant and cross-technology solutions, have made this retail industry scale up to higher revenues for several years.

3. London City Airport – travel & leisure industry

London City Airport was the first airport to make use of AI, the Internet of Things and cross-technology networking to monitor every tiny detail of travel to provide the passengers with informed data.

Cabin crew can now track the whereabouts of the passengers through IoT devices, boarding queue traffic, can update gate information, track baggage and so on.

Right from Industrial IoT (IIoT) protocols & Constrained Application Protocol (CoAP) to Web Socket & application program interfaces (APIs), Contus has a solid IoT/IIoT Digital Engine model. Along with the Business Intelligence solutions and IoT dashboard it helps to accelerate the business delivery process effectively.

We help in leveraging the industry-focused IoT App development solutions in a cost-effective way.

IoT with artificial intelligence has vast use cases across industries, and it is purely dependent upon the organization's budget and goals to align them perfectly to increase their productivity. These are one-time investments that will yield them a life-long benefit. Get detailed analytics, precise data processing, and automation techniques all in one place, all built basically to give better results from bigger and meaningful data.

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

| Impact Factor: 7.186| A Monthly Peer Reviewed & Referred Journal |

Vol. 4, Issue 9, September 2016

IV. CONCLUSION

A IoT is a complex system, but we can break it down into two main components: IoT and AI.

Internet of Things (IoT)
IoT refers to the network of physical devices connected to the internet, collecting and sharing data. These devices can range from everyday household items like refrigerators and thermostats to industrial tools in factories. They're equipped with sensors to collect data and actuators to perform actions. [16,17,18]

Artificial Intelligence (AI)
AI, on the other hand, is the simulation of human intelligence processes by machines, especially computer systems. This includes learning, reasoning, problem-solving, perception, and language understanding. AI can be further divided into subfields such as Machine Learning, Deep Learning, and Natural Language Processing. □

The Power of AIoT

When AI and IoT come together, they create a system where IoT devices gather data and AI processes it. This allows for real-time analysis and decision making, creating a more efficient and intelligent system.
For example, in a smart home, an AIoT system could analyze data from various sensors and make decisions like adjusting the thermostat based on your preferences, turning off lights when no one is in the room, or even alerting you if it detects unusual activity while you're away.

The Future of AIoT

The future of AIoT is promising. With advancements in both AI and IoT, we can expect to see more intelligent and autonomous systems in various sectors, from healthcare to manufacturing to transportation. The possibilities are endless! [19,20]

REFERENCES

1. Gillis, Alexander (2014). "What is internet of things (IoT)?". IOT Agenda. Retrieved 17 August 2014.
2. ^ Brown, Eric (20 September 2015). "21 Open Source Projects for IoT". Linux.com. Retrieved 23 October 2015.
3. ^ "Internet of Things Global Standards Initiative". ITU. Retrieved 26 June 2015.
4. ^ Hendricks, Drew (10 August 2015). "The Trouble with the Internet of Things". London Datastore. Greater London Authority. Retrieved 10 August 2015.
5. ^ Shafiq, Muhammad; Gu, Zhaoquan; Cheikhrouhou, Omar; Alhakami, Wajdi; Hamam, Habib (3 August 2013). "The Rise of "Internet of Things": Review and Open Research Issues Related to Detection and Prevention of IoT-Based Security Attacks". Wireless Communications and Mobile Computing. 2013: e8669348. doi:10.1155/2013/8669348. ISSN 1530-8669.
6. ^ Beal, Vangie (2 March 2013) [1996-09-01]. "What is a Network?". Webopedia. Archived from the original on 22 November 2013. Retrieved 22 November 2013.
7. ^ Dey, Nilanjan; Hassanien, Aboul Ella; Bhatt, Chintan; Ashour, Amira; Satapathy, Suresh Chandra, eds. (2015). Internet of things and big data analytics toward next-generation intelligence. Cham, Switzerland: Springer. p. 440. ISBN 978-3-319-60435-0. OCLC 1001327784.
8. ^ "Forecast: The Internet of Things, Worldwide, 2013". Gartner. 18 November 2013. Retrieved 3 March 2013.

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

| Impact Factor: 7.186| A Monthly Peer Reviewed & Referred Journal |

Vol. 4, Issue 9, September 2016

9. ^ Hu, J.; Niu, H.; Carrasco, J.; Lennox, B.; Arvin, F., "Fault-tolerant cooperative navigation of networked UAV swarms for forest fire monitoring" Aerospace Science and Technology, 2013. doi:10.1016/j.ast.2013.107494.
10. ^ Hu, J.; Lennox, B.; Arvin, F., "Robust formation control for networked robotic systems using Negative Imaginary dynamics" Automatica, 2013. doi:10.1016/j.automatica.2013.110235.
11. ^ Laplante, Phillip A.; Kassab, Mohamad; Laplante, Nancy L.; Voas, Jeffrey M. (2015). "Building Caring Healthcare Systems in the Internet of Things". IEEE Systems Journal. 12 (3): 3030–3037. Bibcode:2015ISysJ..12.3030L. doi:10.1109/JSYST.2015.2662602. ISSN 1932-8184. PMC 6506834. PMID 31080541.
12. ^ "The New York City Internet of Things Strategy". www1.nyc.gov. Retrieved 6 September 2014.
13. ^ "The "Only" Coke Machine on the Internet". Carnegie Mellon University. Retrieved 10 November 2014.
14. ^ "Internet of Things Done Wrong Stifles Innovation". InformationWeek. 7 July 2014. Retrieved 10 November 2014.
15. ^ Mattern, Friedemann; Floerkemeier, Christian (2010). "From the Internet of Computer to the Internet of Things" (PDF). Informatik-Spektrum. 33 (2): 107–121. Bibcode:2009InfSp..32..496H. doi:10.1007/s00287-010-0417-7. hdl:20.500.11850/159645. S2CID 29563772. Retrieved 3 February 2014.
16. ^ Weiser, Mark (1991). "The Computer for the 21st Century" (PDF). Scientific American. 265 (3): 94–104. Bibcode:1991SciAm.265c..94W. doi:10.1038/scientificamerican0991-94. Archived from the original (PDF) on 11 March 2015. Retrieved 5 November 2014.
17. ^ Raji, R.S. (1994). "Smart networks for control". IEEE Spectrum. 31 (6): 49–55. doi:10.1109/6.284793. S2CID 42364553.
18. ^ Pontin, Jason (29 September 2005). "ETC: Bill Joy's Six Webs". MIT Technology Review. Retrieved 17 November 2013.
19. ^ "CORRECTING THE IOT HISTORY". CHETAN SHARMA. 14 March 2015. Retrieved 1 June 2014.
20. ^ Lakhwani, Kamlesh (2014). Internet of Things (IoT) : Principles, Paradigms and Applications of IoT. Hemant Kumar Gianey, Joseph Kofi Wireko, Kamal Kant Hiran. [Place of publication not identified]. ISBN 9789389423365. OCLC 1188989203.