WIA Industry Insights

Artificial Intelligence and its Impact on Wireless Infrastructure

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CONTENT

INTRODUCTION

Artificial Intelligence, or AI, is probably the most mentioned – and hyped – technical term in use today. The impact of AI is a topic of discussion just about everywhere we go, on everything we watch and in everything we read - how it is going to steal our jobs and how it eventually will rule – or destroy – the world!

While there are many definitions of Artificial Intelligence, they all generally refer to the ability of machines or software to perform the same cognitive functions as human minds. In other words, create a machine that thinks like people do.

This is not a new idea, as any reader of science fiction can tell you. A "computer intelligence" or "machine mind" has been discussed for the past half century or more in science-fiction novels. Robots and artificial intelligence often go hand in hand.

The development of massive machine learning and natural language processing has given AI new impetus. OpenAI's ChatGPT entered the general media consciousness in late 2022 and has stimulated much of the current discussion and debate about the impact of AI.

ChatGPT, which uses Generative Pre-trained Transformers (GPT), takes a word and predicts what the next word will be. If we start with the phrase "to be or not," GPT is likely to finish the sentence with "to be." ChatGPT has been trained using billions of pieces of information (basically, the Internet, chat sessions and social-media posts) and millions of parameters that define the rules it follows.

Using those parameters is how ChatGPT can edit an email or construct a poem in a specific style – it has essentially ingested all of the existing sentences, phrases, papers and chat sessions and can use that to complete a task.

But ChatGPT, and other natural language processing engines, are not necessarily the same as the AI that can be deployed in a wireless network.

As with most things, the reality of AI is a little different. While there are certainly sizeable impacts and changes to come, a dose of reality is needed for perspective. This is especially true when it comes to AI's impact on wireless infrastructure.

The definitions of AI are broad, and the term is being applied loosely in business and consumer spaces. The goal of this report is to clarify and level set what AI is and how it applies to wireless infrastructure. Because a considerable amount has already been written and published about AI in telecom and in mobile networks, this report will not provide a deep technical dive into the potential uses of AI but instead will provide context.

Certainly, there will be much more to come on AI. The industry is in its infancy and the potential impacts are vast, but exactly how it will play out has yet to be determined.

The decisions of the mobile operators regarding AI will have an impact on the entire wireless infrastructure sector, including the companies that support them, such as the construction and engineering firms.

Where can AI be used in wireless infrastructure?

In the mobile network, there are several applications for AI being demonstrated, deployed or in actual use:

- **Network planning optimization:** Using AI to analyze traffic flows, predict mobile network demand and plan network capacity. This will impact the network engineering and construction companies through enhancements to the tools and processes they use.

- **Network operations optimization:** As an extension of network planning, AI algorithms can adjust network operations to react to changes in demand. Changes may also be made to predict mobile network demand.

- **Reducing energy use:** By adjusting each component in a mobile network to deliver the precise performance needed, the overall energy consumption can be reduced. For example, radios and antennas that may not be needed at a particular time can be turned off and then powered back on when required.

- **Predicting required maintenance:** By analyzing network performance data and applying predictive algorithms, AI can be used to identify potential points of failure in the network and suggest maintenance to reduce network failures and downtime before they occcur. This includes replacing components that may be at end of life and at risk of failing.

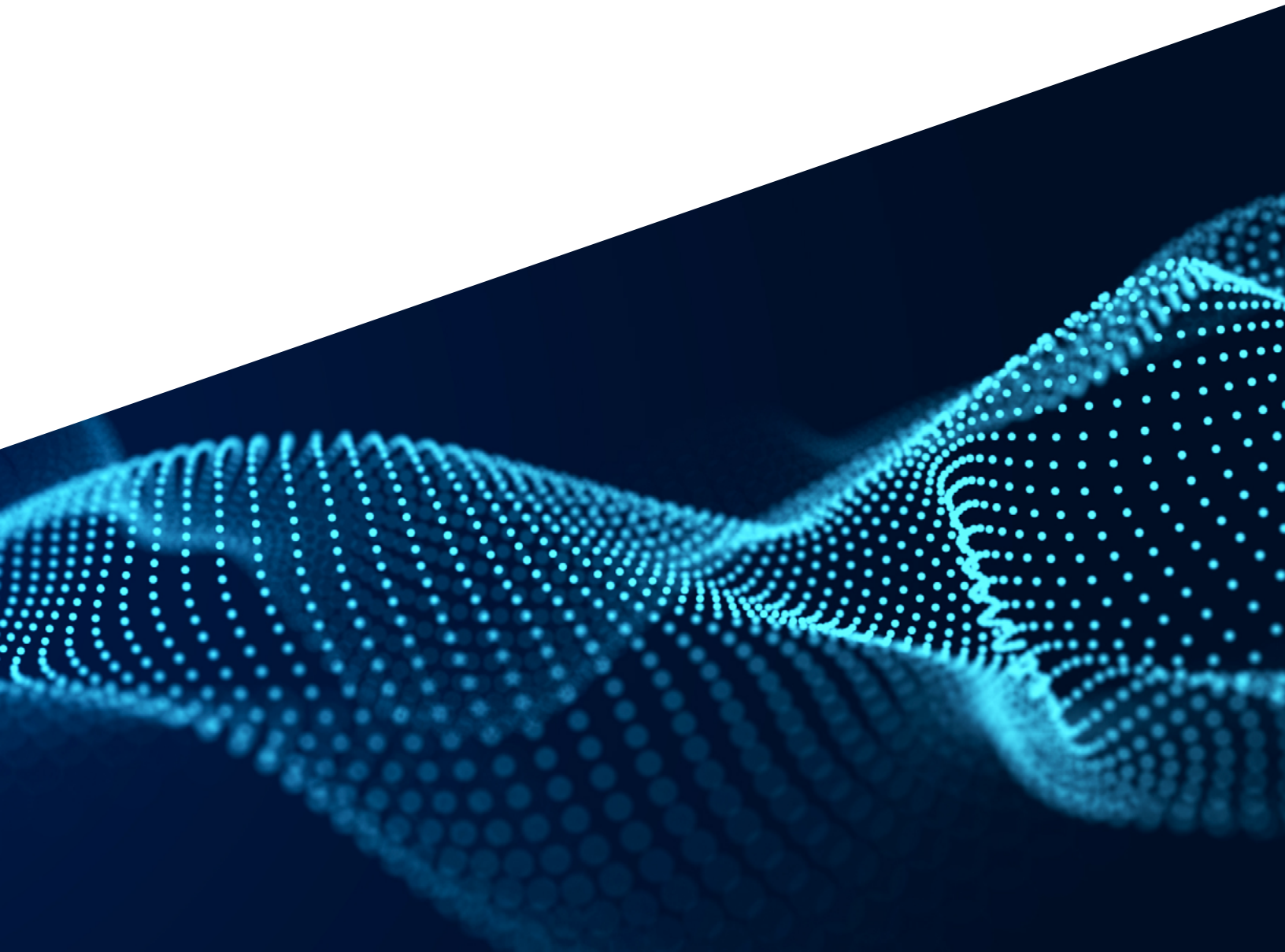
- **Increasing network security:** Using algorithms to analyze network data, devices and usage, AI potentially can identify malicious network attacks, cyber threats and fraud within the network. The system also takes proactive actions to mitigate the potential damage to the network.

The result of these efforts is to not only improve the overall mobile network performance but also to reduce costs through increased efficiency and increase the overall return on network investment.

Is AI just automation?

AI is more than automation. Automation is when software or technology is applied to repeat a task using a defined, unchanging set of instructions or rules. For example, a network may be optimized by tilting antennas on a weekend to address a crowd attending an outdoor entertainment venue – so the automated rule says, "tilt these antennas down 3 degrees on Saturday and Sunday." This rule does not account for the actual need to move the antennas. If there is no event that weekend, the antennas would still tilt down 3 degrees on the weekend.

AI adds intelligence to this type of automation. An AI function would look at the surrounding network data, determine if there was an event planned at the venue, assess the demand for mobile bandwidth and adjust the antenna tilt as needed. Rules are still applied but they adapt to the surroundings.



How can AI be deployed in the network today?

As with many large enterprises, mobile operators are generally focused on using AI to improve overall business operations in areas such as customer service, retail operations and business planning, including developing new rate plans and products. Using AI in the network is possible and there are several examples around the world to show the potential. But making changes to the network must be done carefully to ensure the correct outcome is achieved and new issues are not introduced.

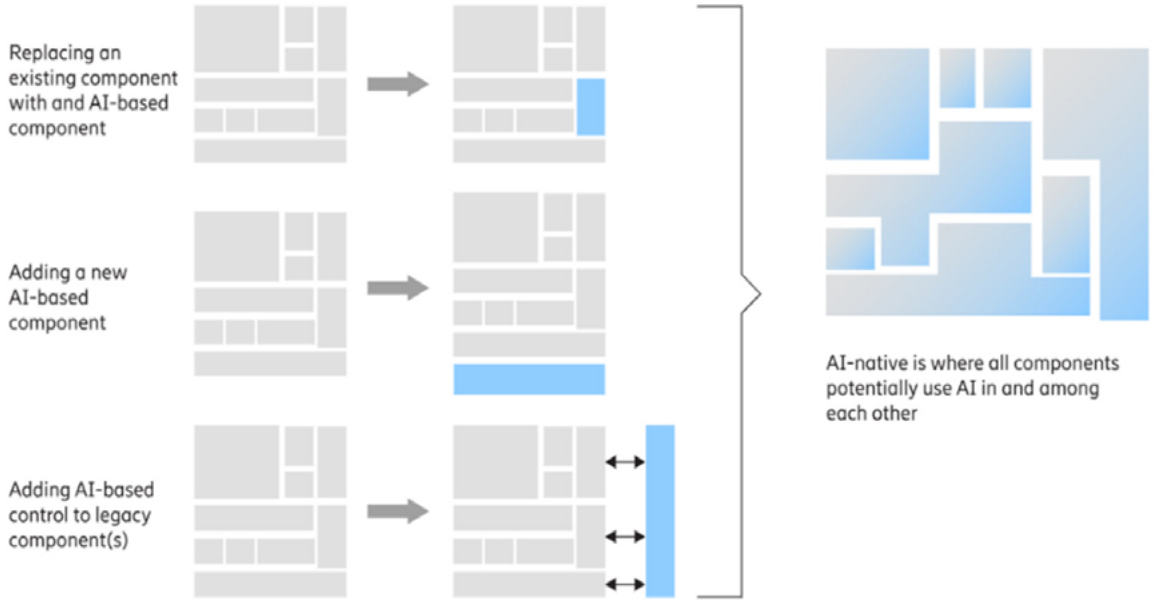
AI could be used in multiple network components from MIMO antennas and radios through to the Distributed Unit, Centralized Unit and the Core. There is not a one-size-fits-all AI solution that applies to every component in every network. Also note that there is a difference between adding AI capabilities to an existing system and using AI-native systems, where all the components of the system potentially leverage AI.

One challenge with deploying AI in mobile networks is the sheer size of the networks themselves. This is especially true of the Radio Access Network (RAN). Each nationwide mobile operator maintains more than 60,000 cell sites. Deploying any new technology or upgrade takes time and must be done carefully to avoid negatively impacting the network experience and user base.

As such, deploying AI in the network is likely to be done incrementally. Ericsson sees AI being incorporated into network components in three ways:

- To replace an existing rule-based algorithm or component with an AI-enabled solution;
- To add a new AI-based component to an existing component, enabling new functionality;
- To add AI-based control to an existing component – no changes are made to the existing network, but new AI-based capabilities are layered on top.

Figure 1: AI-based network component deployment options



Source: Ericsson blog '*How AI and intelligent automation are being leveraged to boost network performance*', September, 2023

While AI can be used across an operator's entire business operation, in the network, the biggest potential gains likely would come from improvements in the RAN. Predictive maintenance algorithms, RF optimization solutions and AI-driven energy efficiency solutions all can be applied to RAN components

.

But the RAN's size means that deployment of AI-based solutions will take time and must be done strategically. Just as it takes a couple of years to deploy a major upgrade to the RAN (moving from 4G to 5G, for example), the same can be expected of networkwide AI. It will take time but the implications will be felt across the industry.

Another challenge is structuring, collating and analyzing the large amounts of data a RAN can generate. For AI-based RAN components to be effective, this data must be processed and analyzed quickly and accurately.

Does AI need 5G?

Machine Learning and Deep Learning essentially depends on the ability to ingest and process large amounts of data. The more complex the request, the more data is required. AI is model-driven and may use large amounts of data but also can be effective by applying the right model to the right problem. 5G networks can deliver more data at lower latency than previous mobile generations. As speed becomes more of an issue for AI applications and services – especially the ability to collect data from multiple sensors and devices and interact with the end user more quickly - 5G will have a more important role.

As AI becomes more personal (think of having a personal assistant available to you at all times), reliable, high-speed connectivity will be needed. Depending on how AI is monetized on a wide scale, this could present new revenue opportunities for network operators.

Does AI need Edge Computing?

To date, natural language processing AI algorithms have been run in hyperscale data centers because these algorithms require a considerable amount of data storage and processing power. The large, centralized data centers used by the hyperscalers are ideal for this application.

As widespread AI use increases, the speed of the connections to these data centers and their ability to process more data at a faster rate becomes key to the overall performance of the AI algorithm. For this reason, the industry has seen investments in the very large data centers to accommodate AI.

But as AI systems and applications develop, they are likely to use more inputs (including from sensors, IoT devices, cameras, etc.) and more types of data input rather than simple text requests. ChatGPT4 (the newest iteration of ChatGTP) already can accept images and sounds as input. More processing closer to the end user or the sensor is likely to be required to ease the amount of traffic sent to the data center for processing.

It is likely that AI processing will migrate closer to the end user or input device. This will be seen first at regional and local data centers, and then at the edge.

But this will take time and ultimately will depend on how AI is used at a personal level. For example, if a consumer asks an AI to analyze an image or video in some way, it makes sense to do some pre-processing of the images or video at the edge of the network, before being sent to the AI algorithm, reducing the amount of data sent and the processing required. This processing could be done in the application layer and may not be done in the RAN.

Processing the AI algorithms also may be distributed to the edge in future architectures that leverage the concept of context-driven data and communications. This would likely increase the response time for the task and obviously the processing would be distributed. For tower companies, this presents an opportunity to house additional compute resources as close as possible to the RAN equipment and hence the end user.

This could mean mini data centers being deployed right at the network edge connected by high bandwidth fiber and fully redundant power supplies. These new architectures will take time to develop and depend on the future growth of AI. There is a sizeable future role for infrastructure providers.

Mobile traffic impact of AI

One big question is what impact AI will have on mobile network traffic patterns. In other words, how will the use of AI impact the amount of data flowing over wireless networks? While current mobile network usage is well understood (and drives how networks are planned, built and managed), the exact impact of AI applications and systems has yet to be fully understood. And rapid scalability of wireless networks may ultimately be required to handle rapid changes in network demand.

How GPT-based AI is used today in a business environment on a Local Area Network (LAN) or broadband connection is unlikely to be a good model for widespread AI access from a mobile device. The mobile device itself will become part of the AI system by handling any necessary pre-processing. And the type of user interface into the AI application is more likely to include images, sound and voice interaction on a mobile device. In short, future AI applications for mobile devices are likely to behave like far more advanced versions of today's voice assistants, such as Siri and Alexa.

Personal AI impact

The majority of AI traffic today is text based; consumers can type a question for ChatGPT and the application will respond in text. ChatGPT4 also has the ability to analyze sound and image inputs. If a mobile device is used to send an image to ChatGPT, more data will be uploaded because the image file is likely larger than a text file.

Video uses even more data. Higher definition images and videos, such as HD, further increase the upload file size and data usage.

As more consumers use AI applications and services, especially those using video and image input, the overall amount of data uploaded on the mobile network will increase. Exactly how fast AI use will increase and impact mobile data use remains to be seen. But in general, the biggest contributor to the growth in mobile data traffic has been the increased use of video, especially HD video.

An unknown factor is how increased use of AI-based applications and services will impact the current use of browser-based Internet searching. In other words, will people use a browser on a smartphone less as the use of AI increases? And what will be the net change to the mobile data traffic?

Machine and IoT AI impact

One of the main value propositions for AI systems and applications is the ability to process very large amounts of data from multiple devices and sensors. This includes IoT devices that can collect real-world data and quickly process it through the AI. In turn, this further trains the AI and improves the overall outcomes.

As more devices and sensors are used to collect data for AI systems and applications, it is likely that they will be connected by wireless networks, including 5G. Just as the use of IoT devices has increased in the past 10 years, the growth of AI could lead to an increase in 5G-connected and wireless-enabled devices on orders of magnitude. Further, wireless networks provide an avenue for data collection, creating and maintaining digital twins, and enabling the sensory fusion of data to enable more effective AI deployment.

CONCLUSION

The press is full of articles about how AI will change the world. But as we have discussed in this paper, the reality of AI is a little different, especially as it relates to wireless infrastructure.

AI is being used in several places in the wireless industry, especially in the business operations of the ecosystem companies. In the network, AI has a significant role to play in the optimization of network operations, including automating network performance functions, reducing energy use, predicting maintenance and increasing network security.

AI technology, systems and applications are developing quickly. Predicting when AI will have a significant role in wireless infrastructure is difficult and the reality is that there are likely to be unseen solutions and implications.

There is a role for AI in the RAN, but deploying AI will be challenging given the size of the networks. AI in the network is likely to be done incrementally by replacing an existing rule-based algorithm or component with an AI-enabled solution, adding a new AI-based component or adding AI-based control to an existing architecture. These AI models will also likely be smaller and distributed, enabling deployment at scale.

The impact of AI on mobile network traffic patterns remains to be seen. While the current mobile network usage is well understood (and drives how the networks are planned, built and managed), the exact impact of AI applications and systems has yet to be fully understood. The mobile device itself will become part of the AI system by handling any necessary pre-processing, and the type of user interface into AI applications is more likely to include images, sound and voice interaction on a mobile device. In short, future AI applications for mobile devices are likely to behave like far more advanced versions of today's voice assistants, such as Siri and Alexa.

There will be much more to come on AI. The industry is in its infancy and the potential impacts are vast, but exactly how it will play out has yet to be determined. Solutions are not simple, and deployment will take time. But as more consumers use AI, especially with interactive multimedia interfaces, demand for mobile network traffic will increase, which in turn will increase demand for wireless infrastructure, networks and spectrum.

The decisions made by the mobile network operators will impact the entire wireless infrastructure sector, including the companies that support them, like the construction and engineering firms.

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