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Organizational transformation with intelligent automation: Case Nokia Software

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Abstract

Nokia Software is spearheading the development of artificial intelligence solutions in the field of telecommunications. The company aims to seize the opportunities of 5G networks with its Telco AI: a powerful artificial intelligence tool for telecom operators that allows a simultaneous optimization of network services and the business behind it. As Nokia Software's Mikko Laine is presenting the solution to a potential client, the latter one brings up potentially significant concerns with Telco AI that Laine has not fully thought through: how to execute an organizational transformation to fully exploit Telco AI's capabilities, and how to prevent skill deterioration and losing control over the process to the intelligent automation.

Keywords

Artificial intelligence, automation, telecommunications, teaching case, organizational change, augmentation, knowledge work

Introduction

Mikko Laine, the Head of Product Strategy at Nokia Software, sits quietly in the conference room of their office situated in Salmisaari, Helsinki. He is beaming of excitement as he will soon give a presentation about the company's new artificial intelligence (AI) solution, called "Telco AI". Unlike the physical networks that the larger Nokia brand is known for, Nokia Software concentrates on cutting-edge software solutions, spearheading AI development in the field of telecommunications. Staying connected is increasingly important in today's technological society, making it paramount for telecom operators to strive for better network functionality. It is no longer okay for mobile data connection to be down, or even slow—the importance of its reliability and consistency is becoming comparable to that of electricity itself.

Nokia Software is seizing this opportunity by developing and deploying AI software solutions (see description in Exhibit 1) for its potential B2B clients: telecom operators offering Internet connectivity. Telco AI is a particularly promising one as it injects business-driven thinking into telecom operations. Its intelligent algorithms provide telecom operators a powerful tool to manage and enhance their services by ensuring the best possible customer experience, maximizing revenue growth, minimizing operational costs, and capturing market share. In comparison, the traditional approach has been very technically oriented as it has concentrated on optimizing the technical network performance, with little awareness of the business dimension. This should be a sure thing, Laine chuckles. Imagining himself in client's shoes, he cannot see why a telecom operator would not immediately be on board with Telco AI. Precisely at that moment, there is a knock on the door and in walks

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Nokia Software helps communication service providers to reinvent themselves to provide digital services to their consumer customers and offer new opportunities to their enterprise clients. The latest network generations and technology are the key enablers, as they entail capabilities such as dynamic on-demand slicing of mobile networks, and a service-based architecture to enable diverse use case requirements of high bandwidth, low latency, ultra-reliability, edge computing, and massive scale interconnection of things. A key in this transformation is to recognize the need for far greater agility with frictionless business and operational adaptability. In other words, digital service providers need to act in and capitalize on windows of digital time.

Digital time window starts before the moment of truth when an opportunity or threat is anticipated. It continues during the moment when the opportunity or threat should be promptly addressed. And it ends shortly after as circumstances evolve. Operating in digital time applies for all areas of operations from marketing to product management, customer experience management, network and service operations, care and monetization.

To operate in digital time, service providers need a holistic and real-time view of what is happening with business and operations to determine the next best action to take.

To provide that view Nokia Software takes a holistic, data-driven approach to connect domains, derive insights and trigger and automate actions in the moments that matter by providing a 360-degree understanding of customer experience, services, and networks. This ability is dubbed as *connected intelligence*.

Creating great digital experiences starts with understanding the customers and all the things and people they connect with.

Exhibit 1. Nokia Software's mission.

Viviana Rich, the Head of Customer Experience at G Telecom, a fast-growing telecom operator. G Telecom is currently experiencing challenges in managing customer experience as their customers are becoming more demanding: degradation of service levels is not tolerated. Having the main responsibility of G Telecom's customer experience, Rich is eager to hear about Telco AI.

Laine offers her coffee and the two sit down at the table. After introductions, Rich starts to explain their current challenges:

> Although we are happy about the current strong growth of both the customer segments and our service portfolio, it gets increasingly difficult to provide consistent and stable service. Since there are no signs of the growth slowing down, I'm afraid the gap between what customers expect and what we can provide may become wider.

Indeed, the business is constantly evolving and covers multiple customer segments. Because G Telecom is operating on narrow margins to gain more market share, the budgets are constrained. Therefore, increasing the team count of human workers is not an option. This is where automation and AI come in: Rich believes that the technology can play a key role in resolving these issues. However, she is still unsure how to unlock the technology's potential as G Telecom is not very familiar with the possibilities of AI. While AI solutions appear attractive, it is not clear what kind of measurable results they produce and if the results can be interpreted in a way convenient for G Telecom leadership.

"I understand your concerns and I think Telco AI might be exactly what you are looking for," Laine says and hooks his laptop to a projector that displays the image to the white screen on the room wall. "First, to give you an idea what our solution is about, let me play a tutorial video of Telco AI." The video[1] lays out the basic functionality of Telco AI, as follows.

Telco AI

Telco AI is a platform that provides telecommunications specific data and advanced AI functionalities across enterprise users and systems. It can optimize connectivity against several different business intents. A smooth and satisfying use experience for the network's end users, whether consumers or organizations, is arguably the most important intent. A telecom operator may leverage Telco AI to prevent the use experience from deteriorating and to find novel ways to improve it. Yet, striving for perfect customer experience does not usually represent a feasible business case. Connection quality is a subject of many variables, some less controllable than others, such as weather. Thus, one could end up pouring endless amounts of resources in network optimization if trying to reach 100% customer satisfaction. Rather, telecom operators typically want to find ways to maintain consistent service levels for acceptable cost, offering fast enough speed while avoiding major drops in connection. Telco AI helps telecom operators to find such cost–benefit balance by determining where the most critical experience-deteriorating problems are about to occur. The AI uses the data compiled on the platform to generate predictions and recommended actions for its operator.

Basic principles

In telecommunications business, there are a lot of data available from various sources, as almost every individual and organizational actor is a customer of some telecommunications service provider. The emergence of 5G networks unlocks opportunities to collect increasing amounts of data from various aspects of the service process. Technical data on network performance can be collected from network elements or probes in the service chain, ranging from network throughput to connection quality and reliability, latency toward service (e.g. browsing, voice messaging, video connection), or other specific indicators (e.g. video and/or call jitter). In addition to technical data, one can collect data also from the billing and customer care processes, typically in the form of key performance indicators that measure those processes. To assess customers' perceptions of network quality, data collection can also involve conducting surveys on them. Finally, data relevant to telecom operators exist beyond an operator and its immediate stakeholders, too. For instance, one might gather data from social media as it could reflect or predict changes in network traffic, or from weather reports and forecasts as weather tends to affect connection quality. The growing availability and quantity of various types of data presents lucrative opportunities for telecom service providers who manage to make effective use of these data. Telco AI is designed as a concrete tool for unlocking this largely untapped potential.

At the heart of Telco AI is machine learning (ML) technology, self-learning algorithms that can be used to reduce voluminous and disorganized data into concrete and simple expressions. Telco AI's ML involves combinations and chaining of multiple types of algorithms, including those used for predictive and prescriptive analytics, heuristics and aggregation, anomaly detection, classification, sorting, and various other purposes. For example, Telco AI leverages Bayesian networks and deep neural networks in its analysis. As there are multiple stages in a data-analyzing process, different algorithms may be used in different stages, depending on which algorithm performs best at a given stage. Both supervised and unsupervised learning are being applied. For instance, anomaly and change detection applies unsupervised learning as that task does not require human supervision or labeling. Classifications, predictions, and recommendations, on the other hand, exemplify supervised learning as human judgment is required to provide correct identifications and to verify recommendations' appropriateness. As external conditions and business priorities change, the system is continuously learning and adapting, both automatically based on data and manually through human-performed tuning.

Customer Experience Index

Using these various methods, Telco's ML translates a wide range of data points into a manifestation of customer experience that signals whether the customer is happy or not. Nokia Software has composed a formula for customer experience index (CEI) in telecommunications, which serves as an aggregate measure for assessing the overall customer experience of communication networks. In the CEI formula, customer experience consists of metric data gathered from multiple service branches (e.g. data and voice connection, customer care, billing). The main branches divide into further subbranches, forming a tree-like model (see Figure 1(a)). Network is an especially crucial aspect of CEI as it reflects the network speeds of both fixed and mobile connections. At the root of network quality score is the measured network latency: Telco AI tracks the latency in each website and online service the end users frequent.

New branches can be added into the formula when found relevant. For instance, social media signals about current public events can be incorporated, as this might affect the connection quality at affected geographical areas. Each branch in the tree model gets a normalized score between 0 and 100 (100 being the best possible value), determined by summing the scores of its subbranches, which are given weight coefficients that correspond the relative significance of each. The weight coefficients as well as the structure of the formula can be tuned up with ML so that CEI reflects known samples of customer experience, such as identified by Net Promoter Score (NPS) surveys, as closely as possible. Consequently, the CEI formula can become a proxy for NPS. Based on the scores and their weights, the formula yields a CEI value between 0 and 100 that is considered to reflect the level of overall customer experience, the higher the better. Thus, a drop in any component causes CEI to decrease, and if it drops under acceptable level, the system alarms the operator to take action. The visual, hierarchical tree structure of the formula allows the operator to track down the cause of the CEI decrease by following the path of decreased branch indicators in the system. The interface makes it easy to do this by highlighting insufficient service levels by using red font. Telco AI informs its operator of the impact of connection disturbances by outlining the expected number of customers and devices affected by the glitch.

The system operator can fine-tune the weights of branches either based on one's own professional experience or data gathered from the automated ML process. This is where Telco AI's intelligent capabilities come in: with ML-driven tuning, CEI formula not only reports the current

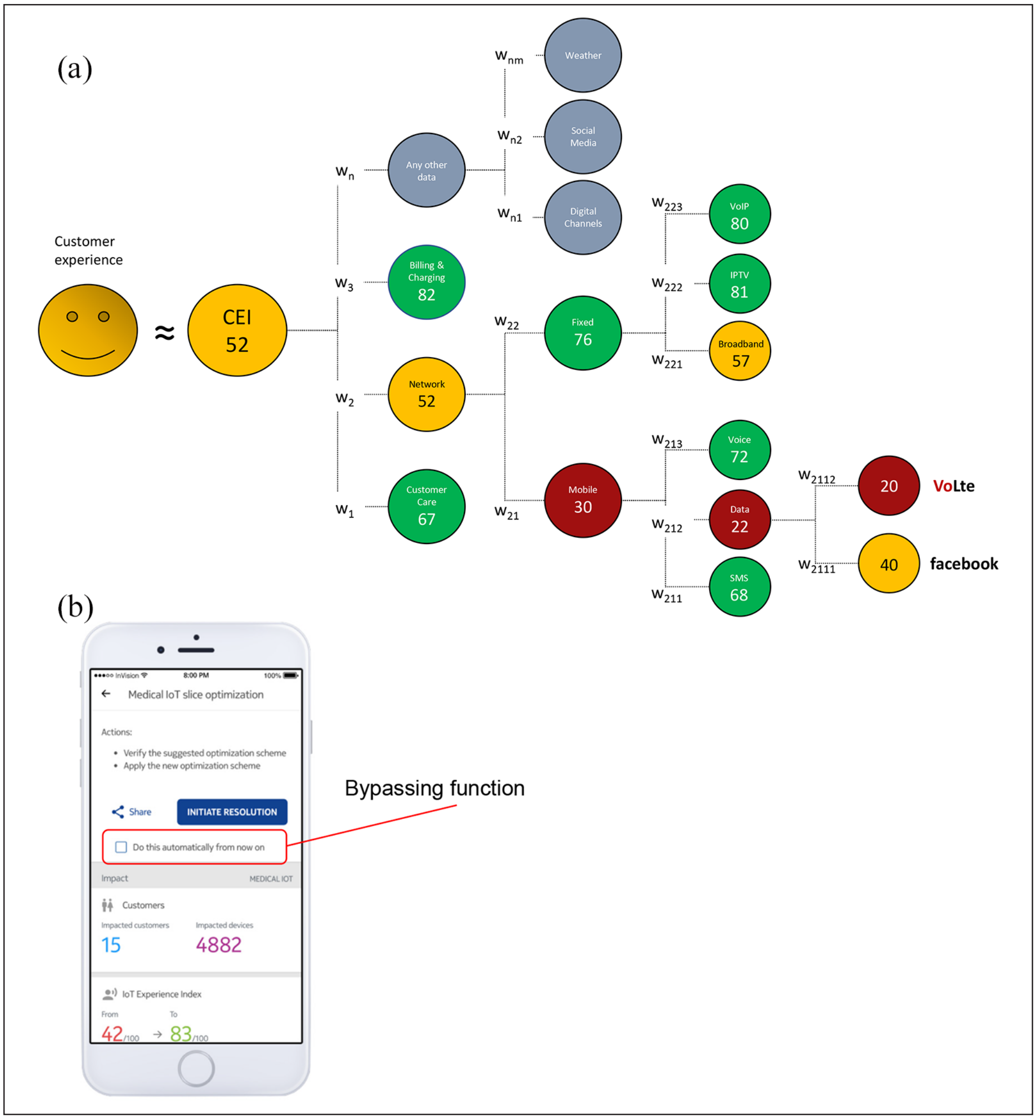

Figure 1. Telco AI:
(a) Telco AI's customer experience index and (b) Telco AI's bypassing function.

customer experience but also predicts its development. What makes it an especially powerful tool is that the predictions contain information on how to impact the future CEI. Indeed, Telco AI constantly analyzes changes in proxies that predict customer experience and produces recommendations based on the change indicators. For instance, it can correlate external weather and social media data with internal technical and customer care data for more accurate predictions. Telco AI's predictions become increasingly useful as their accuracy improves through gathering more data and continuously learning from it.

To ensure that the algorithms' customer experience assessments and predictions stay grounded in reality, Nokia Software calibrates them periodically by using online customer surveys. In essence, Nokia sends invitations to participate to surveys of user experience to a pool of a few thousand customers and then contrasts the results to Telco AI's predictions.

Human–AI augmentation

Considering that telecommunications is a rather complex and technical domain, it is not reasonable for a telecom operator to build a comprehensive AI system that would fully automate decision-making processes. Instead, humans should be kept in the loop and work collaboratively with AI. Such collaborative intelligence aims to maximize the impact of AI through leveraging the advantages of both humans and AI. Nokia Software describes such synergy as *human–AI augmentation*.

Although ML algorithms learn and improve as they process data, in the beginning they must be taught how to perform their work. When an issue occurs for the first time, human is needed to handle it and to teach AI how to process it in the future. Moreover, certain issues occur too rarely for AI to be able to learn from data alone, calling for humans' applied skills. While AI can be harnessed to perform autonomous anomaly detection, there is a need for humans to interpret the anomalies and to build corresponding procedures when appropriate. Overall, whereas AI can be used to automate several aspects of decision-making, humans are needed to make various important and impactful decisions that can relate to corporate processes, policies, legislation, and resource availability, to name a few.

Initially, humans preset processes and policies by defining constraints set by available resources, legislation, and other surrounding conditions. Telco AI produces recommended actions and then asks humans to confirm them. A human operator can reject or approve the recommended action. In addition, a human operator may instruct the AI to take similar actions automatically in the future, essentially *bypassing* the human operator (Figure 1(b)). This should alleviate the workload of the operator significantly, allowing him or her to concentrate on other work tasks.

The process above can be illustrated through the following real-life scenario. A telecom operator is operating a 5G network, which provides a possibility to add or segment more network capacity by programming. A small segment of the network, all the way from radio towers to cloud core, has been provided for the use of highly important, mobile Internet-of-Things (IoT) health devices. These could be, for example, cardiograms or medical imaging devices in ambulances that connect to the Internet. The devices' connections are subject to service-level agreements (SLAs) and customers' service experience is constantly measured. This includes assessing how well devices are able to communicate important data over the network to the hospital so that staff may be prepared for urgent cases. Since the telecom operator is providing similar services to multitudes of enterprises, it needs large-scale business and operational automation that Telco AI can provide. In the case of medical IoT devices, based on network data, Telco AI may go through the following process as a result of a change in CEI:

1. Telco AI detects a change: a degradation of customer experience with medical devices. The degradation is experienced as increased network latency, increased packet loss, and decreased available bandwidth, materializing as a decreased CEI score. The degradation not only hampers the operations of the medical devices, but also threatens to breach the SLA if not acted upon.
2. Telco AI detects insufficient network resources as the cause of this degradation, meaning that the number of connected medical devices has increased, rendering the segment of network provided for them insufficient to optimally support the devices' connectivity.
3. Given the analysis at Steps 1 and 2, Telco AI then determines a recommended action to turn the degrading trend around and prevent the breaching of the SLA. As the telecom operator is running a programmable network with additional capacity, Telco AI's recommendation is to provide a more suitable, larger network segment for the use of the medical devices.
4. Telco AI then provides an analysis based on Steps 1–3 to be considered and validated by a human decision maker in business operations. If the human operator is satisfied with the recommendation and the analysis it is based on, she or he approves the recommended action by asking Telco AI to initiate resolution. Provided the human has sufficient confidence on the recommended action in this kind of scenario, they may choose to apply bypassing, that is, automate the whole decision-making process by Telco AI for similar cases in the future.
5. If the human operator is not satisfied with the analysis, she or he may add more information into the process through the following ways:
   (a) Provided that Telco AI could not correctly identify the change scenario, the human could classify the scenario for it.
   (b) Provided that Telco AI could not correctly identify the root cause of the change scenario, the human could analyze and provide the root cause for it.
   (c) Provided that Telco AI could not correctly identify an action recommendation, the human could provide a recommended action instead.
6. After the human operator's decision, the approved action (e.g. growing the current network segment) is forwarded toward engines, which are able to reprogram the network to increase capacity for the medical devices. Expanding the network segment by adding new network slices would involve the following steps:
   (a) Instantiating and enabling virtual network functions (collection of virtual machines) in the core and edge clouds of the network (network function virtualization (NFV) orchestration).
   (b) Connecting network elements and clouds together with network tunnels (software defined network (SDN) controller).
   (c) Modifying service-specific routing in the network at multiple places (SDN controller).
7. Telco AI then follows up the efficacy of the actions taken, collecting data from network and operations for improving future recommendations.

Toward new operating models

With the video, Rich's cautious curiosity of Telco AI translates into excitement: "The functionality seems impressive

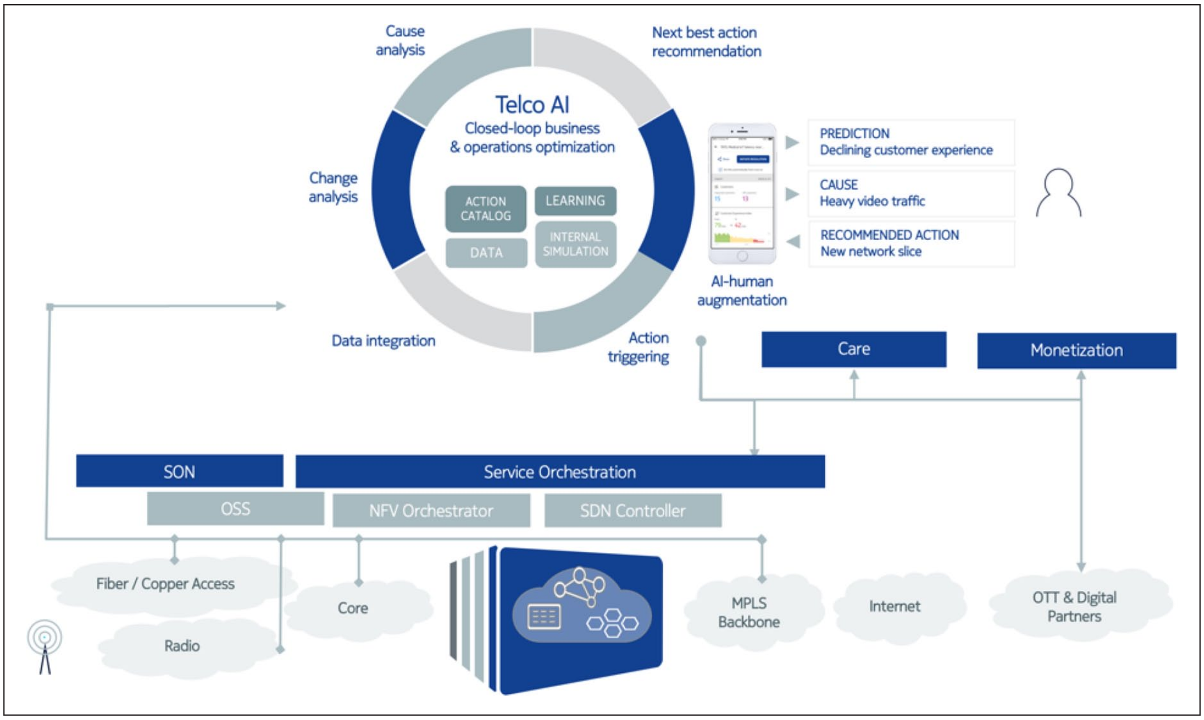

Figure 2. Contemporary operating model: Telco AI's closed-loop model.

indeed, and I believe we could use something like that at G Telecom. But does this really work? And is our organization ready to use it?" Laine starts to explain the wider organizational considerations of implementing Telco AI.

Traditionally, telecommunications enterprises have operated in a manner where business and operations management are *siloed*, that is, disconnected from each other, both pursuing their own goals without a holistic view on the direction in which the organization is heading as a whole. Such operating models sometimes result into situations where operational priorities do not reflect business priorities, or business priorities lead into a situation that is not operationally feasible. This is because decisions in different domains are being made in isolation from each other, without fully understanding the implications of those decisions outside a given decision maker's domain. Moreover, siloed operating models tend to incur duplicate and overlapping work, disaggregation of information and knowledge, and various other inefficiencies. The traditional model can be characterized as fast thinking and mindless: every department follows their own key figures and reacts to changes automatically according to a given set of rules of thumbs, instead of real-time data. Due to operating in separate vacuums, both individual workers and collective units tend to experience changing as painful, as they struggle to see the larger context and purpose of a strategic organizational change. Thus, such traditional model may expose enterprises to the risk of getting left behind in drastically changing and IT-driven competitive environments.

Whereas traditional operating models are largely reactive, AI technologies enable organizations embrace more proactive approaches. Telco AI allows a transition into contemporary, data-driven operating models that are more flexible toward changing needs and dynamic environments (Figure 2). Instead of operating mindlessly, decisions are a product of analytic thinking based on current data. 5G networks and Telco AI enable the collection and utilization of such data. Whereas a data-driven model can leverage a closed-loop logic in the sense that the managerial-level business intent optimization and operative-level technical domain optimization operate on different levels, Telco AI makes sure the domains stay connected. Specifically, Telco AI prevents the formation of silos by acting as a bridge between these two levels or loops, allowing them to inform each other while still operating in relative isolation from each other. Business domain is concerned about factors that relate to business management of service delivery, such as financial figures and customer interface. Thus, if CEI decreases, the business management knows that something needs to be done to improve it, or otherwise future cash flows are in jeopardy. However, the business domain does not know what exactly should be done and how to do it. This knowledge is located at the operational domain optimization level, which, by contrast, does not need to understand the business intentions or the grand scheme of operations (e.g. what kinds of CEI levels are needed for the business to remain sustainable). Rather, the main objectives lie in optimizing network connection. Thus, the operational domain optimization understands how to reconfigure the technology (e.g. to maximize coverage, quality, or density of radio access network) and how to detect and fix malfunctions. The business operates on an aggregate level, communicating their needs to the domain-specific level that can execute the necessary measures to satisfy the former's requirements. This allows both domains to concentrate on their core tasks, increasing dynamism, flexibility, and efficiency. Telco AI helps an organization to balance between cutting costs and increasing customer satisfaction, allowing both to happen simultaneously.

This is no trivial change but a drastic transformation, meaning that Telco AI is not a simple plug-and-play solution. The implementing organization needs to adopt a data-driven and agile mindset to replace old ways of thinking. From the technical perspective, one should reserve a full year for charting what kind of organizational change is required for effective implementation, agreeing on the appropriate measures, and finally conducting the transformation. After this, it will still take a year or two of iterative optimization for the benefits of Telco AI to materialize. While Telco AI can be implemented to run on top of the existing IT infrastructure, the required overall business transformation suggests that the change process should also include a critical assessment of the existing legacy IT.

Taken together, harnessing the benefits of Telco AI to the fullest extent requires a long-term mindset and an evolutionary change process from the implementing organization. When it comes to future directions, the role of AI is expected to increase even more in Nokia's service catering. Although Telco AI has been designed human–AI collaboration in mind, Nokia's vision for Telco AI's evolution is for it to become a zero-touch service where humans remain in a supervisory role, only intervening in the process in exceptional cases. Moving toward a "zero-touch" model represents another potentially lucrative yet challenging future opportunity for an organization that chooses to implement Telco AI.

Potential concerns

While Rich is visibly impressed by the technical execution of Telco AI, she appears slightly hesitant regarding the broader organizational transformation required for effective implementation of Telco AI. "What kinds of abilities are needed from us as an organization to successfully implement it? To what extent should existing organizational practices and structures be altered? How do we know if and when we are ready for it?," she wonders. Rich's concerns wake Laine up to the fact that the specifics of organizational change required for Telco AI may not have been thoroughly thought out yet. While Nokia Software's development and marketing units have invested significant efforts in developing Telco AI's service concept and the related technology, Laine realizes that they have not created any concrete benchmarking methods to assess a client organization's transformation. Moreover, it is not entirely clear what kind of role Nokia Software will assume in selling their transformational solution. Surely, Nokia Software does not want to give the impression of merely automating something for the sake of automation, but rather wants to position itself as an enabler and facilitator of new capabilities that empower clients. Effectively harnessing such capabilities would indeed require organizational changes from the client's end, otherwise they would be buying just another tool, albeit more effective one. While Laine explains the aspects of their service concept that can help the client organization to leverage Telco AI effectively, deep down he acknowledges that perhaps Nokia Software should have a more concrete strategy for selling and delivering the transformational part of the service. "Also," Rich continues, "when it comes to individual users, what kind of skillset should they possess to use the application? Can our staff handle it? Do we need to train them?" Laine emphasizes the ease of use of Telco AI's graphical interface but makes a mental note that perhaps it is not as intuitive and understandable as he has thought, considering that Rich still seems uneasy with it.

Another issue that seems to be disturbing Rich are Telco AI's automatable decision-making abilities, that is, the bypassing function:

> That sounds great from the efficiency perspective. But what happens if the users get complacent with it? What if they start increasingly hand off the control to the AI, letting it take the wheel and losing the track of what it does?

Laine has to agree with the point and acknowledge this potentially hidden issue—humans tend to gravitate toward convenience, even when rational thought would advise against it. Recalling various airplane incidents caused by pilots' attention drifting away due to overreliance on cockpit automation, Laine understands the concern. Whereas automation complacency and automation bias may not cause life-threatening crises in the context of telecommunications, Laine does not want their product to incite undesired organizational outcomes. Then again, if the users under-utilize AI functionality, they fail to reap its core benefits. Laine explains Rich that the bypassing function should always be used with caution and possibly some managerial policies should be set for ensuring that Telco's users will not go rogue with the bypassing. Yet, he realizes that their service concept has not properly acknowledged this issue, and he is unsure whether his arguments have truly convinced Rich.

The assignment

Rich thanks Laine for the meeting and promises to get back to him after having evaluated the options with G Telecom's management. After escorting her to the lobby, Laine sinks into his thoughts as the concerns Rich brought up are still revolving in his head. Apparently, implementing a service like Telco AI comes with challenges for both sides, the client (G Telecom) and the vendor (Nokia Software). Therefore, questions weigh the minds of both Rich and Laine.

Assignment A: Viviana Rich (G Telecom)

As Viviana Rich exits the building, she is convinced that Telco AI could be the right thing for G Telecom. Yet, she knows that careful thought has to be put into its implementation, and she is not quite sure how the required organizational change should be carried out. She acknowledges that G Telecom is currently operating in a rather traditional manner that resonates with Laine's description of a siloed organization. Moreover, she feels that bringing in more automation entails certain threats to the knowledge capital of her company. How to find a balance in leveraging AI so that its users neither under- nor over-utilize it? Assuming the role of Rich, you are faced with two challenging tasks:

A1. Develop a plan for a mindful transformation of G Telecom aimed to make most out of Telco AI. Think how the organization's structure, incumbent work routines, and managerial mindset should change to be ready for a new, data-driven era enabled by Telco AI.

A2. Produce a managerial implementation plan for Telco AI that lays out the principles of human–AI collaboration in using Telco AI. The goal is to reap the benefits of AI and to empower human workers with the technology while mitigating its undesired effects such as workers' skill erosion and disappearance of organizational memory. What should be automated and how to ensure humans are kept in the loop?

Assignment B: Product Manager (Nokia Software)

While Nokia Software has given a lot of thought to efficiency-related aspects of the service, the matter of ensuring the trust of clients and helping them to effectively implement the AI remains underdeveloped. Thus, Laine fears that the current service strategy does not make the most of Telco AI's advanced capabilities. What kind of roadmap should Nokia Software develop in order to address the client concerns raised in the meeting? How to lower the threshold for a client to adopt the solution, how to make it easier to implement? How to produce the service from both the business-process perspective and the user-interface perspective, so that the operator does not end up into the backseat? Deep in his thoughts, Laine walks through the hallway leading to his office. It is precisely there where he runs into you, the Product Manager of Nokia Software. "Ah, just the person I was hoping to see right now," Laine utters, awakening from his bemusement. "Can you meet me in my office? I have a task for you," he continues. You follow him into his office, and he explains the situation:

> . . . so, we need to develop Telco AI into a more client-oriented direction and think how we could help the client to make the most of our product . . . we should also figure out how to position ourselves when marketing Telco AI . . .

In this note, he lays out two tasks for you to start working on:

B1. Produce an action plan for Nokia Software for selling their overall service: assisting a client company in a data-driven, human–AI augmentative organizational transformation. Think what kind of role Nokia Software should assume in the process and how the company should position itself in relation to Telco AI.

B2. Create an enhanced product roadmap for Telco AI that counters the potential barriers of adoption for individual users, improves the user-interface design into more understandable and user-friendly direction, and provides user-oriented guidelines for leveraging the benefits of AI. Consider also the potential negative effects of automation on workers' awareness and skills.

This is no walk in a park, you think as you sit at your work desk with new tasks at hand. However, you remember that when tackling wicked problems, it is advisable to review what has been researched on the topic. "Leveraging automation effectively," "potential problems with overreliance on automation," "human–AI collaboration," should probably find something on those topics, you think as you enter your office and fire up Google Scholar search engine in your computer's browser. You start typing in keywords and results start popping up. Quickly, you come across useful literature (Scheepers et al., 2018; Willcocks et al., 2019) and a website (www.roboticandcognitiveautomation.com) on how to implement automation into knowledge-work processes. Digging further, you encounter a book discussing how AI is revolutionizing work (Daugherty and Wilson, 2018) and a number of relevant articles on how to organize work between human and machine agents (Asatiani et al., 2019; Endsley, 2017; Faraj et al., 2018; Raisch and Krakowski, 2020; Salovaara et al., 2019). As you go on, you find material on automation's unintended effects: a book exploring the dark side of automation (Carr, 2015), case studies that show evidence of automation's unexpected negative effects (Davis and Hufnagel, 2007; Rinta-Kahila et al., 2018), and articles that explore the mechanisms by which such effects eventuate (Parasuraman and Manzey, 2010; Parasuraman and Riley, 1997). This looks promising . . .

Glossary of technical terms and abbreviations

5G. Refers to the fifth generation of telecommunication networks and data transmission systems. 5G represents the next major step of network development after the previously introduced 4G (LTE/WiMax), 3G (UMTS), and 2G (GSM) systems. 5G provides network speeds up to 20 gigabits per second, multiplying the previous network speed capabilities and opening a wide range of possibilities in both public and business domains.

Action triggering. Human operator commanding artificial intelligence (AI) to take an action. For example, accepting and initiating an action recommended by AI after reviewing it.

Deep neural networks (DNN). DNN represent a subset of machine learning that uses multiple layers to progressively extract higher level features from raw data. Neural networks were inspired by biological systems; however, their information processing differs from biological systems in that they tend to be static and symbolic (compared to organisms being dynamic and analog).

Machine learning. Machine learning is a subset of AI and refers to the development of algorithms and statistical models based on (either labeled or unlabeled) training data. In the domain of business problems, machine learning is most often used for predictive analytics.

Network slice. A segment of a telecom network allocated for a specific geographical region.

Network function virtualization (NFV) refers to running previously physical network boxes as collection of virtual machines in telco/network cloud centers. NFV can be situated in the main data center, but also in distribution centers and even at base stations.

Operation support system (OSS) provides a holistic interface to a collection of systems or functions, allowing one to collect data from, and execute configuration changes in, the systems under it.

Software defined networks (SDN) are virtual networks created through NFV.

Supervised machine learning. In supervised learning, the algorithm is trained with data that is already labeled or sorted, so that it can learn the general principles of making predictions.

Unsupervised machine learning. The algorithmic model is produced based on data that is neither classified nor labeled. Thus, the system explores the data and draws inferences from the data to describe its hidden structures.

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Note

1. https://youtu.be/HGzglv0lO5g

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