Rakuten Symphony

Mobile as a Software™

How telecom can transform from an outdated industry to a technology leader

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Tareq Amin, CEO Rakuten Mobile, CEO Rakuten Symphony

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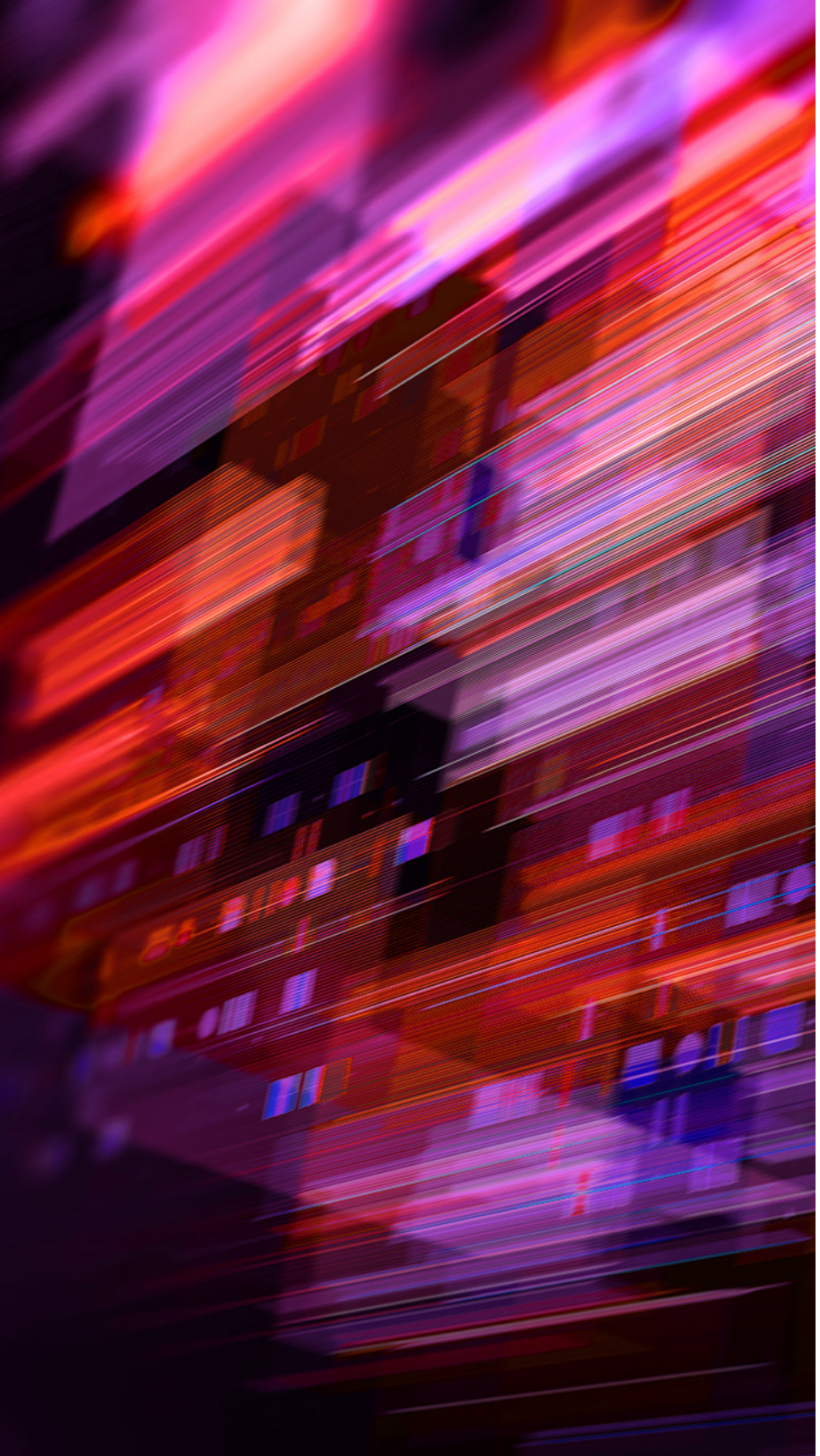

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EXECUTIVE SUMMARY

> If telecom does not place software at the heart of everything it does, it will continue in managed decline with no viable path back to revenue growth and relevance.

Since the 1990s, mobile telephony has moved through five generations of capacity and capability improvements but has never fundamentally changed how it plans, builds and operates networks.

Meanwhile, in the enterprise, IT deployment transferred from dedicated data centers to shared facilities to managed hosting to the cloud to full, software-defined infrastructure, operations and experience creation. Each step of this change decreased cost and time by a factor of 10 and accelerated freedom and capital to focus on revenue generation.

But telecom? It is still defined by its original siloed hardware roots, generational unit economic cost improvements and 1990s operational models. Now it underperforms by every financial and key competitive metric.

Telecom is an essential industry that generates US$1.3 trillion per year. It is also unwieldly, slow-moving and burdened by 70%–90% of the top line being spent on the cost of delivery.

Rakuten is an Internet software company, so when Rakuten Mobile chose to build its own network, it adopted a "Mobile as a Software™" mindset and moved the center of gravity from hardware to software.

In doing so, it did not disregard the value of hardware. Rather, it fully embraced the concept of disaggregation across all layers of the network business and maximized the efficiency and approaches most appropriate to each layer. The results ring out through agility, cost reduction and accelerated delivery speed.

Radio became a software business with Open RAN. Infrastructure became a software business with the cloud. All business processes were fully digitalized, and a single software platform runs everything with one real-time understanding of the end-to-end business.

Rakuten has proven moving to end-to-end disaggregation, software-centric operations and 100% digitalization can reduce the cost of delivery by 30%–50%, increasing the speed of organizational execution and agility and allowing the pursuit of next-generation services with the right software-driven operational foundation.

The opportunity and impetus to change is clear. Telecom must rapidly adopt a software mindset plus radical transformation to reap the proven benefits seen first in the Internet and now in IT companies. Only then will it become a true technology leader in enabling the next era for businesses, societies and countries.

This paper introduces Rakuten's experience of applying Internet software thinking to the overall telecom business and explains how to drive radical cost savings while increasing speed, agility and competitive market positioning.

This is a pivotal time for telecom. There is a significant opportunity for organizations to transform into active participants in the next generation of the Internet, which is simultaneously being reinvented through localization, regulation and governance requirements.

Winning a race requires hard work and training, not just great running shoes, regardless of whatever promises the shoe vendor makes. The time for telecom to start changing is now.

SETTING THE CONTEXT

Over the last 30 years, mobile communication has changed everything. Our dependence on these networks cannot be overstated. Yet, the mobile industry has not changed how it builds these networks. Every 10 years, there is a generational upgrade that expands the capacity of the existing approach but the fundamentals of how the industry plans, builds and operates networks looks basically the same as it did in the 1990s *(see Figure 1).*

Telecom's cadence has been driven by the lifecycle management of hardware deployments, with strong dependencies between software rollout plans and custom-built, proprietary hardware. This situation leads to long lead times and slow deliveries with highly manual operations. Coordination has been embedded within organizations rather than software platforms, leading to complicated, opaque and unique operational structures. The industry prides itself on being standardized but only 20% of an operator business uses standardized interfaces. The rest is highly bespoke and delivered to customers as complex system integration projects rather than as off-the-shelf products they can buy.

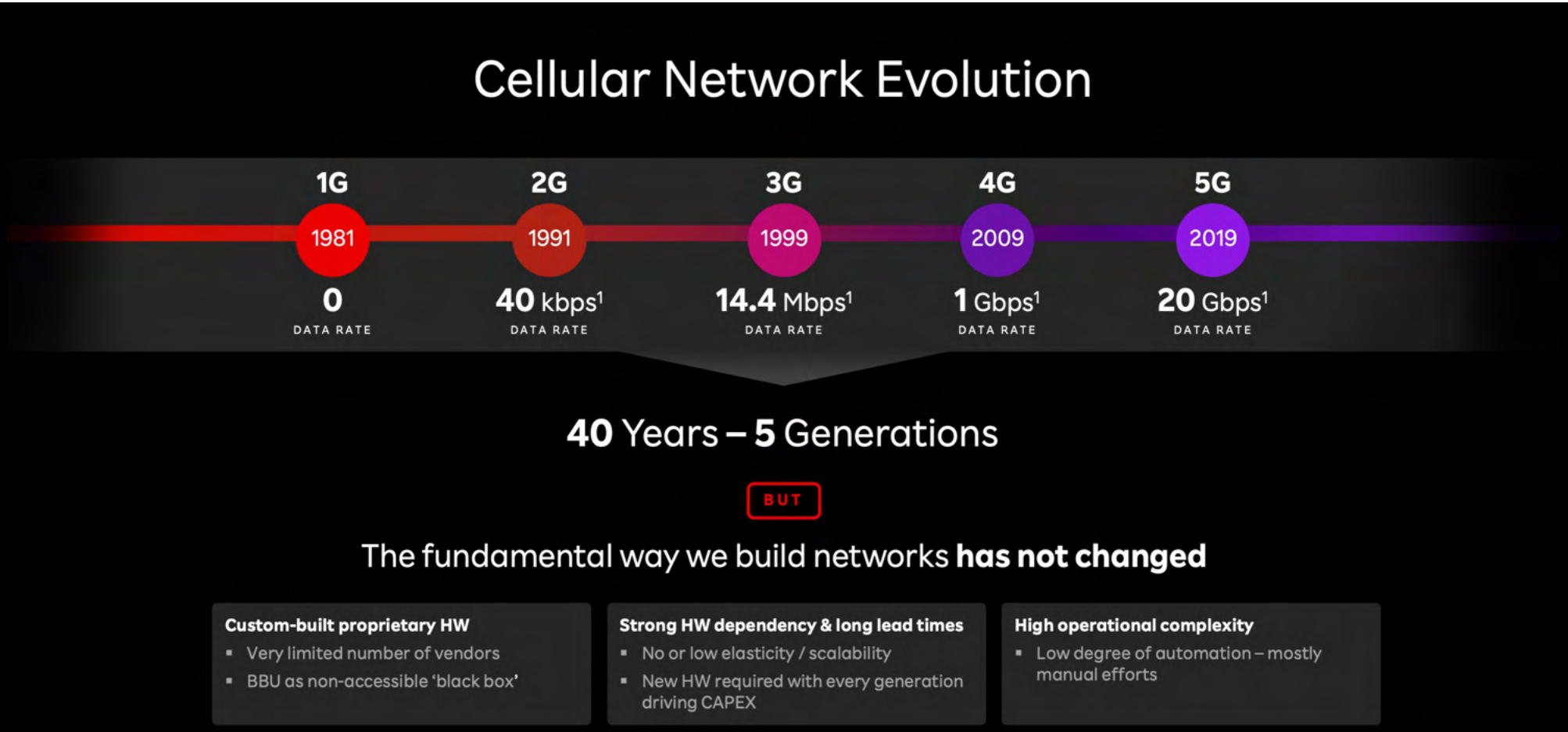


Figure 1. Although network capabilities have expanded dramatically, network development has hardly changed.

In contrast, the Internet, which has had a similarly transformational effect on people and society and has grown on a similar timeline to telecom, has transformed the IT industry along its journey.

Initially, IT had similar deployment approaches to telecom with dedicated sites and hardware. But the demands of its customers required faster delivery at much lower unit economic costs. This requirement led to deployment innovations like shared hosting centers, managed services and the cloud–both public and private *(see Figure 2).* The open nature of the ecosystem created the explosion of open-source software as well as the invention of new disciplines such as DevOps, infrastructure as code and system reliability engineering.

On the other hand, telecom is still stuck in the first phase deployment model mindset, with low 20% utilization and software delivery of applications toiling for nine months between market-readiness and live commercial deployment. If telecom is to become competitive, it must rapidly adopt the proven practices of the Internet and IT and start becoming a leading force for future progress.

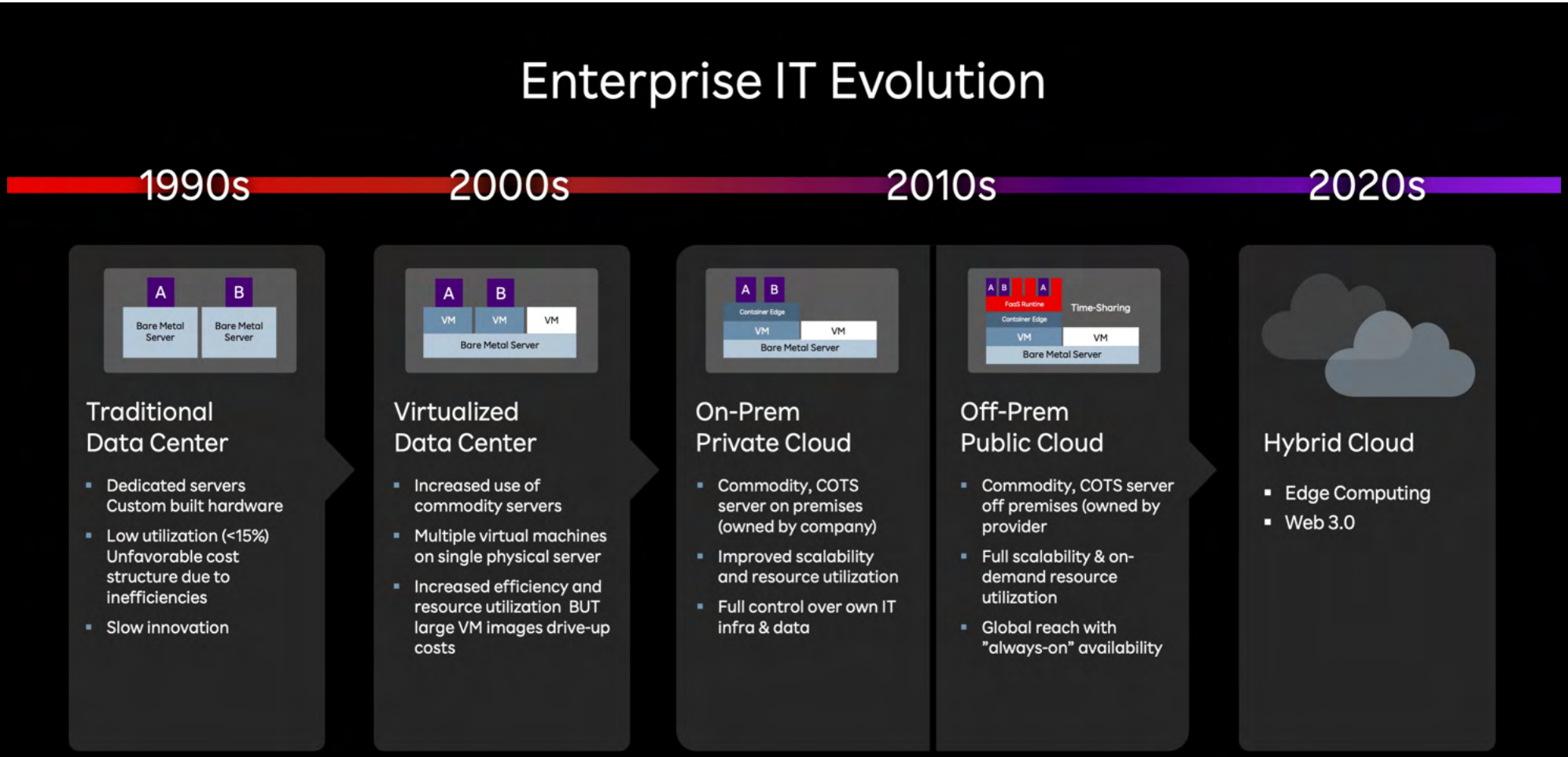


Figure 2. The Internet and the IT industry have transformed in tandem.

AN INDUSTRY IN MANAGED DECLINE

By every financial measure, telecom is underperforming and in managed decline despite being an essential service people cannot live without and increasingly use. No one wants to pay more for it, however, and users find little if any differentiation between providers *(see Figure 3).*

The industry promised revolution through the rollout of 5G, but that transformation has not arrived and there are no indications the massive promises made by marketing will ever occur. The truth is that 5G is irrelevant to telecom's customer base. It is simply a technology standard that helps operators build high-capacity, higher-density mobile networks.

The consumer market will gradually, if unwittingly, adopt 5G as a natural occurrence of handset and network upgrades. Mobile Network Operators (MNOs) have touted 5G revenue growth via the enterprise, but 5G alone does not solve for the desired business outcomes. The enterprise sector will buy the bigger solution, and unless telecom companies can adopt modern software practices, it will not be buying the solutions from them. This development is captured well in the "TelecomTV executive interview with Phil Jordan, Group CIO of Sainsbury's." Enterprises need business change, and 5G networks are a potential value-add ingredient. There are opportunities to create new connectivity and network businesses such as with Fixed Wireless Access (FWA) and private 5G networks. These are aligned with the stand-alone connectivity and the network operator promise of the 5G standard. Time will tell how large these businesses can become.

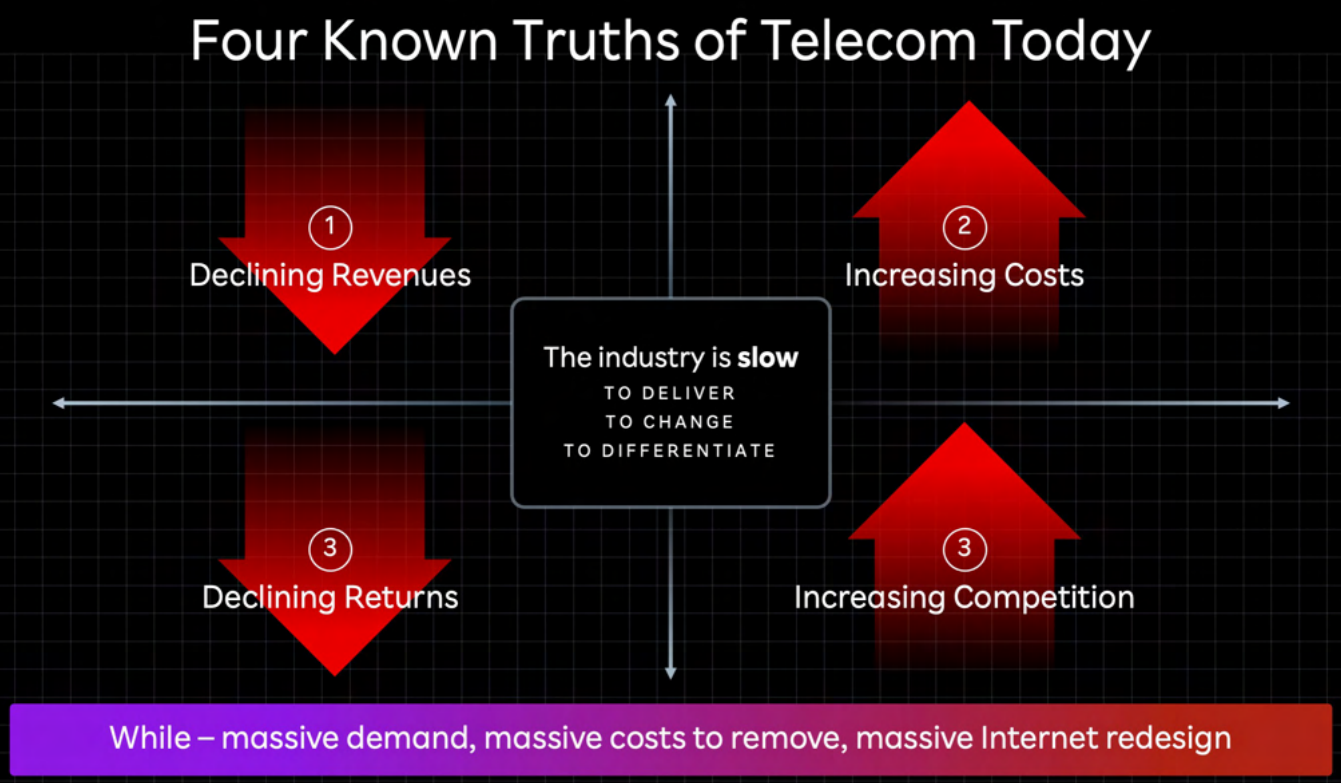


Figure 3. Telecom remains essential, but has become an expensive commodity service.

This persistent lack of revenue growth ("Telecom services revenue will fall 4.2% per user as new tech fails to deliver enough value by 2027" [Omdia]), parallels rises in complexity, densification and operational costs. Inflationary pressures, slow economic growth and increasing energy prices [Bain] increase pressure on telco OpEx. Strategy Analytics says OpEx costs are growing faster than even the most optimistic predictions of revenue growth.

This perfect storm of financial reality increases the costs of capital, and the pressures are reflected in the return on shareholder value. Although telecom was seen as the essential service during the pandemic, it was second to the bottom in terms of return to shareholders [Bain]. Only financial services performed worst.

And nothing is going to get better. More competitors are appearing, and they have adopted the modern IT practices of software, the cloud and automation. Without change, it is impossible for telecom to compete—and without change, it is impossible for telecom providers to survive. Telecom today is too slow, too expensive to run and unable to be competitive.

HOW TELECOM CAN CHANGE

To adopt these new practices, telecom needs to rethink everything, including organization, skillsets and most important, financial and strategic planning *(see Figure 4).* Change starts with changing how to allocate budgets and plan the aligned organization appropriately around them.

Traditionally, telecom has organized around vertical "stovepipes" for different parts of the network investments required to deliver a complete service. Each vertical stovepipe includes hardware costs, operational costs and software costs. Between 70%–90% of the top line is consumed by the operational costs required to deliver the service. In many cases, software and people costs are capitalized alongside hardware costs so they can be amortized according to hardware investment cycles and models.

Modern software-first approaches are horizontal in nature and are built on disaggregated, platform-level thinking. Each layer of a business is managed independently from the layers below and above. Each layer integrates with and understands the other layers through data accessibility, and each layer cooperates with the other layers through programmable and open interfaces.

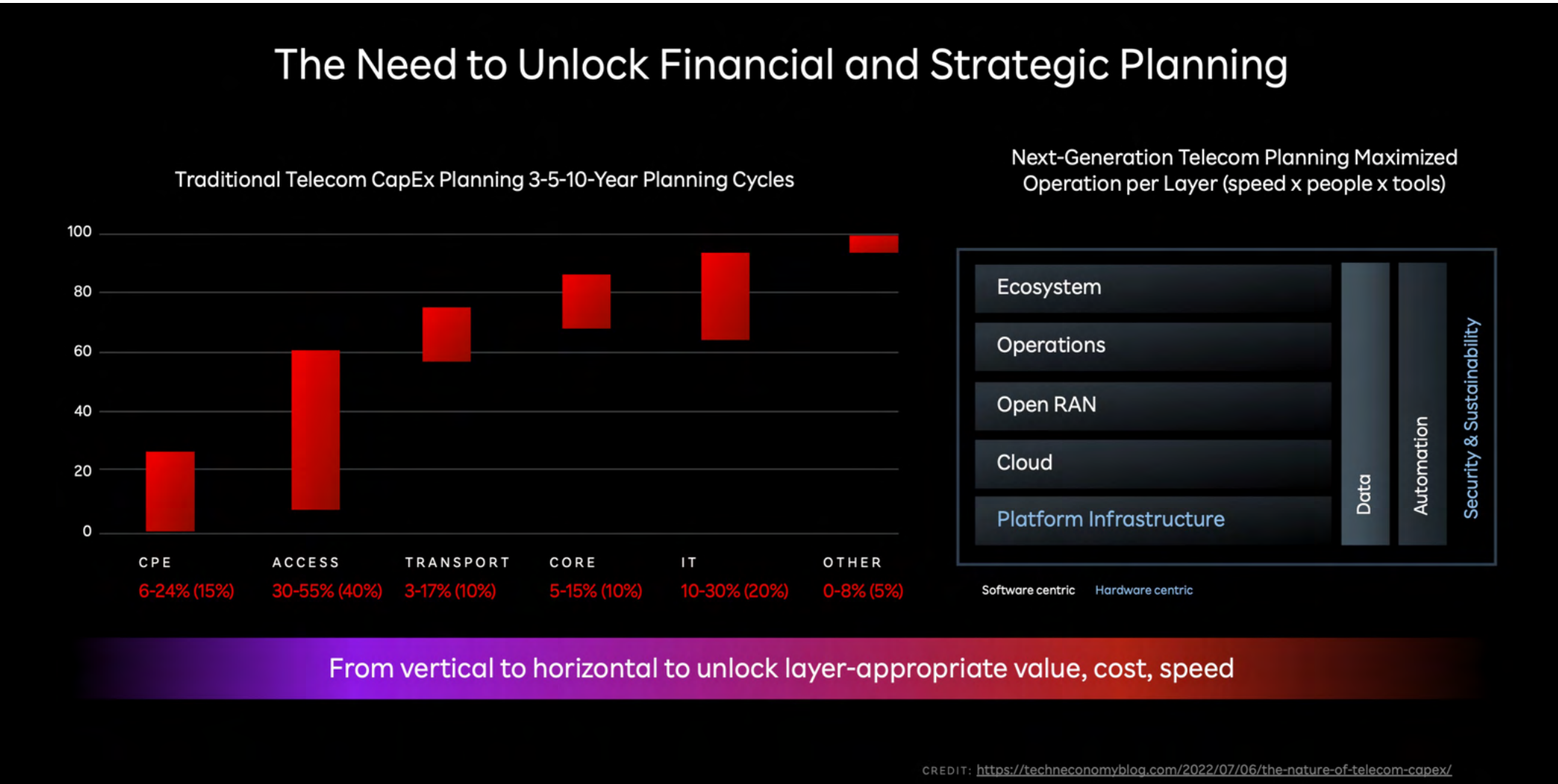
This approach allows organizations to allocate budgets to horizontal business capabilities. It frees each layer of the business to industrialize operations, CapEx and processes as effectively as possible. Software is no longer treated as an amortized part of hardware cyclical investments. This setup prevents each stovepipe from making its own sub-optimized investments into hardware and cloud platforms. Each layer should have teams that specialize in the skillsets most valuable to that specific layer.

Budgets and organizations can be aligned to maximize continuous industrialized improvements most applicable to that layer. For example, choosing large supply chains for software and rapid test and deploy leads to increased innovation and fast improvements. The exact opposite is true for hardware supply chains, where minimizing stock keeping unit (SKU) choice radically improves financial performance by reducing warehousing, spare parts management, returns, specialist management teams and so on. It makes sense to standardize hardware on 5 to 10-year decision cycles. For software, it makes sense to release new versions multiple times per day and continuously improve the performance and experience delivered. Note that even fundamental business functions such as procurement benefit from different approaches and different management mechanisms, depending on what is most beneficial per layer.

Organizations can optimize each layer along three simple foundational dimensions:

1. The number of people required to perform the required delivery.
2. The amount of equipment and tooling investment required to perform the required delivery.
3. The length of time taken to perform the required delivery.

In Rakuten's experience, dramatic reductions can be made across all three dimensions when compared to traditional approaches.



CREDIT: https://techneconomyblog.com/2022/07/06/the-nature-of-telecom-capex/

Figure 4. Telecom needs to transform how it approaches planning.

RAKUTEN-IDENTIFIED LAYERS

While disaggregating the telecom business, Rakuten identified five distinct layers plus automation as a vertical discipline across all layers *(see Figure 5).*

The bottom layer, Platform Infrastructure, is the physical parts of the business and includes all civil engineering and hardware supply chains, including servers. This layer defines the operational cadence of telecom today. The Cloud layer is the pivotal layer of change because it fully disaggregates hardware from software, creating one programmable abstraction interface. The top three layers are pure software businesses and should be managed as such. The vertical layers of common data and automation work with all the other layers and offer the ability to reassemble the disaggregated layers into one common market offering at the most effective point of demand.

Before we take a deep dive into each layer from Rakuten's learnings we will introduce the industrialization cycle, a standard management approach for continuous performance improvement.

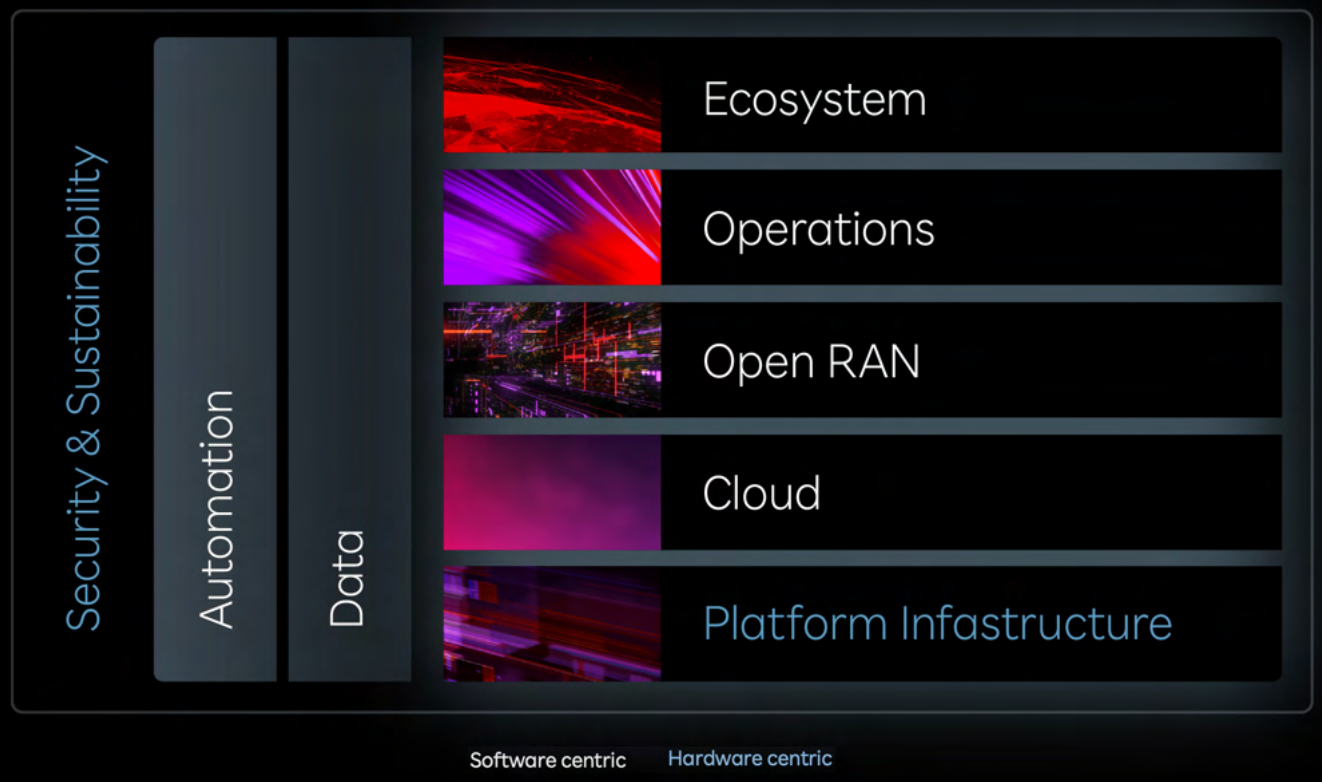


Figure 5. The five layers of Mobile as a Software.

THE INDUSTRIALIZATION CYCLE

The industrialization cycle is a cyclical process that can be applied by any industry for continuous improvement in terms of efficiencies gained and outputs produced versus inputs required *(see Figure 6).*

Each layer can be continuously improved indefinitely by applying the industrialization cycle. This cycle is how any industry can adopt optimized horizontal approaches and move from non-standard operating approaches to highly optimized processes with otherwise unachievable outcomes.

There is nothing unique about telecom. It is the equivalent of a factory that is producing digital goods with tremendously underperforming unit yields and utilizations, and thus a poor return on investment (ROI). Telecom is basically operating a poorly run factory. Applying the following steps, as illustrated in Figure 6, can rectify that situation.

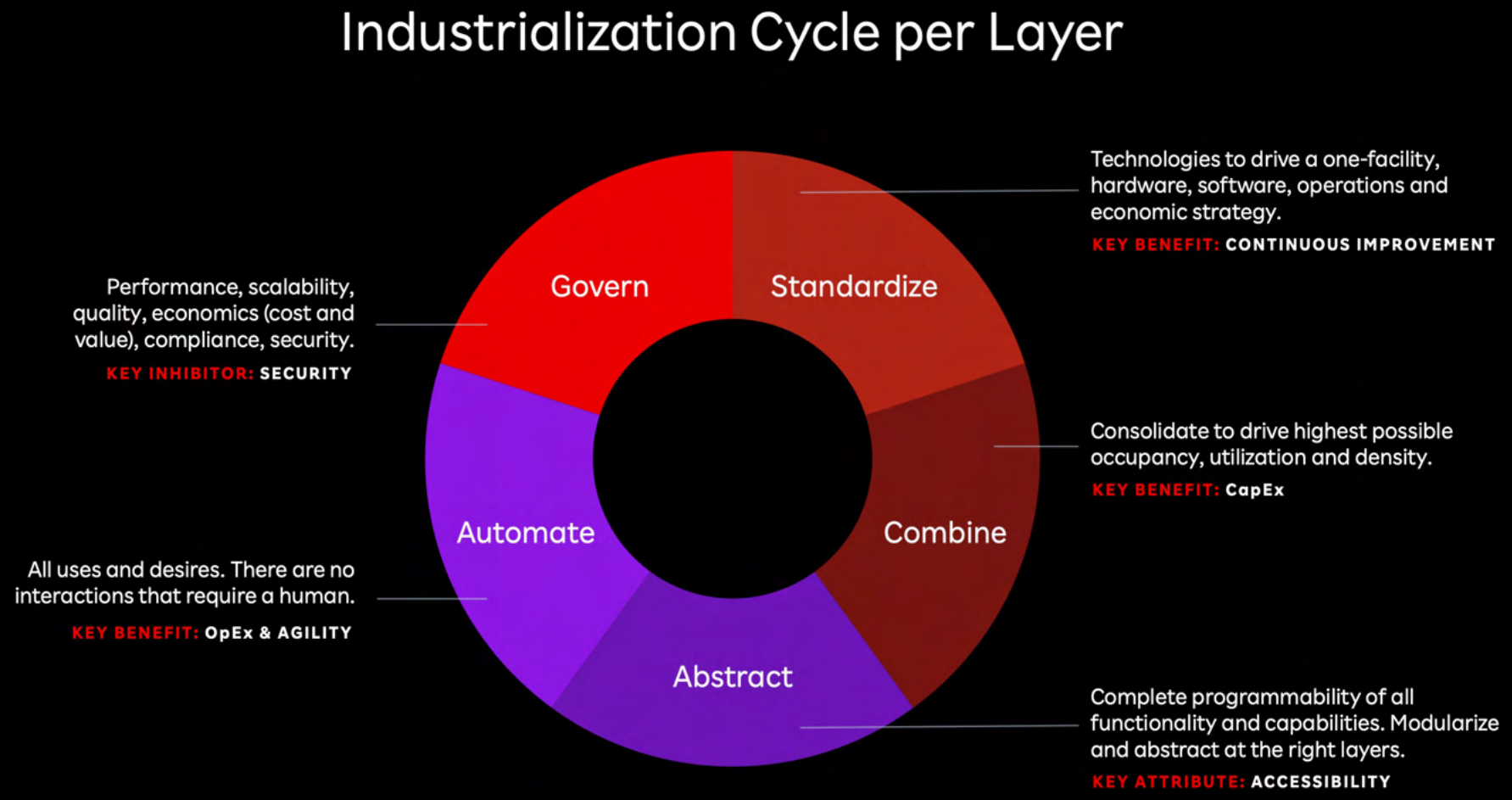


Figure 6. An overview of the standard management approach for continuous improvement.

Standardize

Minimize the amount of variability in a facility, hardware, software, operations or the entire business. In the telecom industry, this concept should not be confused with 3GPP standardization, which exists for end-to-end industry compliance. In telecom, standardize refers to standardizing on business standards and strategies.

Combine

Combine as much as possible to reduce the number of entities and operations under management. Continuously consolidate at the unit level, replacing existing components with higher-capacity components as technology and capabilities continue to improve, leading to the highest possible levels of occupation, utilization and density.

Abstract

Create a normalization layer above all entities that allows the universal application of common management practices rather than managing exceptions. In the technology world, make sure this abstraction is remotely accessible through common APIs.

Automate

Automate everything using the previous abstraction layer. If there are exceptions to the abstraction, they must be handled as specialist automation exceptions at best and manually at worse. No interaction requires a human, lowering OpEx costs and increasing agility.

Govern

Governance ensures the implemented cycle is achieving the needed outcomes across six dimensions: performance, scalability, quality, economics, compliance and security. Without adequate governance, the machine ends up running the business and moving faster than human management.

Start Again...

Once the cycle is complete, it starts again. Every industry continues to evolve in terms of sophistication and improvement, and each cycle builds and improves on the previous cycle's outcomes. The only way to compete against the industrialization cycle for any mass market business is to execute the cycle better and faster than competitors.

The Industrialization Cycle Applied to Other Industries

The industrialization cycle model can be applied to any industry. Let's consider its impact on an imaginary dairy farming operation, for example.

Let's say I have a pet cow named Daisy. I keep Daisy in my backyard, feed and milk her, producing enough milk to sustain my family.

This success leads me to want to industrialize my milk production. First, we are going to decide that we are going to produce milk from cows. This is a choice. All animals produce milk, but we are deciding to **standardize** our milk production using cows.

My relationship with Daisy changes. We remove Daisy from the backyard and place her in a field with other cows. We are no longer investing in individual infrastructure to support the life of just Daisy. The field has one fence and common ground, with many cows sharing common grass. There is one trough for food, one food supply and one water supply. Suddenly, we are starting to **combine** supporting infrastructure costs to reduce the cost per cow. We recognize other potential opportunities for consolidation. For instance, maybe there is a breed of cow that produces twice as much milk as Daisy, so maybe we should replace Daisy with the superior cow model and manage fewer cows for a similar volume of output.

The third industrialization concept is **abstraction**. If we now have thousands of cows, we must manage them as a herd rather than as individuals. We start by removing specialized names. Daisy no longer exists; she has become cow XY1238. Daisy has common characteristics with all other similar but uniquely labeled cows. They all have temperatures, should move a certain amount each day and eat a specified amount of food. We start to abstract the concept of a cow into what we define as being important in a cow. We create an instrumented perspective of a cow.

The **automation** phase moves us away from human management, which allows us to start understanding how we program the herd of cows. When a bell chimes all cows move to the milking facility so they can be automatically milked. No human touches a cow anymore. The thousands of cows are now managed as a herd, moving through the milking facility and automatically milked to produce the required output. This automation is possible because all cows are now programmable due to the abstraction layer.

We are now highly efficient but how do we know the cows are producing the volumes of milk wanted and that they are healthy and producing a healthy milk product? We must apply the following six aspects of **governance**.

1. **Performance**—Are the cows producing the amount of milk we believe they should?
2. **Scalability**—Is the herd producing enough milk for us to sell at the market? Are we producing too much or too little? Can we increase and decrease the amount as needed?
3. **Quality**—Is the quality of the milk what we expect?
4. **Economics**—Are we meeting our economic targets for milk production versus herd cost?
5. **Compliance**—Are we compliant with health regulations so we can prove our milk is safe to sell?
6. **Security**—Is the herd secure so we can ensure nobody can come in and introduce a virus to damage the milk and possibly damage the people we supply?

This is a never-ending cycle: standardize, combine, consolidate, abstract, automate and govern. By the end of one cycle rotation, new alternatives will exist to further optimize and improve operation. Then the cycle starts again.

RAKUTEN MOBILE'S INDUSTRIALIZATION OF LAYERS

Now that we have explained the industrialization cycle, let's examine how Rakuten applied it across the five different business layers to radically reduce execution time and the associated equipment/tooling and people costs.

Platform Infrastructure Industrialization

Industrializing the platform infrastructure requires changes to the civil engineering and hardware layers.

Civil Engineering Digitalization

Civil layer industrialization focuses on the reduction of hardware components, the removal of active components from the site installation and increasing the simplicity of installation like how IKEA simplifies furniture assembly to minimize headcount, material costs and production times *(see Figure 7)*.

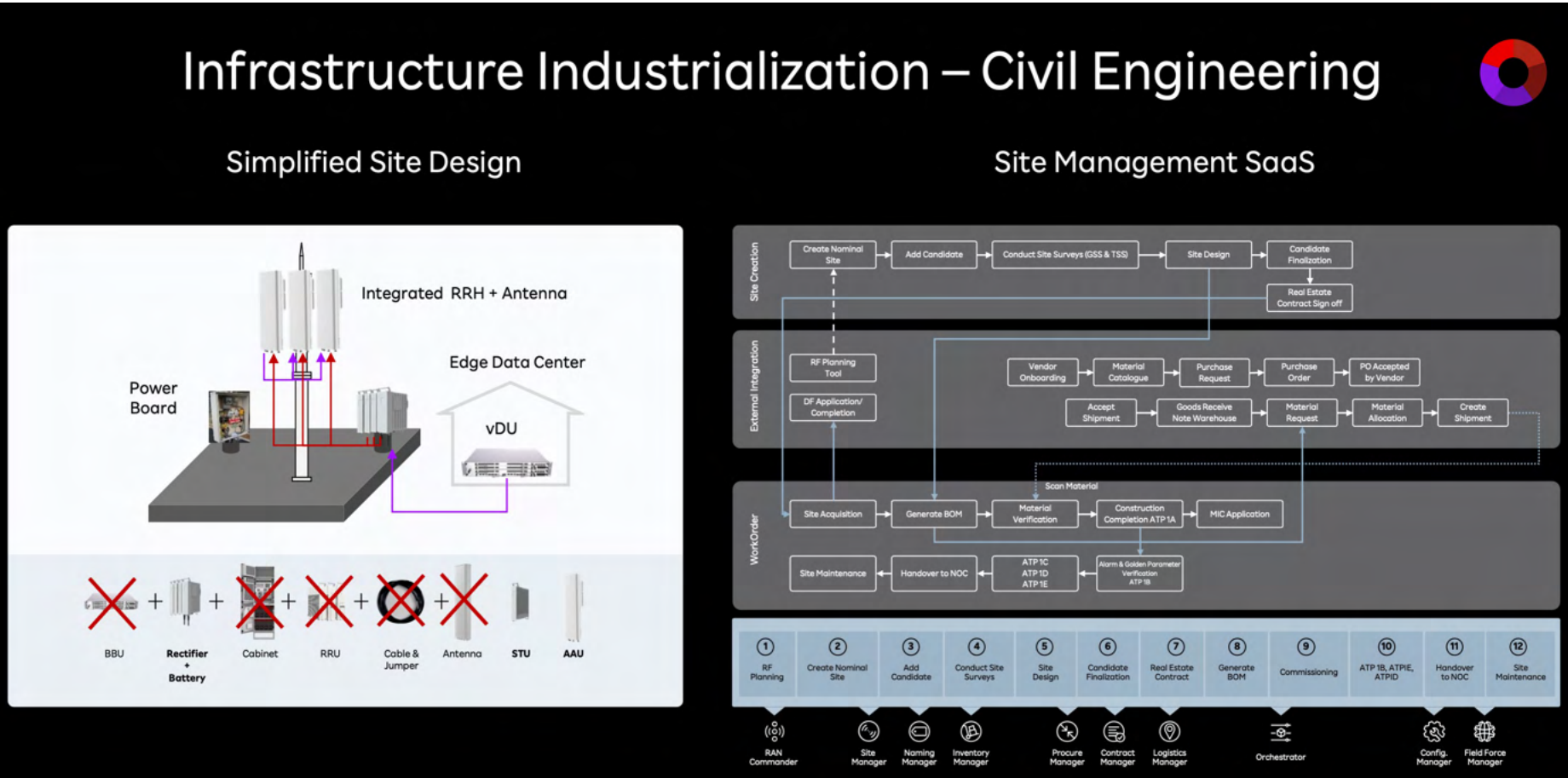


Figure 7. An overview of how industrialization simplifies components, cost and time in civil engineering.

However, the process of telecom site facility design and construction is more complicated than just appearing at a site and building. It is one of many stages moving through many processes, both inside a telecom company and outside the company with local authorities, landlords and outside contracting firms for assembly. It includes procurement of all parts, warehouse management of all ordered parts, spares and returns and the ability to have full audibility and end-to-end program management of the project and operations. The scale is massive—in some cases, upwards of 400,000 people touch a network under construction every day, with coordination of associated people, processes, tasks and necessary parts managed via Excel spreadsheets, emails and phone.

Rakuten Mobile digitalized the process into one plan-and-build management process that included all procurement management processes and people coordination. All tasks are managed through a single pane of glass and one data repository of status. All people and task coordination is automated through the business process automation provided by the platform. Inventory management and allocation of parts to sites is automated through a smartphone app that scans all barcodes on installation, which automatically updates the centralized data. The same applications and platforms are used end to end by all sub-contracted vendors and external parties. When powered, the sites perform full zero-touch provisioning using the same data and augmenting with live software deployments and cloud instantiations, with updates to the same inventory management for live software-associated asset recording.

Once the site is live, it is available for site acceptance, which once more involves the automated allocation and notification to the site acceptance teams, which have their schedules optimized by location and site availability. The site acceptance testing is performed using yet another smartphone app that is integrated into the same platform for automated upload of site acceptance data into the central data repository for data protection and historical auditability reasons. At the peak rollouts of coverage in Rakuten Mobile's Japan network, up to 600 sites were being brought on air using this method every day. Due to the automated nature of the site management, all updates to the sites are also automated, with site management software being used to build a complete digital twin of the installation and operational status.

Using traditional manual methods, first-attempt successful acceptance can be as low as 20% in some cases. Due to the extreme coordination, simplification of physical installation and removal of complex manual software configuration on-site, there are near-perfect installation rates at first attempt with the Rakuten Mobile approach. If there are problems, they are fixed in the software's automated processes.

Wherever possible, active electronics are designed to be located remotely from site locations in one of the thousands of edge data centers Rakuten Mobile operates automatically and through one pane of glass via its cloud abstraction level.

This approach, building on many of the principles first implemented in India with Reliance Jio, allowed Rakuten Mobile to drastically reduce project execution times, delivering full network coverage four years ahead of government schedule, and radically reduced the cost structures of both material costs (CapEx) by 40% and people costs (OpEx) by 30%.

Hardware SKU Reduction

Traditionally, hardware has been delivered as appliances, with software bundled, and with proprietary management interfaces. Some operators have up to 480 different hardware SKUs that need to be supplied end to end. This setup means there are up to 480 contracts, 480 spare parts and 480 return processes to 480 companies, with 480 variations on installation and management.

Hardware was never industrialized in telecom because all telecom nodes have historically been treated as customized and specialized units from each manufacturer. Because budgeting is allocated in vertical stovepipes according to network topology, each part of the network has invested in its own vertically integrated hardware management, procurement and operations. This design is the exact opposite of how the largest Internet and cloud players have approached the hardware supply chain. They radically standardized on a limited number of SKUs that could support all required software workloads, those requiring acceleration and those that do not *(see Figure 8).* This radical reduction of hardware variations transforms the hardware supply chain and allows volume pricing and handling of limited SKUs. The movement from customized hardware to a commercial-off-the-shelf (COTS) supply chain allows volumes to be shared with the advancements of other industries, accelerating its capabilities to support other high-performance computing requirements that appear in all enterprises today.

The standardization on limited form factors and choices allows organizations to maximize inventory management. Every two years, silicon releases double capacity. Traditionally, telecom has needed to forklift appliances to take advantages of upgraded silicon capability. By following hyperscale hardware management approaches, telecom can seamlessly fit new boards and sleds into the deployed hardware, immediately doubling capacity while all other components remain the same. As internal hardware disaggregation accelerates, enabled by internal adoption of fiber connectivity, memory/storage, network and processing components can follow individual optimized lifecycle management upgrade cycles.

Hardware Full Transparency

The existing industry supply chain has resisted this approach in the same way IT vendors initially resisted the requests of Facebook and others to industrialize the IT hardware supply chain in the 2000s. This resistance led to the creation of the Open Compute Project in 2011 and convinced the largest Internet companies to bypass the OEM community and move to supply directly from the ODM community, which was willing to industrialize and meet the new requirements.

Rakuten Mobile is taking a similar approach when it works closely with Intel to remove hardware costs at design, remove components and build supply chain transparency. Rakuten has optimized its Symware™ next-generation distributed unit (NGDU), which due to the massive scale of deployment needs to be as radically optimized as possible. This component supply chain transparency allows visibility into where cost savings can be further employed, such as the combination of separate components into the motherboard, the design of the motherboard to maximize heat dissipation, the removal of all active cooling requirements and the associated mechanical failure operational costs and completely removing the energy costs of forced cooling *(see Figure 9).*

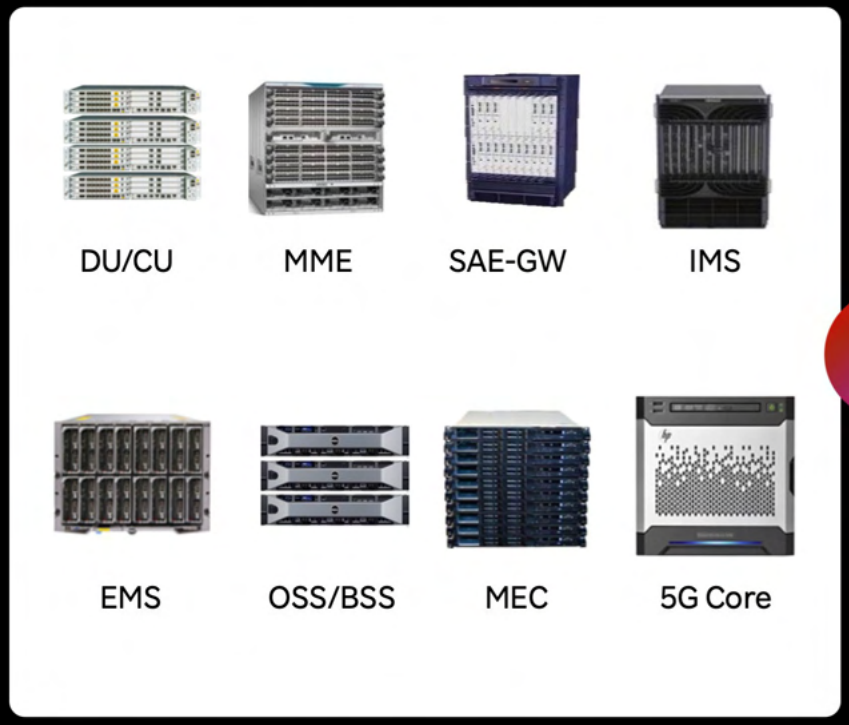
To further support lifecycle management, the Rakuten Symphony Symware NGDU version 2 will replace the 2x board design of motherboard + external accelerator required by version 1 with 4th Gen Intel® Xeon® Scalable processor with Intel® vRAN Boost, which includes the accelerator directly on the processor silicon die. The only uplift is the swap of the old board for the new board.

This NGDU device automatically provisions, is remotely managed and rolled out in the same way as all other site and facility management tasks, as per the above approach. For more details on this journey, please see the joint Intel + Rakuten investor presentation from November 2022 here.

With key partners such as Baytech, we have taken this same approach for Rakuten Mobile CPE and handset products.

Infrastructure Industrialization – SKU Reduction

Mobile Networks



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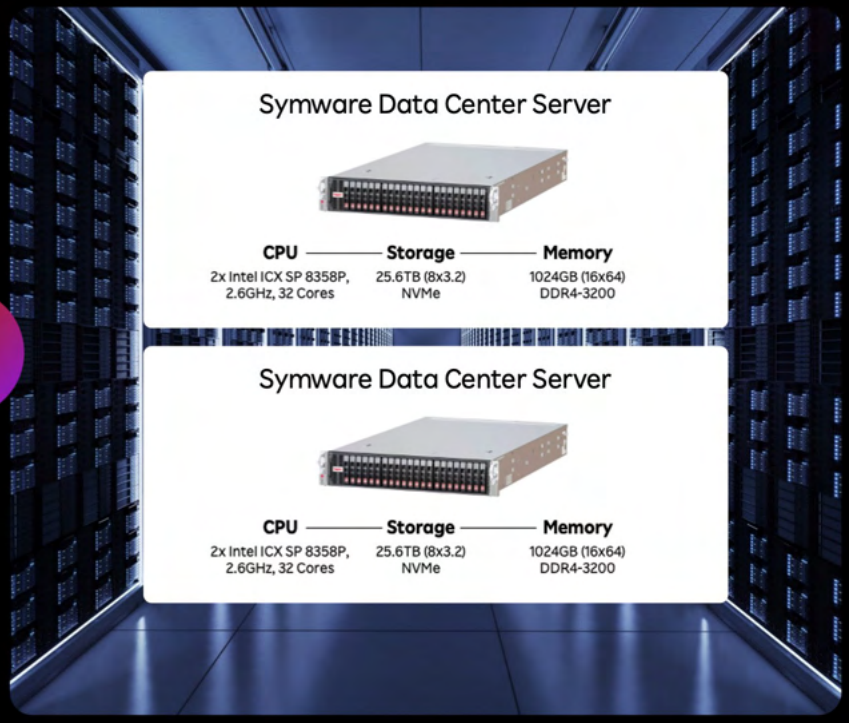

Figure 8. Mobile telecom needs to follow IT's example by standardizing and reducing hardware.

Infrastructure Industrialization – Full Transparency

Legacy Cost Information

Low transparency

e.g. Classic Baseband Units

Non-transparent pricing

No visibility on actual costs

VS

Full Cost Transparency

Transparency on component level

e.g. Symware™ NGDU

with Intel® Xeon® D-2796TE Processor

Compute Board

Cost information for:
- CPU
- RAM
- BMC

I/O Board

Cost information for:
- HW accelerator
- Timing module

Case

Cost information for:
- Case & other parts
- Manufacturing

Figure 9. How Rakuten's NGDU design optimizes costs and provides full transparency.

Cloud Industrialization

Rakuten has one cloud abstraction that abstracts and simplifies across all underlying bare metal and cloud providers, both public and private. It is the only mobile operator running a true end-to-end cloud-native operation across all application types, from radio workloads at the edge, through regional core, to centralized management and operation applications *(see Figure 10).*

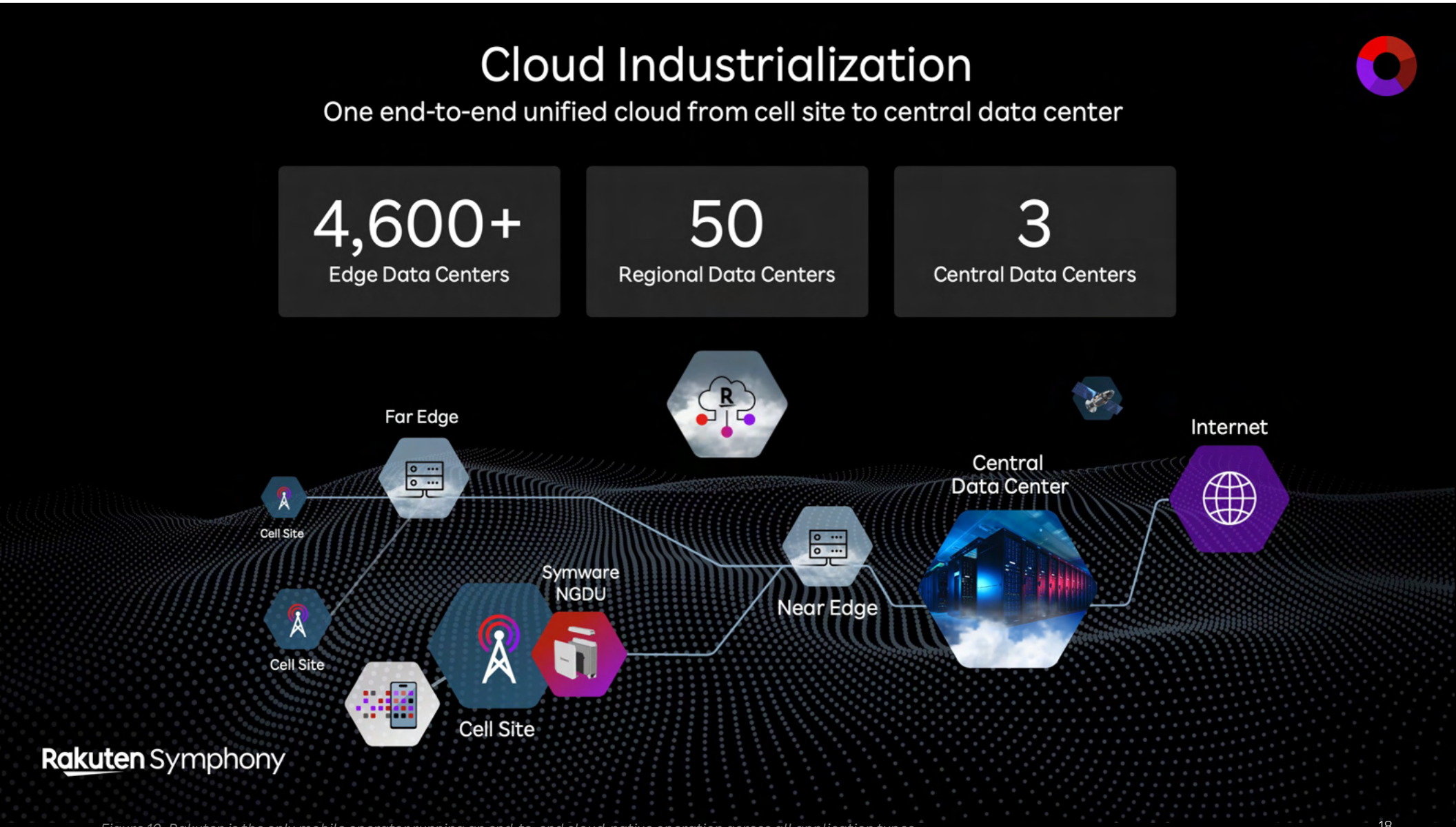

Figure 10. Rakuten is the only mobile operator running an end-to-end cloud-native operation across all application types.

It is possible to now run all telecom workloads fully cloud-native in containers, but it is hard to identify what is vendor hype versus reality. Because we have had to execute for real in a live network serving millions, we know exactly what works and what does not work and readily share these insights. The massive distribution and rollout of disaggregation in radio networks causes economic problems when working with traditional enterprise cloud licensing models. Again, following the hyperscale mantra of removing costs at scale and normalizing operations, we have replaced operating system licensing costs with the use of pure open source Rocky Linux with CIQ, and contribute all findings and improvements back to the community so others can benefit from our progress. For more information, see here.

The telecom industry has been trying to adopt the cloud for 10+ years but non-systemized, siloed attempts mean it has yet to reap any anticipated benefits. Telecom needs to understand and accommodate that the cloud needs to be a horizontal capability across the total organization with one sourcing, one abstraction, one automation and one governance. This approach is when telecom can achieve true transparency of organization industrialization and effectively allocate workloads to the right environments for performance, operational and economic reasons. Otherwise, adoption of the cloud is an additional cost, reinforces stovepiping and sub-optimizes economic value.

Thanks to our unique understanding of the cloud and deep experience in nationwide, high-performance deployments, we have removed 50% of the cost structure from alternative approaches and have normalized and accelerated operational efficiencies across the entire business. The key challenge is not the distribution size, but the unified, automated and simplified lifecycle management of all software workloads deployed; the ability to upgrade and manage all day zero, one and two configurations at scale; and to manage distributed resiliency, re-deployment and service assurance management without the investment of people.

Cloud is the foundational disaggregation, accessibility and programmability layer of operations and needs to be treated with that level of total organization importance. All workloads can run on the cloud, but each application type has specific performance requirements such as high performance, security and high data throughput. Organizations should manage the cloud from an application-down perspective, with maximized economics between public and private, depending on the workload in question, the variability on the load and the maturity and predictability of the roadmap. Many Internet companies now understand that placing all software on a public cloud is an economic tax they cannot afford. For more details, see here and the previous reference here. Telecom has the chance to implement the cloud with more insight, awareness and maturity than other industries. We should not repeat the mistakes of earlier pioneers.

The second effect of building a fully automated, end-to-end cloud for mobile networks is the creation of a full edge cloud operation, where the mobile network is simply the first tenant that covers all the costs as part of the core business spend. Organizations can reuse this edge cloud operation and distribution for other applications and can design the placement of workloads using declarative policy to optimize for limited resource allocation versus economic cost. The successful deployment of radio baseband software workloads means the system is already designed to manage the most demanding real-time applications in existence. As analyst Chris Lewis said, “Design for the edge and you get the middle for free.”

In Rakuten Mobile, we use this same edge architecture to move enablers from Rakuten businesses closer to the customer. This approach lowers transmission costs and increases immediacy of performance. It can then lead to the delivery of new products for these businesses, such as new interactive XR advertising products that can be placed on the Rakuten Advertising rate card for clients. Finally, organizations can make this footprint available for other third-party enablers that often need to address a total market footprint rather than an individual operator share. This is the point where collaboration with fellow operators can start with interconnect, shared facility or shared infrastructure. This same operation allows us to deploy 5G stand-alone with full cloud support for dynamic UPF placement and local breakout at the edge for this purpose, when desired.

We have created a true cloud operation that is designed to work for the use cases of 2030 rather than 2010 *(see Figure 11).*

This design allows us to create a new core business that can be spun out and capitalized independently or maintained as a key enabler in a similar fashion to Amazon Web Services (AWS) and Amazon. Without making the hard initial investments and learnings required, it will be impossible to build new stand-alone value and businesses. Doing hard first-order actions leads to better second-order effects.

Customer Value 2030 – What is happening?

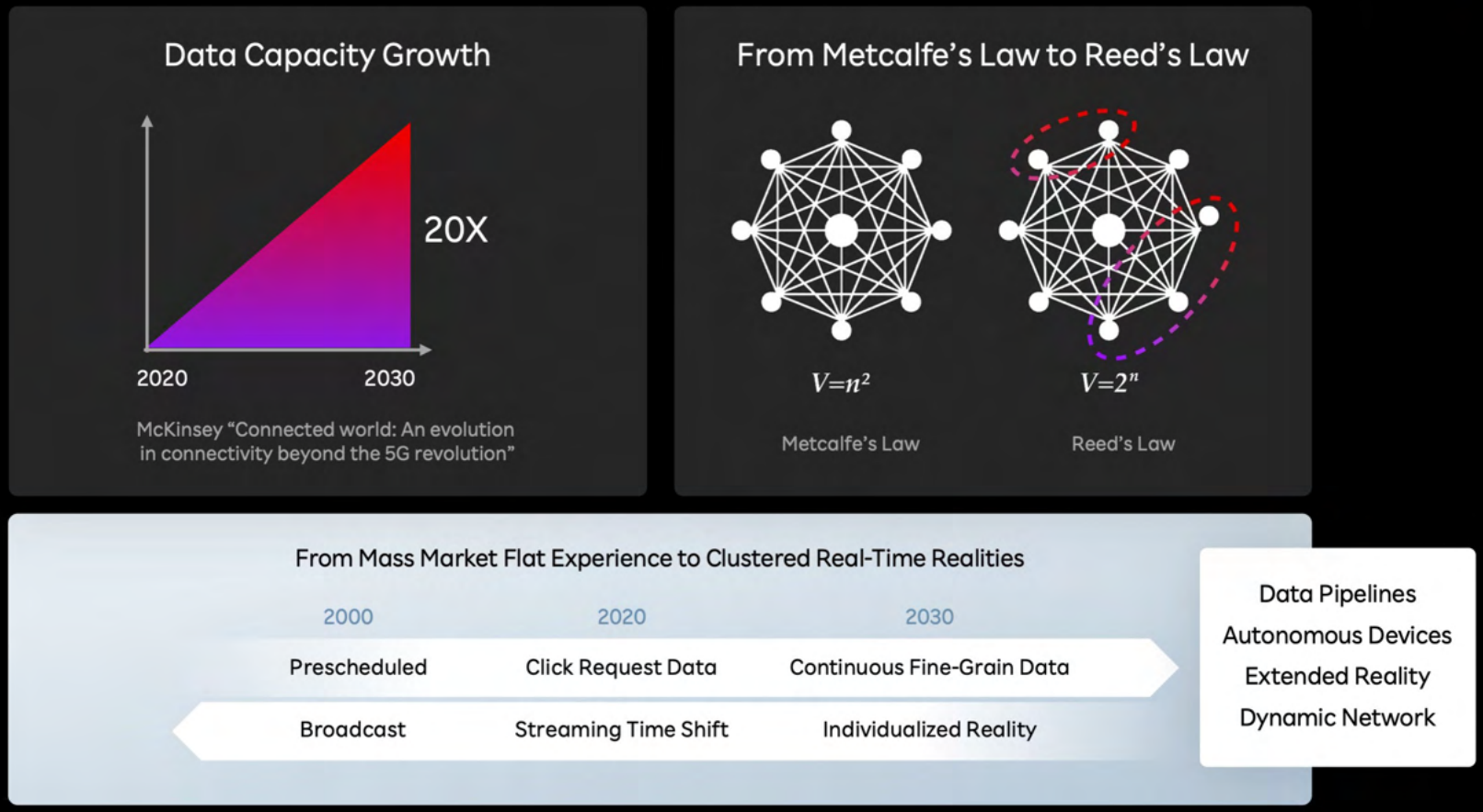

Figure 11. A high-level view of the future of network design.

Open RAN Industrialization

Open RAN is a disruption aimed at the heart of mobile networks and incumbent suppliers *(see Figure 12).* As the mobile industry has matured from its 2G days in the 1990s, vendor side choice has decreased through mergers and acquisitions while the need for radio densification has increased. This situation has led to a highly concentrated supply chain of just three main vendors, which is further limited because of a political divide. Radio base station deployment has always been driven by a generational appliance-based approach, where the whole radio access network (RAN) is viewed as a monolithic black box from single vendors. Although great progress has been made in disaggregation across hardware/software and functional disaggregation through microservice design outside the industry, radio has largely resisted change and is still delivered with the same forklift deployment, generationally improving economic unit costs.

The value of opening interfaces is the increased surface area available for other companies to enter an essential market and offer alternative implementations and innovations in delivery. From a supply chain resiliency perspective, it diversifies source away from limited countries and encourages regional localized supply chain involvement that is more like Internet software service models than traditional telecom *(see Figure 13).*

Opening interfaces also creates new challenges by introducing additional complexity at the point of consumption rather than the point of manufacture due to the disaggregated nature of component delivery.

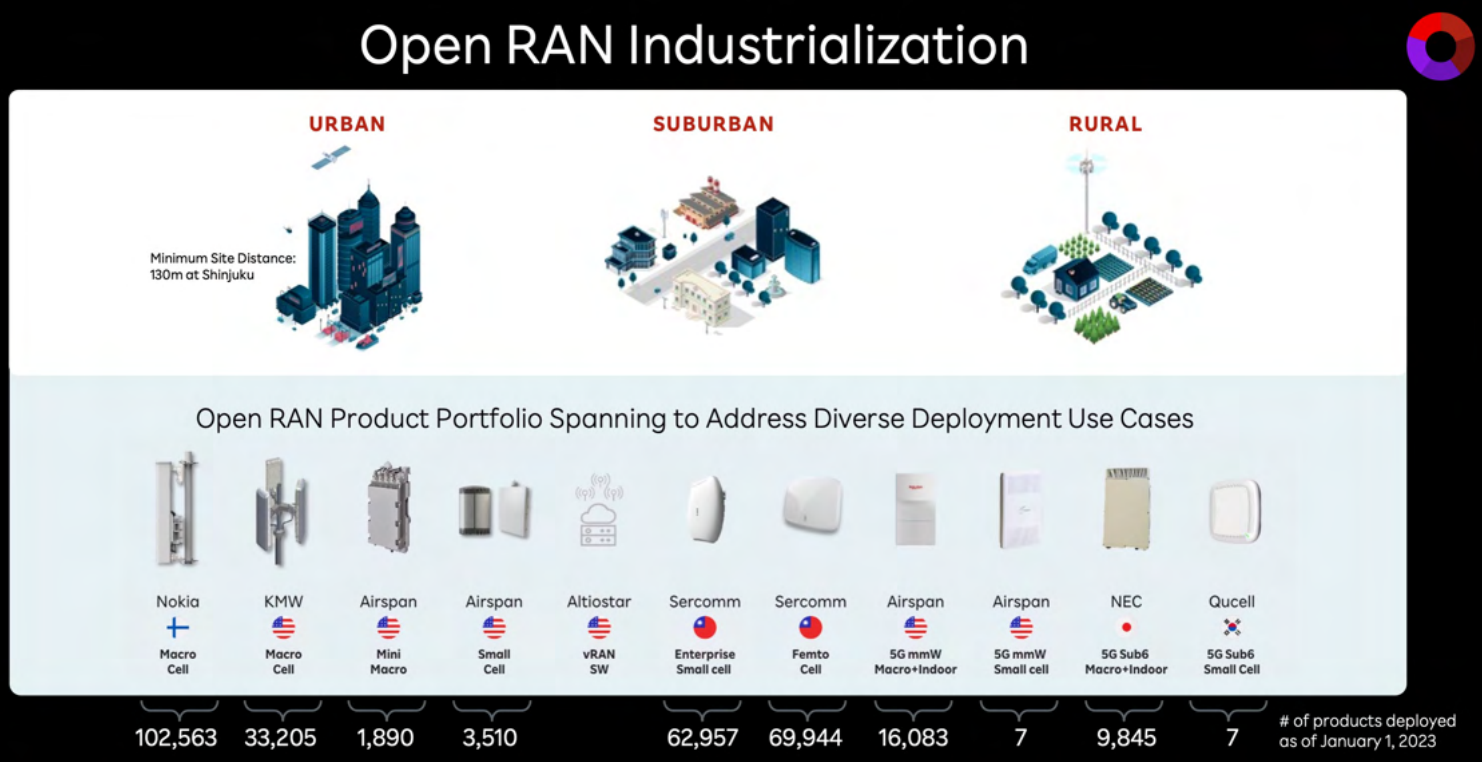

Figure 12. An overview of current mobile suppliers.

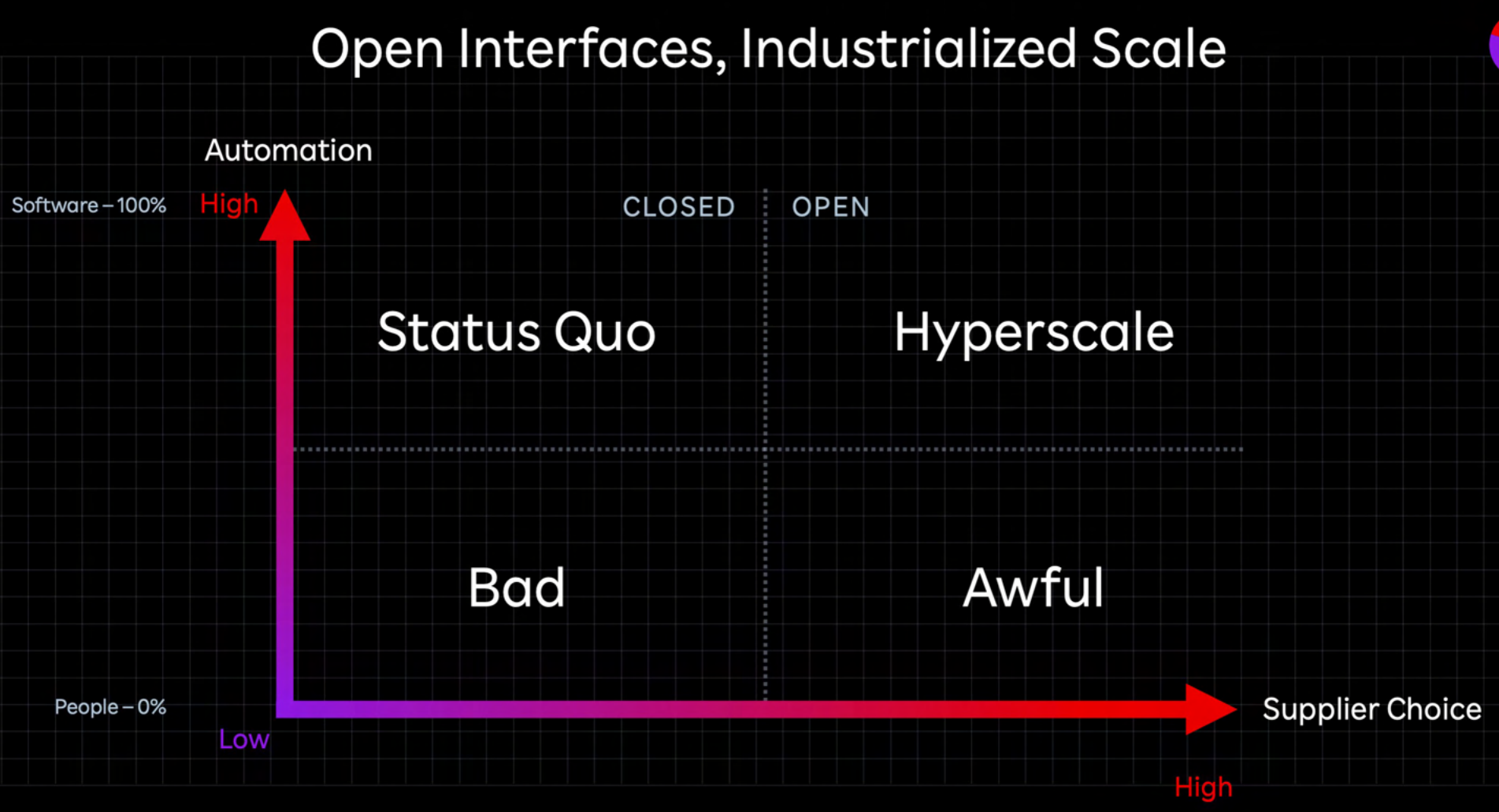

Figure 13. Accompanying open interfaces with automation increases supplier options.

Rakuten Symphony has made Open RAN work at scale and has removed the fears, doubts and uncertainties that have permeated decision-making among some MNOs.

Organizations must automate manual operations to manage the increase in visible complexity. The same is true for interoperability testing. Rakuten has world-leading automated software interoperability testing (IOT) that enables rapid onboarding and validation of new suppliers. If organizations adopt Open RAN without the surrounding changes, the outcomes could be worse than today.

The key difference the Open RAN approach provides is the increased agility and efficiency afforded by the open interfaces when managed through one common control plane. Rakuten has deployed over 300,000 cells covering indoor, outdoor, urban, rural and in-home from more than seven vendors and counting. Each radio supplier offers a unique application for different coverage areas, with automated interoperability testing to onboard each radio type running less than four weeks due to Rakuten Symphony's automated IOT testing. All radios are provisioned according to the standardized management processes of planning, installation, zero-touch provisioning and common observability and service assurance. The entire mobile network is implemented as a software deployment across an end-to-end cloud operation, with software upgrades automated and managed across fleets of common radio types at scale. Software development and releases are now working at the speed of the cloud and can be iterated on in a controlled fashion multiple times per day, if desired. Network software design has moved from generationally controlled to micro-service-level controlled.

As shown earlier, the disaggregation of the solution assembly and delivery from a monolith into its component parts provides visibilities and opportunities for optimizations not previously possible. This approach eliminates the inefficiencies of one-size-fits-all bundling and delivers software-driven solutions running on rapidly tested diverse hardware supply chains.

Because the radios are managed as fleets with full observability and programmability, AI models are easy to deploy to control system-level energy management policies, thus radically reducing energy consumption in addition to the reductions realized traditionally at the component and node levels.

Rakuten Symphony has made Open RAN work at scale and has removed the fears, doubts and uncertainties that have permeated decision-making among some MNOs.

Operations Industrialization

Operations have moved from being delivered by people and paper to being delivered by software and platforms. Software runs the operations and data enables continuous business optimization for future improvements. The first task Rakuten performed was to digitalize all processes required to plan, build and operate a network *(see Figure 14)*. These processes are the same processes required by all mobile operators but because they have organically evolved and grown, they are as invisible to the host organization as the oxygen everybody breathes.

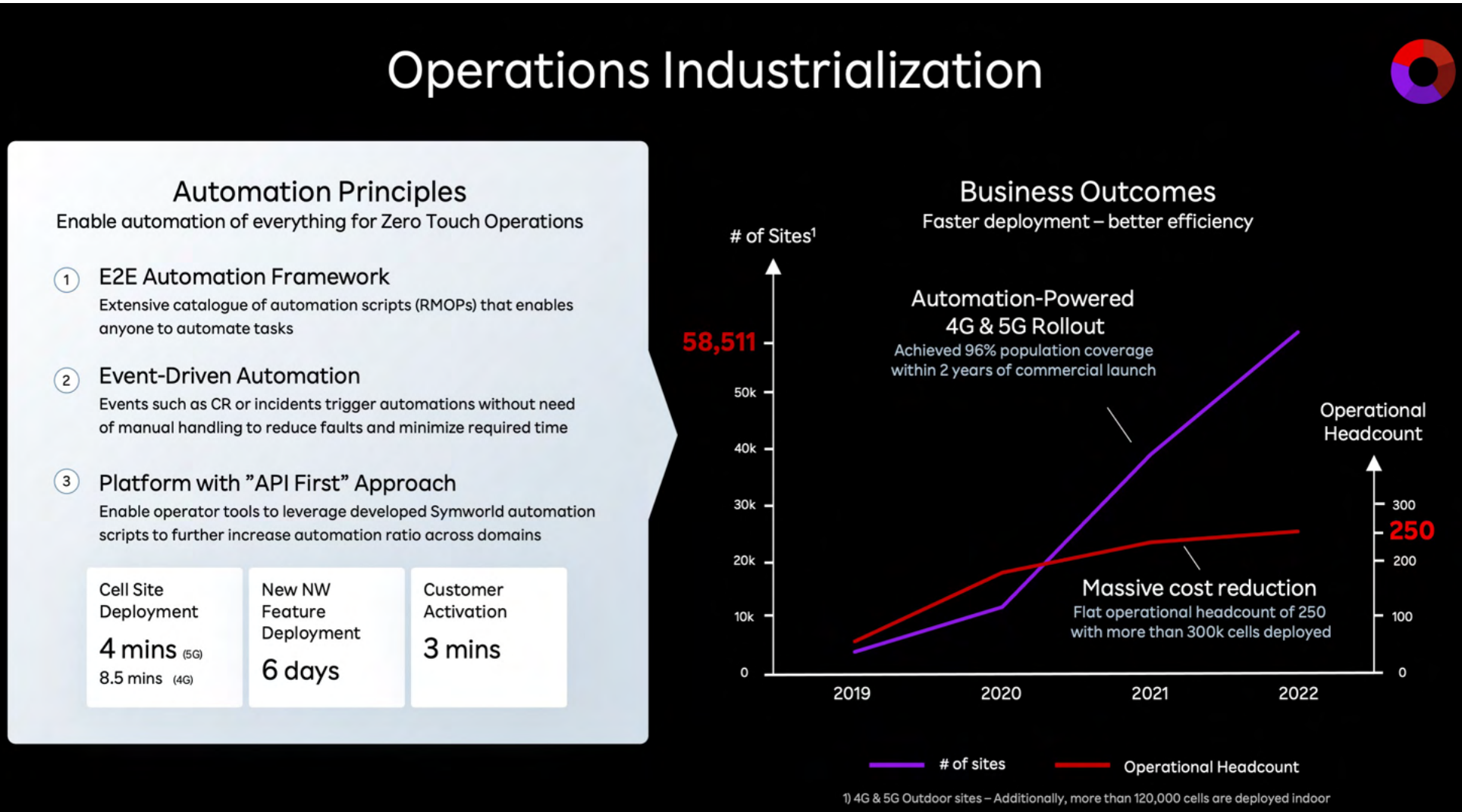

Figure 14. Automating operations delivers continuous business improvements.

The first challenge is to understand how operations deliver all outcomes today. Rakuten Symphony now offers a complete, proven blueprint of all processes that others can compare and modify for adoption. Without understanding the complete process, organizations will find it impossible to achieve full automation. This is the challenge involved with placing many external vendor solutions in operation and finding them to be incomplete.

Implementing zero-touch provisioning of a cell site, for example, requires automated generation of node names and IP addresses that can be inventoried and made available for subsequent service assurance correlations. The node names need to be human legible and machine legible for total transparency. In traditional deployments, common node names and IP allocations are often managed in Excel spreadsheets and shared folders. Although this approach might work in traditional manual static deployments, it does not work on continuously deployed, automated, cloud-based networks. The inventory of what is live needs to reflect the last change that could be altered by closed-loop issue resolution and redeployment where no human is involved in the process.

This approach allows organizations to secure the system without any human involvement and potential compromise of credentials. Rakuten Mobile is the only network that can guarantee all default passwords of all nodes and software have been replaced with unique and automatically generated, highly secured credentials that are then vaulted and never shared directly with any human.

Once any process is implemented and proven, organizations can execute it repeatedly for the same initial cost. True automation is how we template repeat executions, and because software can run in parallel with millions of jobs, there is no limit to the acceleration of deployments. This approach achieves hyperscale economics where service capacity can exponentially increase with fixed operational costs. There is even the opportunity to further reduce direct operational requirements as system trust increases and levels of automation accelerate. We have capped direct operational staff at 250 people for the support of a total network consisting of 300,000+ cells along with thousands of regional data centers and connections.

The close integration of all processes allows us to codify and make available work processes that are normally invisible. For example, business intelligence on common root cause analysis (RCA) understandings in the network and common customer service questions are codified in a knowledge base that is then available to the network engineer for network issues and customer support personnel for customer issues.

Implementing all processes in one platform provides full visibility of all activities as well as 360-degree awareness. This is the foundation on the vision roadmap for creating fully autonomous networks. If fault management detects alarms, it can correlate across all for associations via inventory management, including interrogating if there is active on-site engineering happening, whether a recent upgrade has been made, and can propose RCA and next-best actions for real-time decisions. Once the system is trusted in its correlations, there is a gradual transition of certain patterns to closed-loop responses where appropriate. Adoption of closed-loop automation becomes an issue more of human acceptance than system limitation.

Ecosystem Industrialization

The Mobile as a Software™ stack is now dominated with best practice software implementation at all levels above hardware *(see Figure 15)*. Infrastructure below the cloud is all managed via server APIs or via platform application notifications to people. All software workloads required to place on the cloud to realize a mobile network; all applications required to plan, build and operate a network; and all applications required to manage the customer experience and deliver new services can all be managed as modern containerized applications of different categories. There is no difference between the management of this software and the management of app software on a modern smartphone.

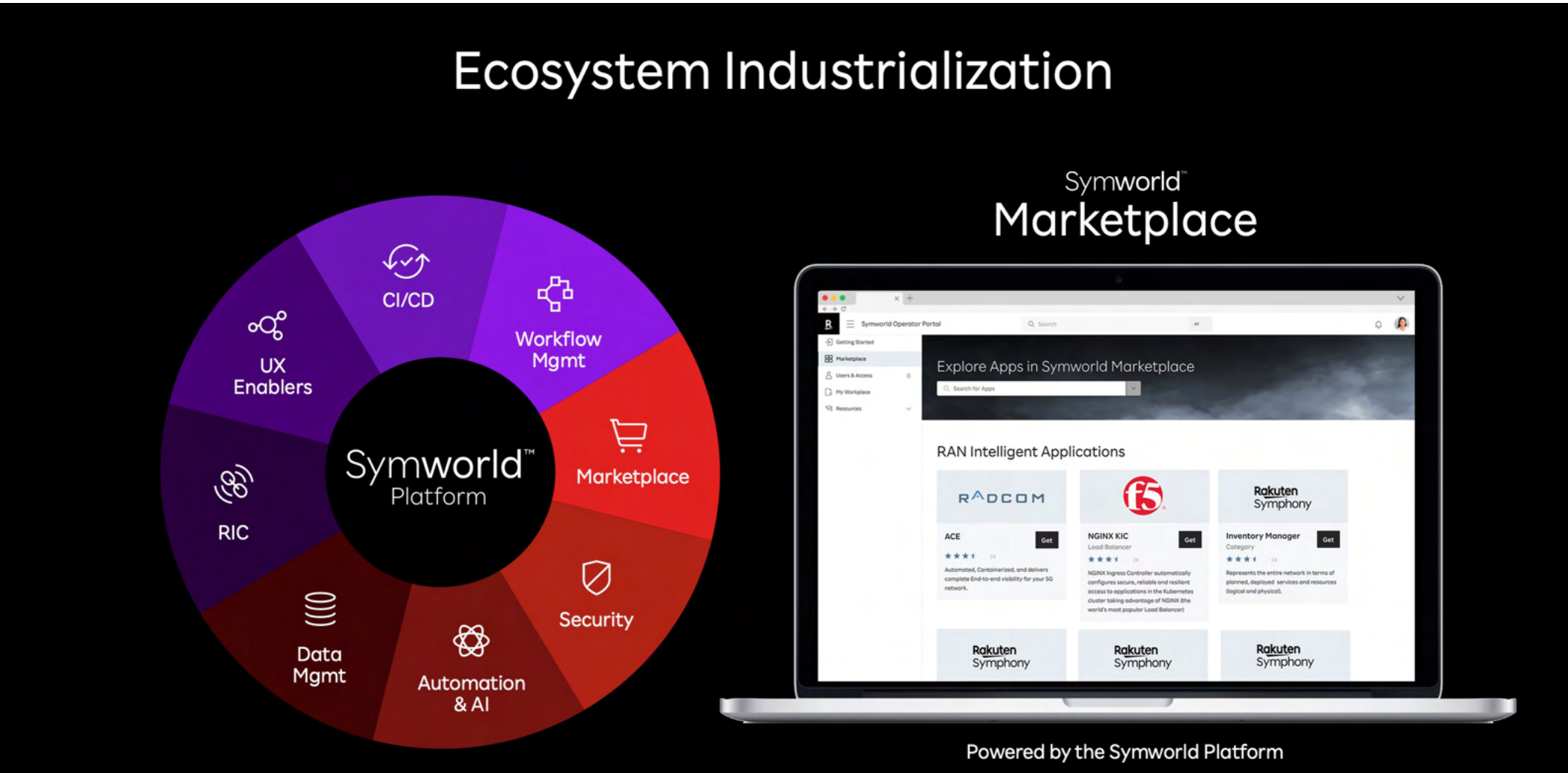

Figure 15. The Rakuten Symworld platform manages everything above the hardware layer.

In today's mobile industry, however, software is not managed this way. It takes more than nine months for released software to move through manual acceptance procedures and lab environments before it is installed in a live commercial network. We need to destroy this cost and process to reduce the time delay of deployment from months to days or hours.

Rakuten uses a one-click app store and deployment model for all software application types. The process is modeled on the Apple App Store developer and app submission processes. Before Apple and the App Store, software deployment on mobile phones followed a similarly closed, bespoke, SI-heavy process that also took 9 to 12 months. Only Apple's intervention and the simplified, self-service with curation model changed this process dramatically. The results are easy to see, and we now live in a smartphone app-driven world. We can achieve the same realities on the network side where we move to being consumers of standard products on a common platform rather than creators of SI-driven, unique and complicated manual designs.

Applications are uploaded with supporting documentation, configuration files and deployment manifests. Sandboxes are provided for application testing through a curated onboarding process that successfully culminates in an application being posted and available in the app store for authorized people to download and install in the local network with appropriate automated testing in cases requiring unique deployments.

Further decoupling the process from the previous hardware-driven approaches destroys current software supply delay times into the network. Doing so allows mobile network operators to build software supply chains with minimized cost structures and time to market, equivalent to alternative software-based service providers, enabling operators to become competitive.

Without this ability to rapidly iterate on software, mobile operators cannot compete on higher-level software offerings. And all higher-level offerings—above connectivity and network—are based in modern software.

Automation Industrialization

Automation is essential for business survival. The world is too complicated, growing increasingly more so, and competitive time to market continues to reduce. Without automation, it is not possible for an organization to be competitive and be a technology leader.

Software is what allows the emulation of humans in a process flow, at the most basic level, and the emulation of human intelligence, at the more advanced artificial intelligence levels. Automation is not a nice-to-have, but a must-have. Out of the three necessary software transformation journeys of the business, it is the most important to prioritize alongside cloud, which at the most basic level is the automation of hardware *(see Figure 16).*

Automation is also a mindset that needs to be managed with discipline as a skillset and as a product. Automation solutions need to be discoverable, reusable, secure and trusted. Automation is not a product you buy. It is not something you outsource. It is something you build, own and continue to develop, improve and evolve as quickly as possible.

To accelerate the required change, it is best to partner with people who have already displayed a relentless obsession with end-to-end automation. These people need to be software people. Rakuten Mobile has 250 people operationally responsible (L1–L3) for running a network comprising more than 300,000 active cells and they are all software people. Software people have a culture of automating everything, even if they are not sure they need to do it more than once. It has been proven that if you are doing something once, you will do it again at some stage, however unlikely it may seem. And doing something manually just feels stupid to the right people.

The side effects of automation are transformational. Speed and scale happen without effort. Monitoring the network evolves into monitoring the algorithms and platforms running the network. Humans are not designed to work 24/7, performing continuously repetitive tasks—computers are. Higher-level automations ultimately appear, building on previous-level automations. All automations play both a producer and a consumer role in a hierarchy of automation strategy.

Automation Industrialization

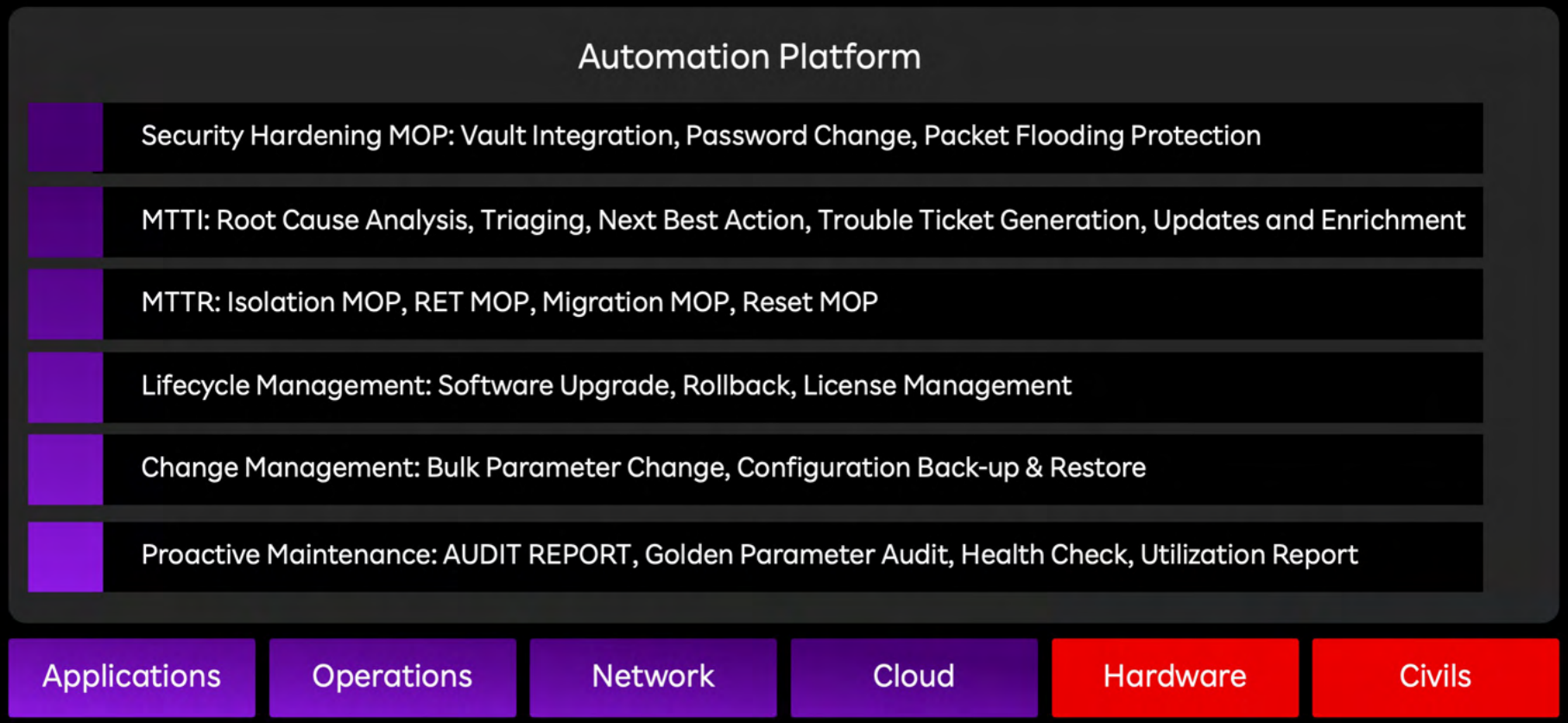

Figure 16. Remaining competitive in today's business environment requires end-to-end automation.

Rakuten's mantra is relentless automation. We automate everything. Our obsession in moving all network layers into software is to enable data accessibility from all and programmability to all.

The foundation of automation is data. Data needs to be as real time as possible so software can "see" what is happening when it is happening rather than after the fact. Most telecom networks have instrumented legacy telemetry systems through various polling and element management systems (EMSs). The industry needs to adopt the types of observability frameworks that first appeared in the cloud to provide streaming data in real time. The more granular the data, the more you can see. The enemy of truth is the average, which hides details. Telecom is no different than any other industry—the moment you increase your resolution 100x, you see 100x more and suddenly have more accuracy in determining the real root causes of any observed issues.

The data required spans different variability categories. Physical asset data is the most long lived but must match the reality of the physical world it represents. That is why it is important to digitalize all lifecycle management activities at all levels of the business, including civils and hardware. Clouds deploy and redeploy using closed-loop algorithms continuously. The inventory of deployed clusters and containers can run into the hundreds of thousands and must be maintained in real time. It must be possible to navigate and correlate all data to allow root cause analysis and obtain next best action advice as quickly as possible.

Catalog

If even a small number of people adopt the correct mindset, the number of automations created will explode, as shown in the automation catalog in Figure 17. The opportunities to automate will be surprising, with each automation needing to be managed and discoverable as if it were a product. The power of automation is the ability to have infinite, parallel, error-free execution scale. The negative power of automation is if the infinite scale occurs with an automation script that contains an error. It must be possible to trust all automation scripts, and a process must exist to secure the integrity and honor of that trust.

In Rakuten Symphony, we have created the concept of an automation studio that allows all people to release and lifecycle manage automation scripts with known states such as testing, approved and production. Imagine a GitHub-type solution for version control, lifecycle management and deployment of automation scripts.

With such a system, it is possible to "gamify" the whole experience by rewarding automation script authors based on how many times scripts are executed, how much time is spent and calculating the reward. With this approach, employees benefit and the company benefits.

All the security credentials required for the automation scripts are separately vaulted and no credentials are ever in the hands of any script or human. Instead, they are automatically injected at the time of execution. This setup creates ultimate Zero Trust because there is no need to trust anyone.

Automation Industrialization – Catalog

Selected Automation Use Cases Among ~230 and Counting

Use Case	Traffic by-pass/Migration and rollback	Disaster recovery for BSS/OSS	Cloud deployment	Isolation RMOP for Core network	Customer plan bundle change from PCRF	Auto trigger RCA/ L1 troubleshooting	Disaster alerts for BCP activities
KPI	MTTR Mean time to restore	Service restoration time	Deployment time	Time to isolate core network component	Time to change Customer plan bundle	RCA time per ticket	BCP setup & response time
Impact	~5 hours saved bringing human effort down to 5 mins	Seamless switchover to the geo-redundant DC	Deployed more than 2500 open stack PODs in 12 months across 1200 DCs	~5 hours saved bringing human effort down to 5 mins	Saved 12 hours of manual effort	Saved 20 mins per tickets of manual effort	Improved by 32% for Earthquake, strong wind and rains
Application	Core	Application	Cloud	Core	Core	All Domains	All Domains
Domain	Operations	Operations	Operations	Operations	Operations		Operations

Use Case	Marketing promotion campaign management	Security Hardening	Privileged access management	Privileged access management	VNF auto-healing	Sleeping Cell	Backup and restore automation
KPI	# Link APP downloads	# Secured network elements	# Accessible network elements	# Accessible network elements	Uptime	Recovery time	Service restoration time
Impact	30% increase in Link Downloads	95% of Rakuten network elements hardened	Just-in-time access workflows for 92% network elements	Just-in-time access workflows for 92% network elements	99.98% availability in Rakuten Mobile	4-6 Hours recovery saved and 60% reduction in manually intervention	~3 hours saved bringing human effort down to 10 min
Application	CEM	All Domains	All Domains	All Domains	RAN Core	RAN	All Domains
Domain	CX	Security	Process	LCM	Operations	Operations	Operations

Use Case	Notifications for campaign eligibility	CDR based notifications for several use-cases management	ACI span lifecycle automation	ACI span lifecycle automation	ACI span lifecycle automation	Ticket RCA compliance	Ticket Assignment and Incident Handling Improvement
KPI	Prevent point-grant incidents	Reduce customer inquiries	Prevent data loss	Prevent data loss	Prevent data loss	RCA Compliance	Assure Tickets assigned to correct groups earlier
Impact	Reduced campaign grant incidents from avg. 3 per month to 0	Reduced 3% of customer inquiries with real-time notification	0% data loss if workloads shift across computes	0% data loss if workloads shift across computes	0% data loss if workloads shift across computes	Compliance improved to 95% from 37%	30 % Improvement in suggested tickets workflow
Application	CEM	CEM	Transport	Transport	Transport	All Domains	All Domains
Domain	CX	CX	LCM	LCM	Operations	Process	Process

Figure 17. An example of the hundreds of use cases captured in an automation catalog.

Key Performance Indicators

As with any initiative, it is important to be able track progress with key performance indicators (KPIs). Each organizations needs to apply KPIs like those in Figure 18 and measure them against what is most important to making the transition and accelerating the desired change. The Rakuten Symworld™ platform generates both dashboards and KPIs at scale and in real time for continuous and instantaneous reporting.

Automation Industrialization – KPIs

Examples of KPIs for Measuring the Maturity of Automation

KPI	Definition	Min. Freq.	Trend	Calculation & Tracking Approach
Fulfilment Rate	Rate at which Automation requests fulfilled/completed	Weekly	Maximize	(No. of automations completed / No. of Request Received)*100
Automation use-case dev cycle time	Automation use-case dev cycle time is the average amount of time that it takes to develop an automation (Execution & Delay)	Daily	Maximize	Categories: •Request pickup time = Sum of all time it takes between AUTOMATION request submitted and AUTOMATION request picked up for review/total AUTOMATION request reviewed •AUTOMATION Development: Sum of all time required to complete coding of AUTOMATIONs/ total AUTOMATION request developed •Test time: Sum of all time required to complete testing of AUTOMATIONs/ total AUTOMATION request tested •Implementation & Execution time: Sum of all time it takes between AUTOMATION tested and AUTOMATION deployed to production/total AUTOMATION request deployed to production
Average Initial Response Time	Number of minutes, hours, or days between when a Request Ticket is submitted, and AUTOMATION feasibility is provided	Daily	Maximize	Sum of all time it takes between the request to be reviewed by the team and approval shared / total AUTOMATION request approved
SLA Compliance Rate*	Percentage of requests developed within the agreed SLA time	Weekly	Maximize	(No. of AUTOMATIONs completed within Agreed SLA / No. of Request Received)*100
# domains covered for zero touch automation	# of domains that use zero touch automation	Monthly	Target all domains	# of domains out of RAN, Core, Transport, BSS, OSS, Security, Edge, Cloud, Applications
# Automation jobs success-rate	% of successful jobs fulfilled within expected execution duration	Weekly	Maximize	# of Successful automation within expected duration/Total automation jobs
# of Active automations	% of active automation vs total automations	Monthly	Maximize	# of active automations/ Total automations

Figure 18. An example of the KPIs organizations can use to track their automation process.

Outcomes

When implemented correctly—as a culture and mindset, not a product or box—automation delivers outcomes that are truly transformational *(see Figure 19)*. What takes humans hours, days and weeks can take only minutes and seconds with automation, and execution can be parallelized infinitely. Because all actions taken are documented and declarative in the automation scripts, there is immediate audibility and traceability, providing additional security for root cause analysis and next best action in case of errors.

Even if the organization has no intention of reducing headcount, automation means people have less stress, fewer errors are introduced and quality, predictability and reliability radically improve. If people do choose to leave a company, they do not leave with their knowledge, so decisions can still be made even if backfill is necessary.

Automation Industrialization – Outcomes

Improvements as a Result of Automation in Rakuten Mobile Japan

Use Case	Metric Impacted	% Improvement
Aged Ticket Reduction	#Aged TTs	54% reduction in aged TTs - From 367 to 171
Ticket RCA Compliance	#Aged TTs	Compliance improved to 95% from 37%
Auto Trigger RCA / L1 Troubleshooting	RCA time per ticket	Saved 20 mins per tickets of manual effort
Isolation MOP/SOP for Core Network	Time to isolate core network component	~5 hours saved by bringing human effort down to 5 mins
Customer Plan Bundle Change from PCRF	Time to change Customer plan bundle	Saved 12 hours of manual effort along with the need to involved multiple teams
Traffic By-Pass/Migration and Rollback	Mean time to restore	~5 hours saved bringing human effort down to 5 mins
Disaster Alerts for BCP Activities	BCP setup & response time	Improved by 32% for Earthquake, strong wind and rains
Marketing Promotion Campaign Management	# Link APP downloads	30% of the of activated users who did not download the LINK app, downloaded after campaign
Security Hardening	# Secured network elements	95% of Rakuten network elements hardened
Privileged Access Management	# Accessible network elements	Just-in-time access workflows for 92% network elements
RAN Upgrades	Upgrade time	Performed upgrade on more than 5000 NEs overnight
VNF Auto-Healing	Uptime	99.98% availability in Rakuten mobile
Disaster Recovery for BSS/OSS	Service restoration time	Seamless switchover to the geo-redundant data center.
Backup and Restore Automation	Service restoration time	~3 hours saved bringing human effort down to 10 mins
Notifications for Campaign Eligibility	Prevent point-grant incidents	Reduced campaign grant incidents from avg. 3 per month to 0
CDR Based Notifications for Customer Enquiries	Reduce customer enquiries	Reduced 3% of customer inquiries by providing real-time notification
ACI Span Lifecycle Automation	Prevent data loss	0% data loss if workloads shift across computes
Router, Switches ZTP	Deployment time	Deployed more than 1000 data centers in 3 months
Router Upgrades	Upgrade time	Performed upgrade on more than 3000 NEs overnight
Cloud Deployment	Deployment time	Deployed more than 2500 open stack PODs in 12 months across 1200 data centers

Figure 19. An overview of the documented outcomes of automation by use case.

RECOMMENDED NEXT STEPS

Telecom is an essential industry that generates US$1.3 trillion per year. Although it is more important to people than any other essential service, it is unfortunately unwieldly, slow-moving and spending 70%–90% of the top line on the cost of delivery. The opportunity for change is clear. Rakuten has proven that moving to end-to-end disaggregation, software-centric operations and 100% digitalization can reduce the cost of delivery by 30%–50%, increasing the speed of organizational execution and agility, and can allow the pursuit of next-generation services with the right software-driven operational foundation.

Telecom providers must rapidly adopt the proven benefits seen first in Internet and now in IT companies and become software-driven companies, not hardware-defined companies. Anything less than radical transformation will lead to telecom missing the largest generational opportunity appearing globally—the reinvention of the Internet as distributed, governed and regulated—to become a true leader in enabling the next era of businesses, societies and countries.

The question for existing operators is how to change

The challenge with this required change is its systemic implications. The existing financial allocations, organizational structures and incentive schemes all create resistance to adoption of the newly required modeling, thinking and implementation. This requirement needs to be accepted and accommodated at the highest governance level. If the change is pushed down into the existing organization and context, then the results will once again disappoint.

Our recommendation is to either select a project that has already been identified as highly strategically important, and choose to execute in a completely new way, OR to select the most important "job to be done" process, or workstream, and focus on transforming that in a similar fashion. The examples we show in Figure 20 are where we have been asked to engage by other customers to start their journey. It is highly important to prioritize the start of execution and begin learning rather than having a perfect understanding that will never exist and be proven wrong later.

The process can be guided. An audit of the existing reality in each layer is the foundation for asking the questions of what can immediately be achieved per layer and what that means in terms of efficiency gains, reduced equipment/tool dependency, reduced number of people required and most important, reduced timescales to execute.

In our experience, starting is the hardest task for all organizations because it requires stepping into unknowns. The second hardest task is maintaining momentum when obstacles appear. Finding the right scope (greenfield in brownfield) from which to first attack, learn and grow is key.

The process can be guided by those that have traveled the road before.

Recommended Immediate Action

Select Priority **Project** for New Approach

Examples

1. Rapid Network Vendor Replacement
2. Rapid Indoor Coverage Rollout
3. Urban Densification Project

OR

Select Priority **Process** for New Approach

Examples

1. Automated Site Management and Rollout
2. AI-Based Radio Planning
3. Automated Service Assurance

Drive rapid tiger team execution using new approaches

Figure 20. How to prepare for and execute the transformation of existing telecom operators.

CONCLUSION

Change is required for telecom and is overwhelmingly achievable if all entities manage incentives, risk and execution with a ferocious and ruthless intensity. There is no alternative. The industry has stalled, previous promises have not materialized, magical 5G revenue growth is not happening and costs are radically increasing alongside complexity and competition. This is a pivotal time for telecom. There is a significant opportunity for all involved to transform into active participants in the next generation of the Internet, which is simultaneously being reinvented through localization, regulation and governance requirements.

Incentives are aligned but execution of the new and unknown is difficult. Winning a race requires hard work and training, not just great running shoes, regardless of whatever promises the shoe vendor has made. By adopting the Mobile as a Software mindset, telecom can make the changes shown in Figure 21 and become a true technology leader.

Mobile as a Software – A Better Way

FROM	TO
Capital/people intensive	Software/automation intensive
Ten-year innovation cycles	Weekly streams of innovation
Big Bang RFP tech model	Trial-to-scale/speedboat model
Opaque supply chain limitation	Transparent supply chain choice
Generationally improving economics	Continuously improving economics
Commodity services race to bottom	Digital ecosystem enabler

Figure 21. Transformation is hard, but the benefits of adopting a different mindset are clear.

Rakuten Symphony

At MWC Barcelona 2023, Rakuten revealed how Mobile as a Software can result in not just considerable cost reduction, but also added network agility and accelerated network build-outs and upgrades. The company spotlighted the experience of Rakuten Mobile in Japan, which built the world's largest cloud-native mobile network in record time.

To learn more about
Mobile as a Software visit:
symphony.rakuten.com