The TSO CIO agenda 2020

Energy transition and digitalization transform the Transmission System Operator and it's IT strategy

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Arthur D Little

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Author:

Matthias von Bechtolsheim
Partner Energy & Utilities
Frankfurt
bechtolsheim.matthias@adlittle.com

Executive summary

Energy transition, IT innovation and digitalization have a significant strategic and operational impact for a transmission system operator (TSO). The mission of a Chief Information Officer (CIO) and the IT department will develop from implementing business requirements and providing IT services to a transformation enabler, if not a driver. Successful CIOs have key topics at the top of their agenda:

- Create a "Digital TSO" vision, milestones and roadmap jointly with executive management and possibly the CDO, which ensures commitment, support and momentum for transformational activities
- Achieve early success with digital pilot cases allowing employees and management to feel and understand digital impact in their day-to-day business
- Expand the IT delivery model from "run" to "transform" the business by using agile project management and grow IT development capabilities
- Bring information and operational technology (IT and OT) under one responsibility of the CIO
- Make people with the best business and IT "sense" to act as "demand managers" for the business with a solid line to the CIO – inside or outside the IT department

Beyond that, CIOs take many more topics on their agenda. Understanding the CIO agenda, allows executives as well as business managers to create value from IT by being informed and involved early and with a look into the future.

Arthur D Little

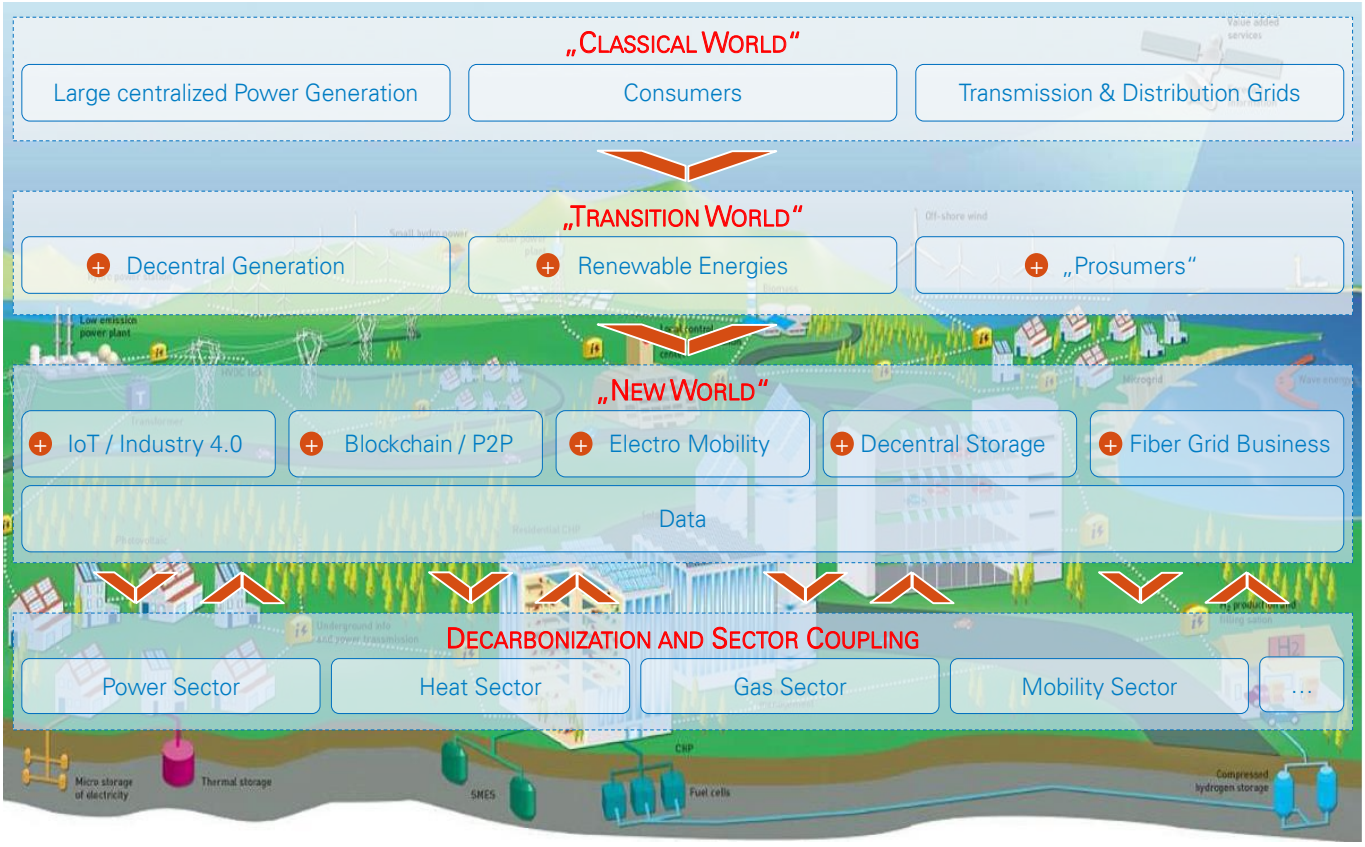
1. Setting the scene

Information technology has never had greater impact on the power transmission business than it has today. Besides copper and steel, silicon and data are becoming key assets in the TSO (as well as DSO) business. The dynamics and complexity of energy transition are meeting the disruptive power of digitalization. The mass of data is growing faster than ever while data protection requirements require a clear data governance. New digital start-ups are mushrooming, as are cyber-security threats. Business requirements are rising, whether this is due to regulatory changes, new transmission technologies or new-build projects. Besides being an innovation driver, IT still must fulfill its "workhorse" role: availability, security and performance to ensure seamless running of the business. Top management becomes aware of the fundamental, even business-critical, role IT plays nowadays.

We conducted interviews with TSO CIOs and included our own international experience in the TSO business in Europe, which had several questions in scope:

- What market-driven business requirements towards IT do you expect, e.g. regulatory, standards, transmission technology etc.?
- What major IT technology innovations do you see, what is the impact on business model and business processes, where will you put your focus on?
- Which business processes will face significant improvement needs esp. IT-supported?
- What key IT technology decision are relevant, pending or have you already made?
- What IT budget trends do you see, where do you stand in key figures?
- How is IT/business collaboration today, and what trends do you expect?
- What is you experience in outsourcing and which sourcing trends do you expect?

Figure 1: High-level Vision of the Energy Transition and drivers of the new energy world



Source: Arthur D. Little, Manuel Sánchez Jiménez, Commission Report European Smart Grids Technology Platform

2. Trends and drivers

Energy transition drives business

Almost all European Transmission System Operators (TSOs) are facing energy transition as the main change driver. To balance the rapidly growing renewable feed-ins, onshore and offshore, connecting offshore-wind farms to the grid and other grid enforcement projects, regulatory requirements demand new IT capabilities. Rollout of smart meters will have an impact the TSO business by making data available at a much more granular level. In order to master these challenges, businesses need the mass of data to be available flexibly to ensure data mining and prediction. End-to-end business processes need new applications and access to existing data silos. Security has become a major priority in almost all markets: from protection of physical infrastructure against attacks, vandalism, and other incidents to cyber security and to data governance.

TSO emerge from the "Classical World" of energy where they were a solid and static element between centralized generation and distribution (see figure 1). That stable - and comfortable - world is in a transition where renewable and distributed generation with prosumers transform the framing conditions in an increasing wave of change. While these drivers persist, new waves are challenging the role of the grid. The "New World" brings "digital" to the grid and extends the grid control beyond traditional scope - e.g. with block chain, smart meters and controls.

Digital drives a mind-set change

For a long time, TSOs' management looked at the internet and digital from a distance, expecting no real impact on their businesses. Industrial automation and communication (such as SCADA systems)have a long history in the grid business, so "fancy new technology" was (and often still is) regarded as immature, unreliable and insecure. IT was (and partially still is) divided into technical and commercial domains, often with separated responsibilities. Long-life assets with long-life, partly proprietary communication-control technology meet fast-changing open-architecture technologies. Traditional views on physical assets, "secondary technology", "technical/operational IT" and "business IT" merge into a "digital world of connected things": the grid becomes a "digital reality". Each asset, be it substation, cable or transformer, changes its capability when becoming digital. The same applies to business processes. Moreover, it applies to people who are planning, building, operating and maintaining the grid. Thus, Digitalization drives IT, requiring new capabilities and enabling new funcitonality. The TSO business is not different from other industries. This mind-set shift has already started at TSOs, sometimes with different speeds, but it is moving. Figure 2 gives an overview of use cases currently discussed, tested or even implemented in the industry.

Figure 2: Example digitalization Use Cases

Asset Management	System Operations	Energy Management
■ Mobile Workforce Management ■ Mobile access to maintenance documentation ■ Autonomous drones for line inspections (air, sea) ■ Sensor data analysis for grid status checks ■ Augmented Reality glasses for remote expert support e.g. in substations ■ Spatial imagery (3D models, LIDAR) for grid infrastructure and environment	■ Improved forecast through smart meter data ■ "Digital Substation" ■ Balancing energy from distributed resources (e.g. Virtual Power Plants, Batteries, HVAC) ■ Automated security monitoring and risk analysis for remote locations (substations, poles)	■ Improved forecast through smart meter data ■ Balancing energy from distributed resources (e.g. Virtual Power Plants, Batteries, HVAC) ■ Crowdsourcing distributed balancing energy via Blockchain

Source: Elia, TenneT, ENTSO-E

Digitalization of assets

Besides transmission lines, substations are TSOs' key assets. Digitalization of the grid infrastructure is a key priority for some TSOs. The long-term vision is complete digital control of grid assets, mainly substations. The digital substation is aimed at much easier, cost-efficient configuration, extension, control and operations of substations than that of existing station automation. This capability will pay off in the future, when renewables plants, batteries and dynamic loads are added to the grid more often and in larger quantities, i.e., when the grid must be more agile than it is today. In addition, armadas of sensors attached to grid equipment will allow more precise prediction and localization of failures, as well as faster problem resolution. The attitude towards digital "agilization" of the grid is not the same across the market. It depends on the grid-planning strategy or mind-set: adding more "bandwidth" through new lines and substations versus creating more flexibility within the existing asset set-up.

AI will transform systems operations and energy management

Digital will also have an impact on system operations: a TSO tested artificial intelligence (AI) machine learning to size the frequency balancing reserve in a more efficient and faster way. There are many other use cases possible in areas where human experience and judgement are required, such as line inspection. An AI system will even take over some of the tasks of control-center operators, giving them more time to focus on optimization. With an increasing share of renewables, systems operation will become more dynamic and short-term driven, which makes AI a prerequisite to mastering the challenges.

Digital disruption on the horizon

Few companies have explicit digital strategies or expect disruptive impact on the industry, compared to, for example, the consumer retail business, which has firms such as Amazon as game changers. Nevertheless, there are some indications that digital could influence the TSO business model, as one can see in the innovation projects initiated by some industry players: as an example, crowdsourcing of balancing power from batteries in homes mingles transmission with distribution grid level.

Widespread roll-out of smart meters would allow activation of millions of decentralized electrical loads, prosumers and storages for grid control. Blockchain-based contracting and settlement enable this kind of mass transaction. The long-term trend of decentralizing renewable power generation and storage, load management, aggregation and power-to-X can lead to convergence of the grid-control mechanisms of transmission and distribution grids.

Could you imagine a scenario in which all power grids, distribution and transmission are under control of one "super" system operator, a kind "power-grid Amazon"? Besides all regulatory, political and technical, as well as other "man-made" reality, who says this is impossible? Who could disrupt the TSO business? This is why IT, especially digital, is on the agenda of the TSO CEO.

Business processes in search of excellence

While regulation drives grid operators to increase efficiency, quality of processes is even more important. The growing regulatory requirements, increased risk exposure in large capex projects, and exposure to public opinion demand faster, more agile, and more reliable processes. Management steering and control must become more "intelligent", i.e., proactive and situational, anticipating deviations and dealing with them specifically.

End-to-end process support, consistent company-wide data and process management, and smarter management control are key objectives for a TSO's IT strategy. However, the reality is often a historically grown, patchwork application landscape with multitudes of interfaces and different kinds and ages of software packages, often legacy. The CIO office is not in charge of business processes. Even business process management (i.e., defining clear, cross-departmental responsibilities for processes and actively measuring and improving them) is rare among TSOs. However, some TSOs have equipped CIOs with process management capabilities, often with a dedicated team of process re-engineering consultants managing cross-departmental improvement projects, as well as temporarily managing process improvement projects or programs.

Technology innovation under control

CIOs expect selected technology innovations to have significant impact on the TSO business. Mobile and Internet of Things technologies have high priority. With assets spread over a huge geographical area and a significant workforce on the ground, there are plenty of use cases improving efficiency and availability. The more data becomes available, the more data mining and artificial intelligence technology will become beneficial in the longer term. Cloud computing and related "as-a-service" provision models are not as popular as they are in other industries, due to critical infrastructure concerns. In general, top management's attitude towards technology innovation is rather conservative in this industry.

Technology innovations mostly come short term, often implemented in piecemeal, bolt-on approaches, and not all of them affect business as a whole. In particular, technology "platforms" (such as operating systems, interface standards and application software) have long-term perspectives and lifetimes,

and thus improve incrementally. However, eventually their end of life comes closer. This is especially the case with proprietary platforms such as database systems and application software (e.g., SAP, which will discontinue support for its current product in the mid-2020s and is offering S/4 HANA as a successor product). Switching or migrating to a new platform is costly and time- and resource-consuming, often without a clear business case. CIOs use these opportunities to review their technology and vendor preferences and look for additional business value from platform renewals.

IT budgets are on the rise – So is cost management

Most TSOs have seen rising IT budgets in recent years, in OPEX as well as CAPEX. Some TSOs have experienced IT CAPEX doubling or even tripling in the last five years. OPEX has increased only moderately, mainly due to improved hardware virtualization and operations automation. The IT cost/revenue ratio is around 4 percent (OPEX, including CAPEX depreciation) in a five-year average. The more "technical" and "commercial" IT converge, the more budget comparison is blurred. This calls for more transparency on cost and more proactive cost management. Some TSOs have started initiatives for more proactive IT costing, which allows allocation of cost to IT services, as well as identification and influence of cost drivers.

3. Making IT future-proof

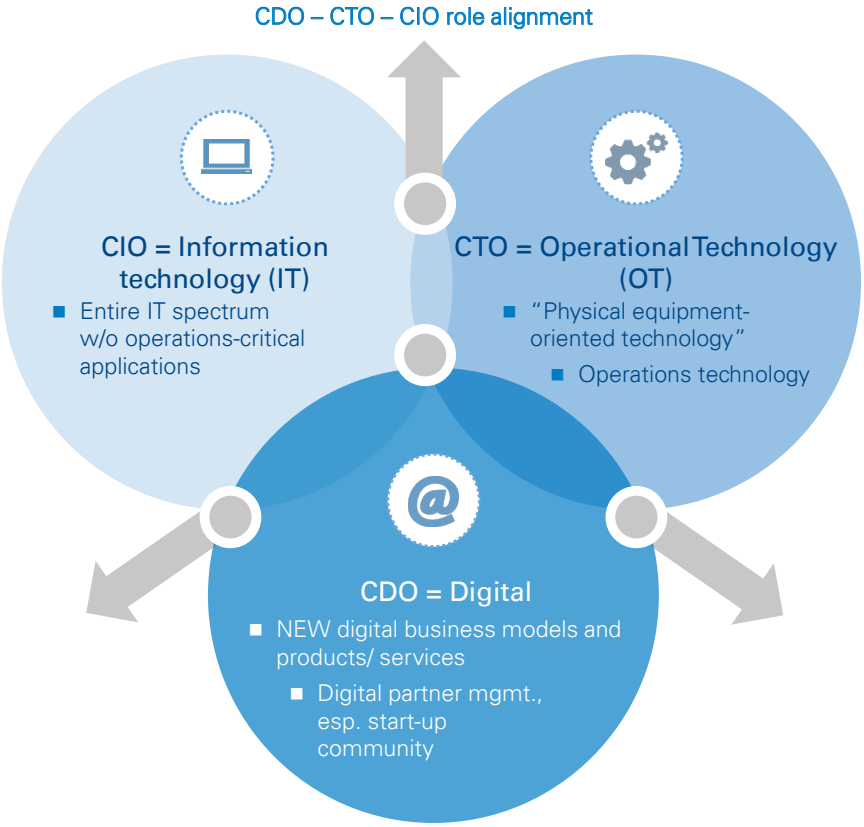
If all that we have previously mentioned becomes reality, traditional IT will need to change significantly. The technology layer will change: from proprietary protocols to All-IP; from software monoliths to open service-based architecture; from data silos to big data. Even bigger is the change for the IT organization – the people making it happen. What capabilities do you need to accomplish the transformation, on the IT side as well as in the business? Many questions arise: Do we need a Chief Digital Officer? What, then, will be the roles of the CIO and CTO? How do we become faster? What about "shadow IT"? How do we set up effective IT steering? How can IT sourcing help to improve?

The future CIO role

Many large corporates have created positions of Chief Digital Officer. The CDO leads the business side of digital: developing the digital strategy and roadmap, leading company-wide digital initiatives, and managing start-up ventures; some lead new digital business units or provide technology centers with dedicated resources. We have not yet observed a dedicated CDO at a TSO. However, some CIOs have extended their competencies into digital, e.g., by dedicating teams to digital projects. From our perspective, there are clear reasons for "digital-enhanced CIOs": speed is not as critical as in highly competitive businesses, new business models first need regulatory approval or even new regulation, and there will be a close link between new and existing business.

Nevertheless, split responsibilities between CDO and CIO roles might be beneficial when there are significant business innovations that could conflict with ongoing business. Another issue arises with the competences of CTOs at grid operators. For many TSOs, the "technical IT" (mostly SCADA systems) is managed by the CTO department. Linking the already-digitalized grid components with digital asset management makes a closed link between CIO and CTO necessary. That is why some TSOs have shifted SCADA systems to the CIO.

Figure 3: Roles and Alignment needs



Source: Arthur D. Little

How do we become faster?

Agile development is becoming mainstream, at least with the majority of firms today, even in the utilities industry. Shorter time to market, closer links with users or customers, and more flexibility: this is the "agile" promise. However, are speed, customer focus and flexibility relevant for grid operators? That is a question we have heard from TSO executives. For a regulated business with no competition and no real customers, speed is indeed not the primary driver for agile. It is, rather, a cost issue: some TSOs have observed that the cumulated cost of change requests over the lifetime of an application has reached, in some cases, 10 times the initial investment. Change requests drive total cost of ownership (TCO), i.e., translating business demand into application code efficiently is a major lever to increase IT efficiency. "Agile" reduces the slack created by traditional approaches ("waterfall") between business and IT, and thus offers less cost and risk in projects. We expect TSOs moving to agile and similar interactive ways to collaborate with businesses.

In addition, some TSOs are practicing DevOps (integrating application-specific development and operations in one function) – to ensure shorter cycle times and improved quality. Another angle to agile is digital innovation: some TSOs have discovered start-ups as a way to find new solutions, and so agile finds its way into the company from the business side, and IT must be prepared. There remain domains where agile is not the appropriate approach, e.g., when implementing regulatory requirements, algorithmic computations, etc. In these cases, traditional approaches will do.

Shadow IT – A sandbox for innovation

Closely linked with the need to become more flexible is when business units start IT work on their own: sometimes called "shadow IT".

Businesses driving their own application development, independent from corporate IT, has been a reality since the personal computer appeared on the market. Nowadays, with cloud-based, on-demand software, easy-to-use tools, and more computer-literates in business, shadow IT is a new normal. Challenges are obvious: be they cyber security, data protection or legal issues. On the other hand, decentralized development cannot and should not be avoided. Instead of fighting against it, CIOs support decentralized IT with expertise, training and support in development and integration. As a side effect, shadow IT will follow security and quality standards better than working alone.

IT governance is needed more than ever

Most TSOs have clear rules for fundamental decisions regarding IT, and assign governance to the CIO or decision-making bodies. Almost all have a clear governance for the IT project portfolio with dedicated resources, or at least apply clear decision criteria. Closely linked to projects is budget ownership. Almost all TSOs have central IT budgets, allocated according to project priorities and service needs. Another governance area is standards setting and architecture. While technical standards are relatively easy to define and promote, IT architecture has not been a key topic in recent years. It gets more attention now, with its growing complexity and cost. Few companies have installed dedicated IT architecture functions. IT security has been put back on the CIO agenda in response to rising cyber threats, and so become part of IT governance. A comprehensive, competent and effective IT governance function is clear priority and a success factor.

IT sourcing reflected

The TSO business, like many other industries, is using different kinds of outsourced IT services. We have observed rather small shares of outsourcing at many TSOs, while some have shown significant shares of external supply. Staff leasing of developers or experts is quite common (where it is legally viable) and offers IT departments more flexibility. Some TSOs subcontract application development and maintenance (ADM) by application if they do not have enough of their own application development capacity. Others have outsourced ADM of whole clusters of applications to external service providers.

With few exceptions, TSOs operate their IT infrastructure (data center, network, servers and services) internally, all using their own locations. The cloud has not yet arrived at TSOs; however, hybrid models are in discussion, in which commercial applications would be transferred to the cloud, with technical/operational applications kept on premise.

We have observed a trend reflecting existing sourcing relations and rethinking of the sourcing strategy. In general, internal developers have been focusing more on innovative "digital" solutions than established business processes. TSOs are facing the same "war for talents" in IT as other firms, and must offer attractive job prospects and compensation – which is a challenge given that most TSOs are medium sized. A well thought through sourcing strategy combined with IT HR concept is a must-have for the CIO.

IT operating models

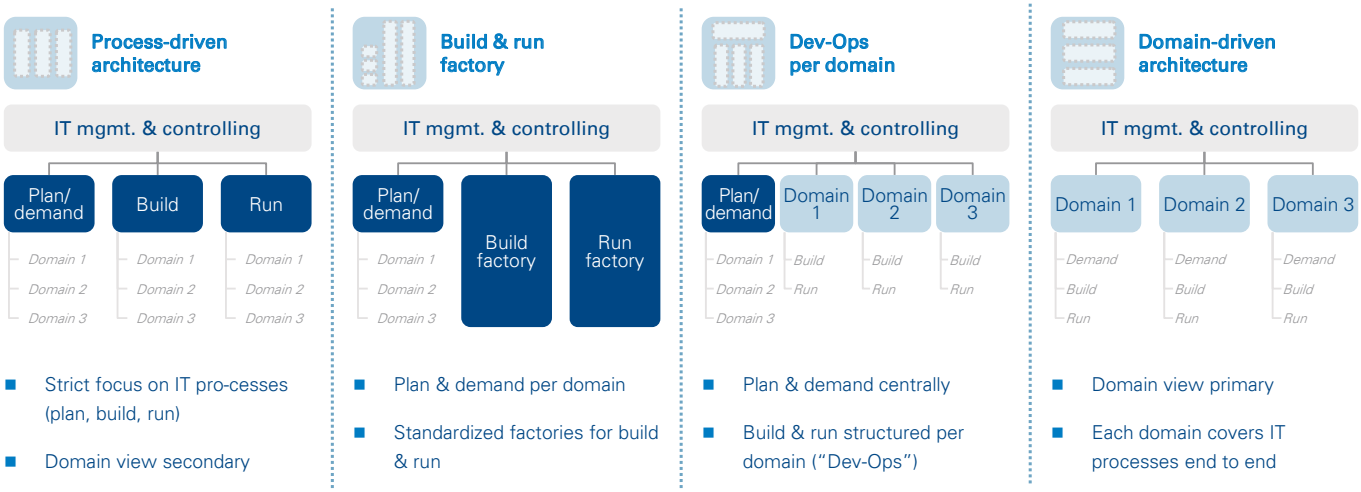
As business requirements and technology trends accelerate, IT organizations must adapt their operating models, i.e., the way they structure their resources to fulfill requirements.

In established businesses with low degrees of change, the often-preferred operating model is process-oriented. It allows for domain specialization, functional synergies and efficiency, but not for speed and a high degree of change. Even more efficiency

driven is the build-and-run factory model, which requires a high degree of standardization in build-and-run, reducing flexibility in implementation and with change requests. The DevOps model is focused on specialized build-and-run, which allows for fast cycles of development and change-request implementation. This model is very suitable for digital projects with high degrees of change during the life cycle.

The domain-driven architecture model has a high degree of specialization, which allows for domain-specific efficiency and flexibility; however, it needs a critical mass of project and change requests to be economically viable. The models can also be combined, e.g., the domain model for customer/market applications and the build-and-run factory for financial applications. We have observed process-driven as the primary model for TSOs, with dedicated DevOps or domain models for selected applications or domains. Figure 4 shows examples of operating models we observed in practice. We recommend to mirror these models with the business requirements and the choosen IT application and technology architecture.

Figure 4: Basic IT Organization Models



Source: Arthur D. Little

4. Three top priorities on the agenda

IT in TSOs is at a crossroads of energy-market dynamics and digital disruption. An IT department, positioned as the pure service provider for the business (as it is practiced sometimes), will fall short. Facing the strategic role of IT, the CIO must be a partner and change agent for executive management – visionary and pragmatic, linked with the business and technology minded. Some TSOs already have plans under way, while others' are in the starting blocks. We see at least four topics that are at the top of the CIO agenda to make this happen:

1. Develop the digital TSO vision with executive management and create a digital roadmap. The vision should start with the trends and the impact of digital and other technologies on the energy system as a whole. Create scenarios of the changing role of the TSO and other market participants. Select a "least regret" scenario and define short and mid to long-term actions to achieve the envisioned scenario.
2. Start with short-term actions and use agile approaches. Agile approaches allow to becoming faster, reduce the total cost of ownership and live a new kind of interaction between business and IT.
3. Be significantly involved or have the lead for medium to long-term innovation projects in the digital space, be it robotics or the digital substation. It is of utmost importance that a CIO with his team take an active role in the long-term innovation topics to link these with the IT strategy and architecture.
4. Review the existing (written or unwritten) IT governance, compare it to the business and digital strategy and your company's overall governance setup. Make IT governance an essential success factor for your company's IT strategy.

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Conclusion

- Information Technology at Transmission System Operators is facing challenges from energy transition and digitalization in most European markets.
- Digitalization will push IT into a transformational role and a prerequisite for the future success of the TSO.
- CIOs are increasingly transforming IT from an internal service organization to a proactive enabler.
- CIOs link executive management, business owners and IT department with strong vision setting, leadership style and communication capabilities.
- CIOs have a clear agenda which enables internal communication and stakeholder buy-in.
- CIOs are initiators and owners of transformational projects with clear sponsorship in top management.
- CIOs are aligning IT governance and business/IT interfaces with a clear role and responsibility split between business and IT.

Contacts

If you would like more information or to arrange an informal discussion on the issues raised here and how they affect your business, please contact:

Austria
Karim Taga
taga.karim@adlittle.com

Belgium
Kurt Baes
baes.kurt@adlittle.com

China
Russell Pell
pell.russell@adlittle.com

Czech Republic
Dean Brabec
brabec.dean@adlittle.com

France
Vincent Bamberger
bamberger.vincent@adlittle.com

Germany
Michael Kruse
kruse.michael@adlittle.com

India
Srini Srinivasan
srinivasan.srini@adlittle.com

Italy
Saverio Caldani
caldani.saverio@adlittle.com

Japan
Yuma Ito
ito.yuma@adlittle.com

Korea
Chulseung Son
son.chulseung@adlittle.com

Latin America
Daniel Monzon
monzon.daniel@adlittle.com

Middle East
Jaap Kalkman
kalkman.jaap@adlittle.com

The Netherlands
Martijn Eikelenboom
eikelenboom.martijn@adlittle.com

Norway
Lars Thurmann-Moe
thurmann-moe.lars@adlittle.com

Russia
Alexander Ovanesov
ovanesov.alexander@adlittle.com

Singapore
Yusuke Harada
harada.yusuke@adlittle.com

Spain
Juan Gonzalez
gonzalez.juan@adlittle.com

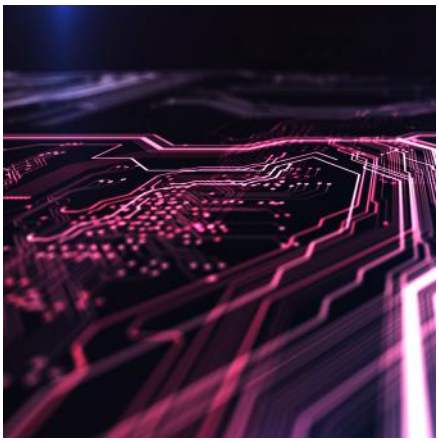
Sweden
Lars Thurmann-Moe
thurmann-moe.lars@adlittle.com

Switzerland
Michael Kruse
kruse.michael@adlittle.com

Turkey
Coskun Baban
baban.coskun@adlittle.com

UK
Stephen Rogers
rogers.stephen@adlittle.com

USA
Bob Peterson
peterson.bob@adlittle.com



The TSO CIO agenda 2020 – Energy transition and digitalization transform the CIO and IT roles

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