



Introduction

In AI projects it is desirable to have agile capabilities for strategy creation, R&D, deployment and maintenance, characterized by the DevOps and MLOps concepts. There are anyhow AI transformation cases when such agility is not possible, and long-term strategies over several years need to be created, involving significant risks. We will study one such case example from telecommunications, and apply a method designed to support the development of a robust, market-shaping strategy. In telecommunications it is typical that a long-lasting process is used to first define international standards by cooperating industry stakeholders, followed by a long development of specialized and proprietary embedded SW and HW products. In history this process has produced results of varying quality, typically achieving the introduction of new important services that have changed the world, but often also solutions that have not met their expectations despite of significant investments.

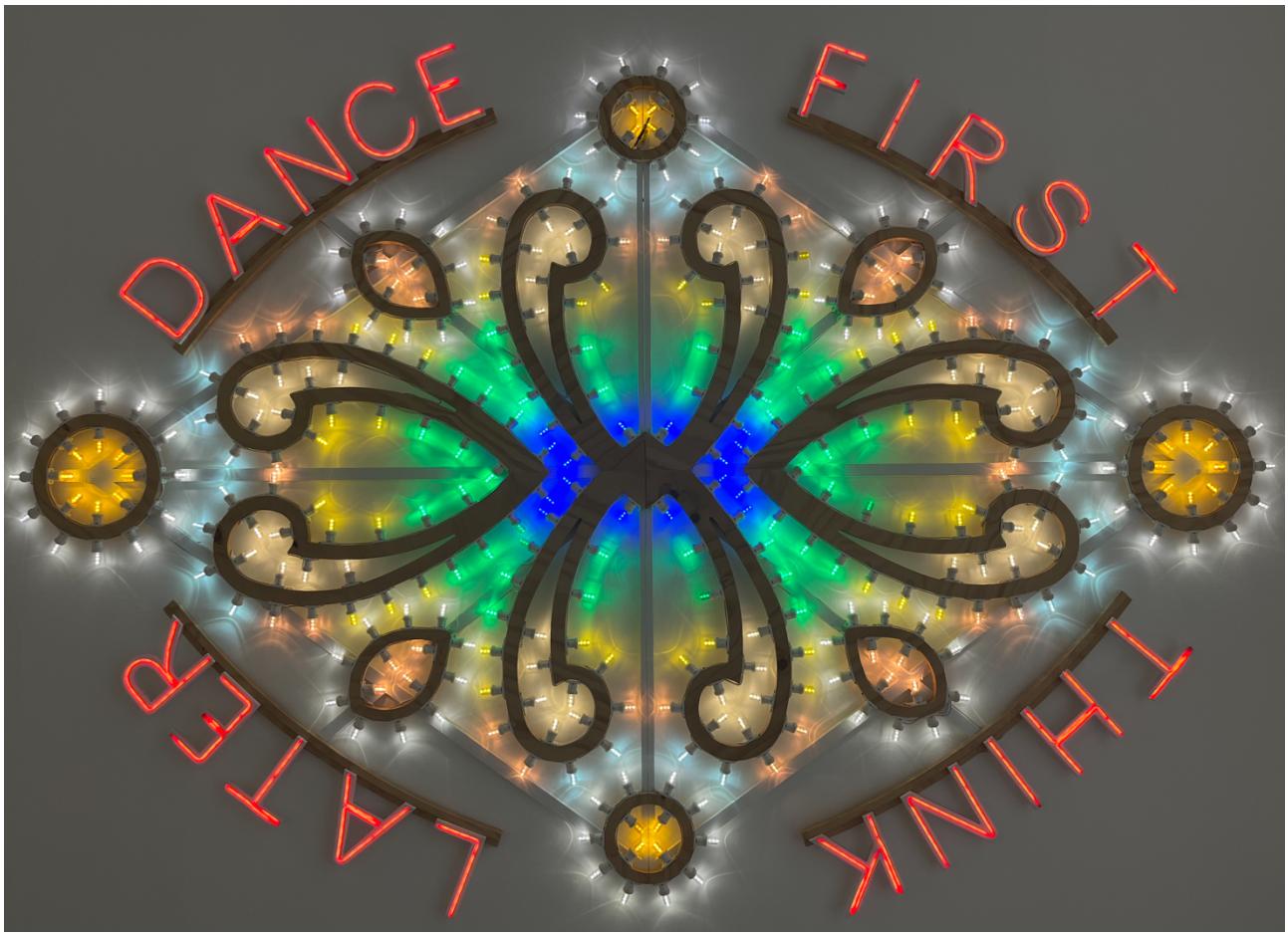


Figure 1 By the artist Marinella Senatore, from the Milan Museo del Novecento

Background of the Case Example

The case we are studying here is about the vendors of the cellular radio network (RAN) equipment, software and associated professional services for network operators and enterprises. The top 5 RAN suppliers based on worldwide revenues are Huawei, Ericsson, Nokia, ZTE, and Samsung (Dell'Oro, 2024). Despite of the key nature of RANs in the global ICT infrastructure the RAN vendors are struggling with profitability in a flattening or even shrinking market. The global RAN market is now projected to decline 5 to 8 percent in 2024 (Dell'Oro, May 2024).

The recent Mobile World Congress 2024 showed a significant change of attitude and focus in the cellular industry (Antlitz and Soper 2024). The major new cellular technologies, 5G and 6G, were discussed very little, pointing to the challenges the telecom industry continues to face with revenue growth and ROI. The current challenges of the RAN vendors are largely a consequence of the business challenges and the bargaining power of their customers, the mobile communication service providers (CSPs). According to (Antlitz and Soper 2024) the CSPs have a track record of two decades of underachieving transformation initiatives and

weakening business. As in the past, the CSPs are still keen to discuss about B2B use cases, network slicing, private networks, cloud-native transformation, AI/GenAI and network APIs as key enablers of the digital economy and new revenue for themselves. But it seems that their strategic messages are losing credibility as it looks like they do not have sustainable value to show for their efforts in these areas. As a consequence the vendors are forced to adjust down their investments in the RAN business.

Mobile radio network regulations significantly impact vendors by shaping spectrum allocation, technical standards, competition policies, consumer protection, and safety requirements, according to OpenAI (2024). Spectrum allocation determines the frequencies available, while technical standards ensure their products are compatible globally. Competition rules foster a fair market, offering both opportunities and challenges. Consumer protection laws mandate high-quality service and data privacy, influencing product design. Environmental and safety standards require compliance, affecting manufacturing processes. As the AI technologies are now being introduced to the vendor operations and products, the practical impacts of the emerging AI trustworthiness requirements and regulations in different regions and countries must be studied and understood as well. For the vendors, these regulations mean higher compliance costs and operational challenges but also drive innovation. Adhering to regulations provides a competitive edge, essential for maintaining and expanding market presence. Overall, regulations deeply influence the strategies and operations in the mobile network industry.

Given the currently challenging market outlook the RAN vendors are forced to adjust their bets and look carefully for the opportunities to invest in. This is challenging also because at the same time the vendors been forced to cut costs and lay off a significant portion of their employee base (Techblog 2024). AI is one topic in which the RAN vendors havetried to put more focus on. While the vendors already have a large number of AI and analytics initiatives, yet no major impact to the vendor business performance is not currently foreseen. Reflecting the telecom industry status regarding the exploitation of AI in general, a very recent report by TM Forum about telecom operators revealed that 'There is nearly universal recognition that AI will lead to a paradigm shift in Communication Service Providers' operating models. However, very few operators have a clear picture of what that operating model will or should be.' (TM Forum, 2024).

The 2023 Strategic Foresight Report provides a comprehensive overview of the sustainability challenges the European Union is facing (European Commission 2023). The global telecommunications industry knows many of those challenges as well. Climate neutrality and sustainability is high on the agendas of the CSPs, at least partially due to the fact that RAN energy costs represent a large part of the operational costs of their networks. The importance of geopolitics has grown steeply in telecommunications, as in the ICT in general. Especially the growing technological confrontation between China and the west have caused trouble for the western vendors. There is a risk that the future 6G standard will be split to different specifications, and that would reduce the addressable market and increase development costs for the vendors (MERICS 2023). Some western vendors do have a significant R&D workforce in China, and there can be pressure from the west to reduce their presence in China. On the other hand the exclusion of the Chinese vendors from many western markets has in practice helped the business of the western vendors.

The playing field of the RAN vendors has thus grown extremely complex and demanding, and identifying and exploiting opportunities for growth requires understanding the future

market and technological opportunities extremely well. There might be opportunities to expand the business to say e.g. satellite communications or IoT, but the limited economical resources of some vendors won't help much with the challenge. As its customers the CSPs, the RAN vendors need to carefully focus their investments in the most important key topics such as AI, 6G and Open RAN (Dell'Oro, March 2024).

Introduction to the Scenario-Based Analysis Method

The paper by Vilkkumaa et al. (2024) presents a model-based framework designed to support the development of a robust, market-shaping strategy. This framework is particularly tailored for strategic decision-making, where there are multiple conflicting objectives, long-term planning horizons, and significant uncertainties regarding future scenarios. The approach combines scenario planning with portfolio decision analysis to assist organizations in not only preparing for multiple potential futures but also in shaping the market towards desirable outcomes.

The core of the method lies in integrating scenario planning with robust portfolio decision analysis. Scenario planning is used to explore and define a range of plausible but distinct future scenarios that capture uncertainties in the operational environment. Portfolio decision analysis then comes into play to evaluate strategic actions across these scenarios, considering their scenario-specific impacts and the likelihoods of different scenarios occurring.

The framework is characterized by its ability to handle incomplete information—a common challenge in strategic decision-making. This includes incomplete preferences between objectives, undefined impacts of strategic actions, and uncertain scenario likelihoods. To address these, the authors develop new decision-analytic models and algorithms that generate strategic recommendations by identifying non-dominated action portfolios. These portfolios are robust across a variety of potential futures and can actively shape the market to increase the likelihood of more favorable scenarios.

The framework uses a stepwise approach for performing the analysis:

1. Development of Scenarios and Assessment of Scenario Likelihoods
2. Definition of Strategic Objectives and Elicitation of Attribute Weights and Utility Functions
3. Creation and Evaluation of Action Proposals
4. Identification and Creation of Market-Shaping Action Proposals and Assessment of Their Impacts
5. Development of the Decision-Analytic Portfolio Model
6. Computation of Decision Recommendations

The first step in the framework is the development of plausible future scenarios. Scenario planning serves as a tool to explore a wide range of potential future states by identifying key drivers of change and considering various plausible outcomes for each driver. These

outcomes are then combined to create scenarios that are both internally consistent and mutually distinct, capturing the full spectrum of uncertainties. Importantly, the process also involves assessing the relative likelihoods of these scenarios, which allows decision-makers to weigh the potential risks and opportunities associated with each. This step lays the foundation for a strategic plan that is resilient across different possible futures.

Once the scenarios are established, the next step is to define the strategic objectives and the criteria by which success will be measured. This involves identifying the key objectives that the strategy must achieve and determining the attributes that will be used to measure progress toward these objectives. To accommodate the complexities of real-world decision-making, the framework allows for the incorporation of incomplete or uncertain information regarding the relative importance of these attributes. This step is crucial because it aligns the strategy with the organization's long-term goals while providing a flexible approach to handle the uncertainties inherent in strategic planning.

With the objectives and scenarios in place, the framework then focuses on generating a comprehensive set of strategic actions. These actions are intended to address the challenges and opportunities identified in each scenario. The creation of action proposals typically involves brainstorming sessions followed by a prioritization process to refine the list of potential actions. Once the actions are defined, their impacts on the strategic objectives across all scenarios are evaluated. This evaluation provides the necessary data for the subsequent portfolio analysis, ensuring that the strategy is grounded in a thorough understanding of how each action will perform under different future conditions.

Beyond merely preparing for different futures, the framework emphasizes the importance of actively shaping the market. In this step, the framework identifies actions that could alter the likelihood of different scenarios, thereby steering the market toward more favorable outcomes. Participants assess the potential for certain actions to significantly impact scenario likelihoods and may create new actions specifically designed to influence these probabilities, such as lobbying for regulatory changes. By incorporating these market-shaping actions, the framework enables organizations to adopt a proactive stance, not just reacting to future changes but actively shaping them.

The heart of the framework lies in the development of a decision-analytic portfolio model. This model evaluates the proposed actions across all scenarios, using the scenario likelihoods, attribute weights, and utility functions established in earlier steps. The model is particularly powerful because it accounts for incomplete and uncertain information, allowing decision-makers to identify non-dominated portfolios—those combinations of actions that are robust across multiple scenarios and objectives. This step transforms the complex strategic problem into a manageable set of actionable recommendations, providing a clear path forward.

The final step in the framework is the computation of actionable recommendations based on the portfolio analysis. An algorithm is used to identify the non-dominated portfolios, and the core index is calculated for each action, indicating how frequently an action appears in the optimal portfolios. This results in a prioritized list of actions categorized into core actions (which should be implemented), borderline actions (which are recommended but not essential), and exterior actions (which should be avoided). The outcome is a set of clear, data-driven recommendations that guide decision-makers in implementing a strategy that is both robust and capable of shaping the future market landscape.

Futures Table

As the first step of the exercise we create a *futures table* with following properties:

- A time frame between 3-7 years in the future
- Identified 4-6 critical dimensions / drivers of change / key uncertainty factors that could impact the target organization within the chosen time frame. These can include technological innovations, market trends, regulatory changes, socio-cultural shifts, environmental factors, or geopolitical events. Come up with 3-4 variable values / outcomes for each dimension.

The method involves selecting three interesting combinations of variable values / outcomes. We name the combinations and write one paragraph “Future state assessment / scenario narrative” for each combination.

1 Futures table for 6G and AI

Global standard for 6G?	Speed of market adoption of 6G	Role and success of AI in 6G RAN? ¢¥	Cost of 6G AI for the vendors?	Global AI chip supply
One global standard for 6G	Market adoption of 6G is fast and the demand for 6G RAN products is strong .	AI is an essential part of 6G and provides significant benefits for operators and their customers.	Introduction of AI decreases the costs of the vendors like the western vendors.	Geopolitics restricts the AI supply of western chip vendors to non-western 6G providers, western AI chip technology has superior performance compared to non-western suppliers.
Fragmentation of 6G standards to two or more regional standards driven by geopolitics	Demand and market adoption of 6G is relatively OK , not slow nor fast.	AI is an essential part of 6G but fails to provide benefits for operators and their customers.	No significant impact to the vendor costs.	Geopolitics does not have significant impact to the access to advanced AI chip technology, free market rules.
One global standard, but the market is fragmented due to geopolitics, leaving only a fraction of the global market addressable for the western vendors.	Market adoption of 6G is slow and the demand for 6G RAN products is weak .	Introduction of AI fails to provide benefits for operators and their customers. AI does not become a mandatory part of 6G network system solution.	Introduction of AI increases the costs of the western vendors.	Geopolitics restricts the AI supply of western chip vendors to non-western 6G providers, western AI chip technology has worse performance than non-western suppliers (e.g. Chinese).

Based on the futures table above we have identified three different scenarios for the western vendors. The first one is called '**6G AI dream**', marked with green in the table. The second one is called '**'Shrinking 6G'**', marked with yellow. The third one is called '**'6G and AI crisis'**', marked with red.

In the 6G AI dream scenario there is only one global standard for 6G. Market adoption of 6G is fast and the demand for 6G RAN products is strong. AI is an essential part of 6G and provides significant benefits for operators and their customers. Introduction of AI decreases the costs of the western vendors. Superior AI chip technology is available only to western 6G vendors.

In the Shrinking 6G scenario there is only one global 6G standard, but the market is fragmented due to geopolitics, leaving only a fraction of the global market addressable for the western vendors. Demand and market adoption of 6G is relatively good, but not particularly good. AI fails to provide any significant benefits for the operators, and the investments in it can be considered largely lost, AI becomes a curiosity in the 6G standards that is not implemented. In this scenario all vendors can access high performance AI chips.

In the 6G and AI crisis scenario the 6G standards are fragmented to two or more regional standards driven by geopolitics. Market adoption of 6G is slow and the demand for 6G RAN products is weak. AI is an essential part of 6G but does not provide significant benefits for 6G operators and their customers. Introduction of AI increases the costs of the western vendors. Also the AI chips that the western vendors can access are worse than those of the non-western vendors.

When comparing the 6G AI dream and the 6G and AI crisis scenarios, there are many radical differences. One aspect is whether the global 3GPP 6G standard will remain as one as it has been since the introduction of 3G. The key driver for the potential split of the standard is the geopolitical conflict between China and the west, spammed by the western concern about the cybersecurity risk related to Chinese network equipment and in general Chinese competition in network equipment market. India has as well been interested in increasing its position in 6G (Bharat Exhibitions, 2024). Market adoption of 6G is also essentially different in the scenarios. AI is important part of 6G networks in both scenarios, but only in the 6G dream scenario AI provides benefits for the customers. Difference is as well whether the western vendors can access the best AI chips especially compared to the non-western vendors.

When comparing the 6G AI dream and the Shrinking 6G scenarios, the major differences is whether the market is fragmented due to geopolitical hurdles and the importance and successful introduction of AI technology in 6G network solutions.

When comparing the 6G and AI crisis and the Shrinking 6G scenarios, one difference is whether the is one global or several regional standards. In Shrinking 6G scenarios 6G market adoption is much better. AI provides no significant benefits in Shrinking 6G scenario and increases costs in 6G and AI crisis scenario. In neither scenarios the western vendors do not gain a competitive edge from AI. In Shrinking 6G scenario the western vendors have access to better AI chips than the non-wester competition than in the AI crisis scenario, but it does not help much.

When comparing the scenarios main differences are found in whether the global 6G market is fragmented or not, whether the 6G market adoption is slow, whether AI provides benefits for the operators and whether the western vendors can access to best suppliers to provide AI solutions for its 6G products.

Strategic response

The strategic objectives for the western vendors in 6G

In our study we are pursuing the following strategic objectives for the western vendors:

- Maximizing revenue
- Achieving strong profitability
- Contributing to the creation of a successful 6G ecosystem that includes mobile operators, network equipment vendors, mobile device vendors, enterprises, regulators and mobile application providers.

Next we use the TOWS method for each three scenarios to identify the threats and opportunities posed by the scenario and the western vendors' strengths and weaknesses in the scenario.

2 TOWS canvas for the AI Dream scenario

6G AI Dream	Opportunities	Threats
Strengths	How to make use of opportunities through our strengths? <ul style="list-style-type: none"> • Good presence and installed base in western 5G market 	How to prevent threats through our strengths? <ul style="list-style-type: none"> • Non-western competition with very competitive price and features
Weaknesses	How to make use of opportunities to minimize our weaknesses? <ul style="list-style-type: none"> • Weak presence and installed base in non-western 5G market • Limited capabilities to develop AI 	How to minimize the potential dangers lying in sectors where our weaknesses meet our threats? <ul style="list-style-type: none"> • Create an aggressive market entry strategy for the non-western market that utilizes the cost advantages achieved due to the AI technology in 6G

3 TOWS canvas for the Shrinking 6G scenario

Shrinking 6G¹	Opportunities	Threats
Strengths	How to make use of opportunities through our strengths? <ul style="list-style-type: none"> • Use the existing 5G products as a baseline for the 6G, reuse as much as possible the current 5G product. 	How to prevent threats through our strengths? <ul style="list-style-type: none"> • Use relations with western operators that have operations/affiliates also in non-western markets.
Weaknesses	How to make use of opportunities to minimize our weaknesses? <ul style="list-style-type: none"> • Skip the investments in AI technology and redirect and readjust the resources reserved for AI work. 	How to minimize the potential dangers lying in sectors where our weaknesses meet our threats? <ul style="list-style-type: none"> • Withdraw from the markets that are not addressable

4 TOWS canvas for the 6G and AI crisis scenario

6G and AI crisis	Opportunities	Threats
Strengths	How to make use of opportunities through our strengths? <ul style="list-style-type: none"> • 6G is in crisis 	How to prevent threats through our strengths? <ul style="list-style-type: none"> • Two or more regional 6G standards to be implemented. • Costs increase due to AI for the western vendors the western vendors. • No access for the western vendors to the best AI chips
Weaknesses	How to make use of opportunities to minimize our weaknesses? <ul style="list-style-type: none"> • Try to downplay and delay 6G as much as possible, promote 5G evolution instead • Start an initiative to develop 7G standards in order to skip 6G altogether 	How to minimize the potential dangers lying in sectors where our weaknesses meet our threats? <ul style="list-style-type: none"> • Try to downplay and delay 6G as much as possible, promote 5G evolution instead

Combined list of action proposals

We introduce here a combined list of action proposals based on the previous step. The actions are evaluated based on how they help attain the strategic objectives in different scenarios.

5 Combined list of action proposals. Actions marked with green have positive impact to the strategic given the scenario, yellow means neutral impact and red means negative impact.

Action	6G AI dream	Shrinking 6G	6G and AI crisis
Invest significantly in the development of the 6G ecosystem (vendors, operators, application providers)	✗	✗	✗
Invest big time in 6G in AI. Invest already in 5G in AI and create a common reusable platform for 5G and 6G AI solutions.	✗	✗	✗
Create AI solutions that utilize maximally the better AI chips accessed by the western vendors	✗	✗	✗
Create AI enhanced 6G solutions that have superior performance compared to the non-western vendors dominating the non-western market	✗	✗	✗
Use the existing 5G products as a baseline for the 6G, reuse as much as possible the current 5G non-AI-based product.	✗	✗	✗
Skip the investments in AI technology and redirect and readjust the resources reserved for AI work.	✗	✗	✗
Use relations with western operators that have operations/affiliates also in non-western markets to sell to non-western markets.	✗	✗	✗
Create an aggressive market entry strategy for the non-western market that utilizes the cost advantages achieved due to the AI technology in 6G	✗	✗	✗
Withdraw from the non-western markets that are not addressable	✗	✗	✗
Try to downplay and delay 6G as much as possible, promote 5G evolution instead	✗	✗	✗
Partner with other vendors to create the 6G products	✗	✗	✗
Start an initiative to develop 7G standards in order to skip 6G altogether	✗	✗	✗
Merger with another 6G vendor	✗	✗	✗

The three studied scenarios ranked from the most desired to the least desired are:

1. 6G AI dream
2. Shrinking 6G
3. 6G and AI crisis

The action proposals that impact the probability of the *6G AI dream* scenario are:

- *Positive impact:*
 - Invest significantly in the development of the 6G ecosystem (vendors, operators, application providers)
 - Invest big time in 6G in AI. Invest already in 5G in AI and create a common reusable platform for 5G and 6G AI solutions.
 - Create AI solutions that utilize maximally the better AI chips accessed by the western vendors
 - Create AI enhanced 6G solutions that have superior performance compared to the non-western vendors dominating the non-western market
- *Negative impact:*
 - Skip the investments in AI technology and redirect and readjust the resources reserved for AI work.
 - Try to downplay and delay 6G as much as possible, promote 5G evolution instead
 - Start an initiative to develop 7G standards in order to skip 6G altogether

The action proposals that impact the probability of the *Shrinking 6G* scenario are:

- *Positive impact:*
 - Skip the investments in AI technology and redirect and readjust the resources reserved for AI work.
 - Start an initiative to develop 7G standards in order to skip 6G altogether
- *Negative impact:*
 - Same as those having positive impact in the 6G AI dream scenario

The action proposals that impact the probability of the *6G and AI crisis* scenario are:

- *Positive impact:*
 - Skip the investments in AI technology and redirect and readjust the resources reserved for AI work.
 - Start an initiative to develop 7G standards in order to skip 6G altogether
- *Negative impact:*
 - Same as those having positive impact in the 6G AI dream scenario

Recommended actions for the western vendors

Based on our analysis we recommend the following actions to be performed by the western vendors:

- Invest significantly in the development of the 6G ecosystem (vendors, operators, application providers, regulators, governments, ...). One global standard for 6G should be targeted, and a strong ecosystem in general ensuring that there will be strong end-to-end products requiring 6G that drive and fulfill significant market need for 6G network solutions.
- Invest big time in 6G in AI. Invest already in 5G in AI and create a common reusable platform for 5G and 6G AI solutions.

- Create AI solutions that utilize maximally the better AI chips accessed by the western vendors.
- Create AI enhanced 6G solutions that have superior performance compared to the non-western vendors dominating the non-western market.

In order to avoid the negative impact of the non-desired scenarios the western vendors should be prepared:

- The analysis should be continuously reviewed and updated. The scenarios and their likelihoods can change. The western vendors should prepare for the non-desired scenarios as well, and there should be alternative strategies in case the most desired scenarios would not materialize. This means also that there should be preparations made in advance to take the recommended actions of the undesired scenarios and roll-back the earlier prioritized actions.
- The success of the above recommended actions should be continuously monitored in order to be able to react fast if everything does not go as planned.
- The continuous risk analysis should be shared by the whole 6G ecosystem in order to ensure a healthy 6G market.
- The risk of 6G AI research should be outsourced to projects funded by public risk money.

Conclusions

In our case study we managed to produce a set of prioritized strategic actions for the western vendors that would maximize the western vendors 6G business under desired scenarios and increase tolerance against less desired scenarios. Some actions also increase the probability of the desired scenarios and decrease the probability of the less desired scenarios.

We have found the used methodology as an improvement to the typical current strategic methods used in telecommunications. Perhaps the biggest gain of the new approach is the acknowledgement of the risks related to the difficulties in predicting and committing to one solid future plan, instead of foreseeing different possible and conflicting scenarios. This is important especially in industries where risk tolerance is low, as is in our example case.

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