



5G REPUTATION IS EVERYTHING

It takes 20 years to build a reputation and five minutes to ruin it. If you think about that, you'll do things differently. - Warren Buffett

5G is in a massive hype-cycle and public media is awash with 5G announcements, commentary and opinion. As technology vendors compete for the 5G-limelight, their reputations are on the line and influence operators as they look for leaders to partner with. Vendor reputations are impacted by the complex interplay of many factors, including market endorsements and success stories, negative publicity and missteps, outbound marketing initiatives, divestitures, and even the strategic and security concerns of nation states.

5G network technology vendors, including Cisco, Ericsson, Juniper, Huawei, Nokia and ZTE were benchmarked for this report to assess their online reputations, and to baseline their 5G market positioning. The benchmarks used variety of data science and natural language processing (NLP) techniques. Content was collected from targeted web searches and collated to create a content corpus for each vendor. The content corpuses were then analyzed to assess the **Content Quality** and the **Content Sentiment**, see Exhibit 1.

Content Quality

The Content Quality measures the semantic dominance of '5G', the semantic association of the vendor name with '5G' and the rank of the online content. This is achieved by combining the results from several techniques, including:

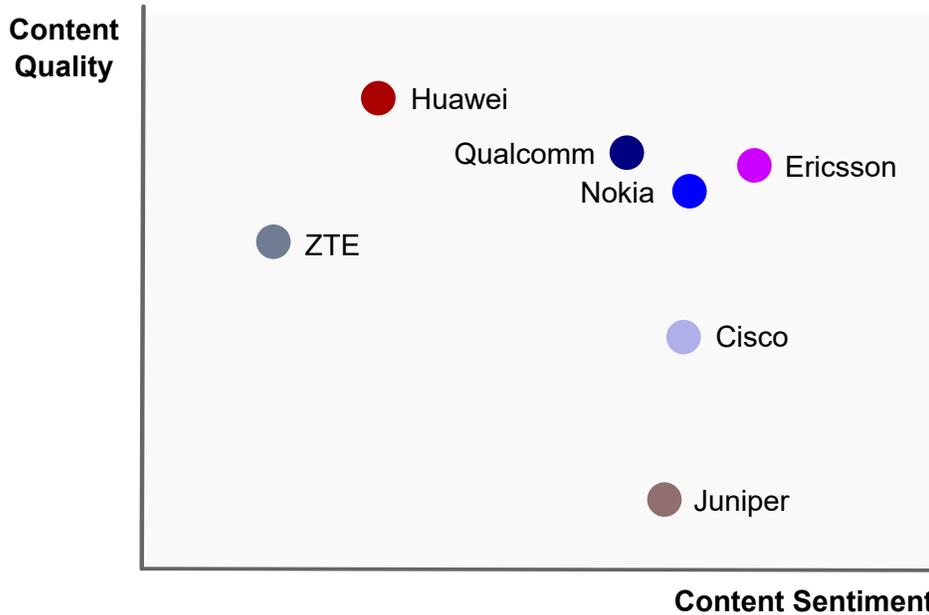
- Graph theory to measure the semantic dominance of 5G in the content. Graph theory is commonly to rank content. Keywords are represented as graph-vertices, and the graph-edges connect related words. The keyword dominance, in this case '5G', was estimated from the quantity and magnitude of connecting edges and connected words.
- Word frequency measures.
- Word embeddings and cosine difference estimates to measure the semantic association of the vendor name with 5G in the content, and;
- Alexa website rankings.

Content Sentiment

The Content Quality benchmarks described above do account for whether the content reflects positively or negatively on the vendor that is being assessed. To achieve this, additional benchmarking was conducted to estimate the sentiment of the content for each vendor. The sentiment analysis was derived from a supervised learning algorithm, which used both Naïve Bayes and State Vector Machine (SVM) capabilities, and was trained with sample data.

Exhibit 1: 5G online content sentiment and content quality ranks

Source: Tolaga Research 2019



Vendor Evaluations

Ericsson Leads the Pack

In recent years, Ericsson has recovered from financial challenges under the tutelage of Börje Ekholm, who has been Ericsson's CEO since January 2017. Ekholm has been successful in bolstering investor confidence, as reflected by Ericsson's share-price and share price-to-book-value, see Exhibit 2. Throughout this recovery period, Ericsson has maintained a pragmatic approach towards its 5G investments and thought leadership. Our research places Ericsson as a leader amongst its peers in terms of 5G online content. This content included:

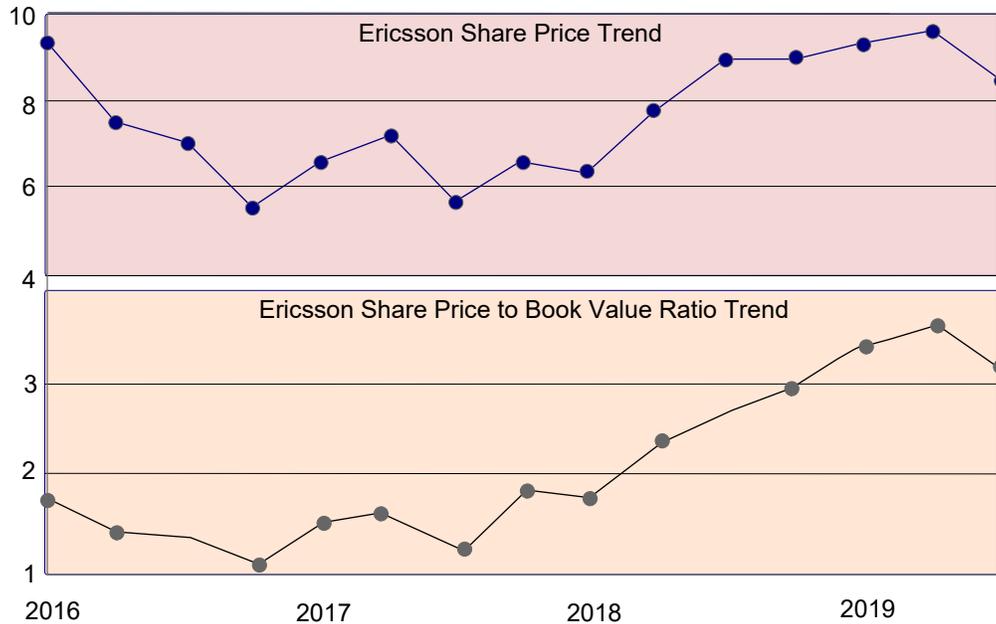
- Contract announcements for 5G network trials and deployments.
- Thought leadership, trials and early market deployments for 5G use cases in vertical industries including manufacturing and Industry 4.0, agriculture and transport.
- Collaboration with other 5G stakeholders, and;
- The acquisition of Kathrein to bolster its position in RF filter and antenna technologies.

As 5G develops, we believe that Ericsson must continue to advance its radio technology capabilities and broaden the scope of its offerings with greater market scale from its service provider customers.



Exhibit 2: Ericsson's historical share price and share-price-to-book-value

Source: Yahoo Finance and Tolaga Research 2019



Nokia maintains a robust 5G reputation

Nokia successfully navigated a restructuring process after Rajeiv Suri took over as CEO in 2014 and the acquisition and subsequent integration of Alcatel Lucent (ALU) in the 2015-2016 timeframe. The ALU acquisition gave Nokia key strategic fixed and core network assets, but we believe has slowed progress in its development of 5G radio technology. Based on the results in Exhibit 1, Nokia has a robust 5G online reputation, which reflects:

- Commercial network deployment and trial announcements.
- 5G thought leadership and studies for advanced use-cases

- Collaboration initiatives with 5G stakeholders to deliver vertical market solutions, such as for smart grids.
- 5G device innovations and announcements.
- Advanced technology initiatives in collaboration with 5G stakeholders, such as cloud native core network implementations, and;
- Announcements for advanced products, such as the Quillion chipset in the case of semiconductors.

The early arrival of 5G has placed Nokia under tremendous pressure to respond. We believe that over the next 24-36 months it is crucial that Nokia focuses on its core competences and responds to innovation challenges, particularly with continued advancements in radio technology.



Huawei surprisingly strong in the face of security headwinds

Amongst its peers, Huawei had the highest rank for 5G online Content Quality. The sentiment of this content was surprisingly positive given the security concerns expressed by several nation states, most notably the United States. In addition to these security concerns, the online content included:

- Device innovations and availability announcements.
- Infrastructure innovation efforts, including some that aim to eliminate Huawei's dependence on US subsystem providers, and;
- Operator trials and commercial network deployments

Huawei has benefited from endorsements made by a variety of high-profile operators who believe Huawei has a leadership position in 5G radio technology, and from nation states including Germany who believe that the security concerns are unjustified. Even with the security headwinds, Huawei has gained 5G contract wins internationally and will continue to benefit from large scale 5G deployments in China.

ZTE lags in quality and slips streams Huawei for sentiment

ZTE's 5G reputation is also overshadowed by security concerns expressed by some nation states. We believe that ZTE benefits from Huawei's efforts to stem negative sentiment towards Chinese network infrastructure vendors. However, we also believe that ZTE is too complacent and lacks the aggressive

approach needed to promote its 5G capabilities outside of China. This is reflected in the results shown in Exhibit 1, for both Content Quality and Content Sentiment. Online content that contributed to ZTE's reputation included:

- Security concerns and debate amongst a variety of nation states.
- Device innovations and availability announcements, and;
- Operator trials and commercial network deployments.

Although ZTE will benefit from massive 5G network deployments in China and contracts with targeted International customers, we believe that it behooves ZTE to bolster its global 5G reputation with marketing efforts that are better aligned to the industry outside of China.

Qualcomm maintains its 5G pioneer status

Qualcomm is a 5G pioneer and is a leading semiconductor technology and intellectual property provider to the industry. Qualcomm invests heavily in research and development and thought leadership, and stands to benefit from having a differentiated position in 5G technology. It has had more than its fair share of a controversy, such as its recent royalty dispute with Apple, which was settled in April 2019. The benchmarking in Exhibit 1 shows that Qualcomm has a robust 5G reputation online, which included:

- Commentary relating to its legal settlement with Apple and the implications of Intel divesting its modem business by selling it to Apple.



- Innovation and thought leadership activities for 5G devices, artificial intelligence (AI), networks and edge computing.
- Collaboration efforts with 5G stakeholders, including device and equipment vendors, services providers and vertical industry players, and;
- Vertical industry market initiatives such as in the automotive sector.

Qualcomm has successfully positioned itself in a leadership position for 5G. However, it is vulnerable to competition from other players, changing market demands and product mix for 5G, changes to mobile device market concentration, and its dependence on the premium device market segments.

Effective ingredient marketing strategies are important for Qualcomm. To achieve this Qualcomm must maintain a pioneering role in the industry, and have relevance to a broad range of 5G stakeholders, including developers, service providers and end-users.

Cisco well positioned to capitalize on 5G

Today 80 percent of 5G capital expenditures (CAPEX) are for radio network infrastructure. Since these expenditures are largely un-addressable for Cisco, we expect that Cisco's service provider businesses will be negatively impacted in the early stages of 5G. During these early stages, operators will likely prioritize radio network investments for coverage expansion efforts. In the longer term (i.e. after the 2021-2022 timeframe), Cisco is well positioned to capitalize on core, transport and edge network upgrades and expansions, and

the migration from non-standalone to standalone 5G.

Cisco's current online reputation for 5G reflects its position in the current market juncture. Cisco's online reputation is impacted by its:

- Thought leadership for end-to-end 5G architectures, and the positioning of 5G relative to WiFi, security and artificial intelligence (AI).
- Acadia acquisition announcement in July 2019 for optical transport.
- Contract announcements for core network virtualization and IP transport.
- Collaboration initiatives with other 5G stakeholders, and with use cases focused toward industrial applications, IoT and smart cities.

We believe that Cisco must continue to promote its 5G market activities, thought leadership and broad ecosystem positioning. This thought leadership must emphasize the relevance of Cisco amongst 5G stakeholders, including operators, vertical industry providers and end users.

Juniper underestimates the importance of its 5G reputation

Our broader NLP research shows that the overall online reputation of a company tends to be elevated by 5G subject matter as opposed to subject matter that focuses on next generation network technologies, like NFV, SDN, virtualization, orchestration etc. The 5G online reputation rank for Juniper is shown in Exhibit 1. We believe that Juniper ranks relatively low because it does not adequately



promote its role in 5G. Juniper's online 5G content included the following:

- Collaboration initiatives in partnership with Ericsson.
- Thought leadership relating to network operations and software, machine learning and network transformation, and;
- Commercial service provider engagements for network transformation.

A moving target

5G is capturing tremendous market attention and will continue to do so for the foreseeable future. It is not only capturing the attention of mobile operators, technology vendors and industry geeks. 5G is also capturing the imagination of consumers and enterprises as they look for opportunities to feed their digital appetites. Today 5G technology vendors are building their reputations through 5G market success stories and technical and commercial thought leadership. But as 5G develops we believe that technology vendors must continuously evolve their positioning to protect their 5G reputations. In particular,

- To appeal to mobile operators, there is still plenty of opportunities for vendors to evolve

their messaging and thought leadership with radio and core network advancements. This is particularly the case in the areas of antenna technology, core network migration from non-standalone to standalone, and private 5G etc.

- 5G case studies provide important proof-points, but must evolve from placing 5G at the center of the discussion to focus more on the overall commercial drivers and end user benefits of solutions enabled by 5G, and;
- As 5G matures, and assuming it is successful, the diversity of 5G stakeholders will proliferate. The roles of network technology vendors in the overall 5G value chains will diminish, and ingredient marketing strategies akin to the famous 'Intel Inside' initiative will come to the fore and require network technology vendors to appeal to much broader audiences beyond their network operator customers.

5G reputation is a high stakes game and network technology vendors that dismiss its importance will be severely penalized in the marketplace.

ABOUT TOLAGA RESEARCH

Tolaga Research is a leading consulting and advisory firm with a focus towards communication networks and the Fourth Industrial Revolution. Tolaga was founded in 2009 and is the world's first firm to apply artificial intelligence with natural language processing and system dynamics modeling to industry research. By combining these sophisticated capabilities with its extensive primary research, Tolaga delivers unique and actionable insights that are fortified with robust data science and system modeling solutions.

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