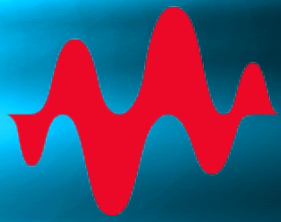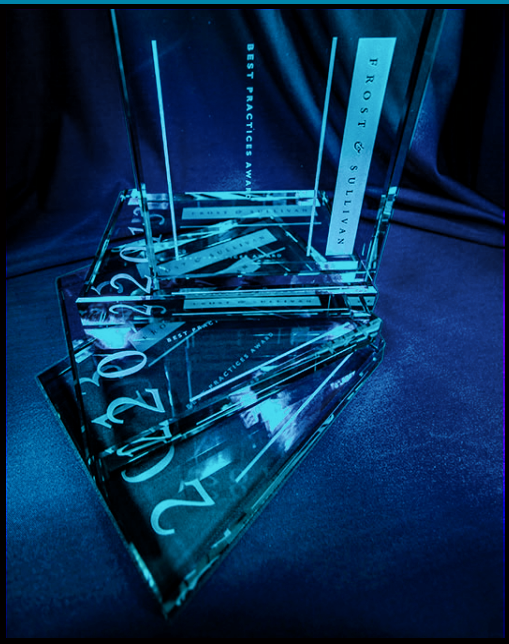FROST & SULLIVAN

KEYSIGHT
TECHNOLOGIES

2016 Global Test & Measurement for IoT Company of the Year Award

FROST & SULLIVAN

2016 BEST PRACTICES AWARD

GLOBAL TEST & MEASUREMENT FOR IoT
COMPANY OF THE YEAR AWARD

2016
BEST PRACTICES
AWARDS

Contents

Background and Company Performance

Industry Challenges

Companies at the forefront of the electronics Internet of Things (IoT) design industry have been growing steadily in a dynamically changing business environment. The electronic instrumentation market is changing at an unprecedented pace and the need for higher frequencies and resolution is much greater than before. The use of wireless technology has risen phenomenally, with an increasing number of devices having wireless technology added to them for connectivity. With billions of devices using wireless technologies expected to be connected by 2020, there is a concentrated focus on IoT.

More than 60 legacy technologies and emerging radio frequency (RF) formats for IoT applications are used today. ZigBee and Thread are emerging technologies whereas Bluetooth and cellular have been used extensively for some time. Wi-Fi and cellular are widely used for several IoT applications. In the current market dynamics, companies must be able to keep up with evolving technologies to carry out more precise and realistic testing. The continuous emergence and proliferation of wireless technology standards require new test instrument capabilities. Moreover, with enhancements being made to long term evolution (LTE) and LTE-Advanced (LTE-A) systems and the upcoming 5G standard, the need for testing is on the rise with a new technological framework needed to support the increasing number of wireless systems. Networks will present new design challenges for IoT devices. This will require sophisticated test equipment that is highly modular and flexible, and can evolve with changing requirements. Time-to-market and development time for IoT devices will increase with more configurations to be tested. More effective automated test solutions that also minimize the cost of test will be required.

Potential delays in IoT design and product development can also occur due to incorrect module (Bluetooth, ZigBee, etc.) selection. A comprehensive test solution supporting wireless technology, data throughput, latency, power consumption, robustness, and regulatory standards compliance is needed.

Supporting complex IoT systems and embedded functionality can be time-consuming and costly without an appropriate test plan for mixed-signal devices. Design teams face challenges in identifying the root cause of problems, whether with their module or with their integrated devices. There is a need for an all-inclusive design and test solution that help resolve complex digital, analog, and radio frequency (RF) system issues.

Power management, energy consumption, battery life, and processing power for IoT

devices are other key challenges faced by design and test engineers. Designers need to optimize their designs for IoT with power-efficient designs. Actions must be taken to ensure a constant voltage for device operating modes, guarantee acceptable measurement bandwidth for the sample rates, evaluate power consumption using intricate waveforms, conduct systematic energy analysis, and separate device design matters from power source problems.

Finally, with rapidly evolving technology, test instruments need to be continually modified and maintained to meet ever-changing functionality and system-maintenance requirements with the integration of subsystems and verification of performance. Test systems used for IoT devices need to be adaptive and scalable through software while creating custom and standard-compliant test signals.

Overall, customers are looking to new testing scenarios with higher modularity and software-defined radio (SDR) solutions covering all of the main wireless technologies and all of the stages (R&D, validation, manufacturing, and deployment) of an IoT device. Industry participants need to work to overcome these technical challenges to revolutionize the test and measurement space, thereby supporting the evolving needs in the IoT industry.

Visionary Innovation and Performance and Customer Impact

Addressing Unmet Needs

Keysight Technologies (Keysight) has sustained its market growth by providing superior support for the entire IoT product lifecycle based on a common understanding of the measurements required. The company has developed its solution portfolio based on its distinctive test equipment. Unlike many of its competitors, the company is strongly focused on offering a comprehensive solution and designing path-breaking technologies to support hardware design and modular and automated calibration procedures.

To address key unmet customer requirements in the current global test and measurement (T&M) industry for IoT, Keysight offers the broadest test equipment product portfolio available (benchtop and standalone instrumentation, modular, wireless test sets, and handheld test equipment that support the evolving wireless formats used in IoT devices across all the different stages of these products' lifecycles).

With its profound technological expertise, Keysight leverages its test equipment technology for IoT devices and is able to provide an all-inclusive test solution while focusing on a holistic hybrid approach with a combination of instruments spanning different form factors.

Keysight has made significant inroads this year into the IoT industry. The company has

released its EXM and UXM wireless test set to enhance cellular devices for IoT. These one-box testers are optimal to support RF measurements ranging from 300 MHz to 6 GHz with multi-layer protocol logging which brings insights to increase the battery life of IoT devices. The company also offers 4 modular signal analyzers (M9393A, M9392A, M9391A, and N7109A) with a frequency range of 9 kHz to 27 GHz and 250 MHz of analysis bandwidth. Keysight's analyzers use superheterodyne technology, analog-to-digital converters (ADC), and digital signal processing (DSP) technologies developed in-house to achieve high-resolution spectrum measurements.

Keysight's standalone bench instruments for IoT include the MXA signal analyzers and MXG signal generators, which offer a wide range of test capabilities supporting wireless local area network (WLAN) and ZigBee. Keysight's PXA series of signal analyzers offers 160 MHz of modulation bandwidth up to a frequency of 50 GHz and is in a leading position to address evolving testing needs for digital modulation analysis.

For field applications, Keysight offers FieldFox, a portable and lightweight handheld analyzer. FieldFox is an integrated all-in-one handheld analyzer and replaces 4 separate single function instruments. It is the first 50-GHz handheld all-in-one instrument. Highly portable, it can be configured as an antenna analyzer, vector voltmeter, power meter, cable analyzer, interference analyzer, spectrum analyzer, and vector network analyzer. This kind of hybrid-instrument model provides customers cost and flexibility benefits that significantly simplify test tasks.

Implementation of Best Practices

Striving to take the T&M technology to the next level for IoT, Keysight has been focusing on bringing to the market the broadest product portfolio in the industry to accelerate an IoT product's evolution from R&D, design validation, compliance, production floor, and deployment. Keysight seeks to consolidate its leading position in the T&M industry by combining T&M capabilities with the broadest format coverage to ensure IoT device product performance and quality over time.

Overall, Keysight solutions are designed to provide the right combination of software and measurement expertise to achieve greater insights during IoT product research, manufacturing, and deployment and cover the unmet needs of the IoT industry.

Keysight has introduced and made significant inroads in to the design of simulation software. Signal Studio software, Advanced Design System (ADS) software, and 89600 vector signal analysis (VSA) software have been enhanced with capabilities for the waveform playback approach to customize test signals for test components and receivers. Configuration is easier for test parameters with representation of RF subsystems. Digital modulation tool is used for troubleshooting wireless setups. All these software tools enable IoT device designers to effectively discover every side of a signal and improve their most advanced IoT designs. All these software tool options

can create customized and standard test signals.

For RF design verification stages, Keysight has brought into the market its M9420A VXT PXIe Vector Transceiver with a modular form factor. This allows users to refine designs and deliver the test speed and flexibility suitable for custom solutions that integrate the capability of a full test rack into a sole PXI framework.

The company has introduced the Keysight IoT Automation Test Solution, which is an effective technology for the manufacturing stages in the IoT lifecycle. It is widely accepted in the industry and offers intelligent automation test solution for high volumes of production, high test speed, and IoT coverage. It uses automated software and the EXM product platform to support legacy wireless technologies, LTE-A, and the widest accepted connectivity standards. The solution also eases the burden of calibration on end users. This unique proposition distinguishes the company from other leading participants in the industry and enables users to perform calibration of one or more IoT devices concurrently using 1 to 4 TRX modules in the E6640A EXM wireless test set and support the highest throughput in high volumes of production. Moreover, with the introduction of the IoT automation test solution software, users can shorten the test plan and parameter setup. This software provides users with a pre-defined test plan reducing testing intricacy. With the introduction of Keysight's IoT automation test solution, users can adapt to support new measurement challenges.

Price/Performance Value

Keysight's product offering exhibits striking differentiation adapted to the budget necessities of each organization without compromising on quality. The product portfolio of instruments for budget-conscious organizations offered by Keysight's solutions provides customers with a significant value addition. Keysight's comprehensive package that includes 33522B dual-channel waveform generator and N9310A RF signal generator, the N9000A CXA, and the N9320B/N9322C spectrum analyzer addresses the main frequency field measurement requirements for consumer electronics, R&D, and spectrum monitoring. All these options are suitable for low-cost response measurements at affordable prices for small to medium size companies.

Offering a variety of suitable options, from product development and verification to manufacturing for a wide range of budgets across many organizations provides Keysight a price performance advantage. IoT test equipment can become expensive if users require additional equipment for each new standard. Keysight is bringing into the IoT market a cost-effective packet of test solutions that can test all the required standards and provide the technical capability required to support new standards.

Customer Purchase Experience

Keysight has ensured a best-in-class customer purchase experience for its test equipment to provide the right combination of hardware, software, and measurement expertise for IoT products and support new measurement challenges. The company has a burgeoning customer base as a result of its commitment to lowering total cost of ownership and ensuring measurement continuity across benchtop, modular instruments, and wireless test sets. Keysight is the only company that provides up to 3 years of a standard warranty for all its IoT test equipment. The company also offers a 1-year warranty on a wide range of accessories and custom products. Moreover, the largest assurance plan protection option available in the industry (up to 10 years) enables the company to occupy a leading position in the T&M market.

Brand Equity

According to Frost & Sullivan's benchmarking analysis, Keysight's success in the T&M market for IoT applications is largely driven by the effective implementation of its end-user-centric strategies. Frost & Sullivan research indicates that Keysight remains the absolute market share leader in the T&M market for IoT, holding almost 40% market share.

According to Frost & Sullivan's analysis, the strong brand loyalty enjoyed by Keysight is derived from its know-how and capability to offer the broadest product portfolio available in the market supporting the evolving wireless formats used in IoT devices and across stages of the product lifecycle. The company's commitment to covering areas of RF design validation, manufacturing, automated calibration procedures, design, and simulation software helps companies tackle the hardest design and test subjects. A thorough understanding of the needs of IoT designers and manufacturers further increases the company's brand equity.

Conclusion

There is a need to provide a fully integrated test system that includes full test coverage supporting the evolving needs in the IoT industry. Keysight Technologies has ensured a best-in-class customer purchase experience for its test equipment to provide the right combination of hardware design and modular and automated calibration procedures, and to support new measurement challenges. Keysight Technologies has consolidated its market leadership by combining T&M capabilities with the broadest format coverage across the entire product life cycle of IoT devices to ensure product performance and quality over time.

With its strong overall performance, Keysight Technologies has earned Frost & Sullivan's 2016 Company of the Year Award for its contributions to the T&M market for IoT.

Significance of Company of the Year

To win the Company of the Year award (i.e., to be recognized as a leader not only in your industry, but among your non-industry peers as well) requires a company to demonstrate excellence in growth, innovation, and leadership. This kind of excellence typically translates into superior performance in three key areas: demand generation, brand development, and competitive positioning. These areas serve as the foundation of a company's future success and prepare it to deliver on the two criteria that define the Company of the Year Award (Visionary Innovation & Performance and Customer Impact).

- Acquire competitors' customers
- Increase renewal rates
- Increase upsell rates
- Build a reputation for value
- Increase market penetration

- Earn customer loyalty
- Foster strong corporate identity
- Improve brand recall
- Inspire customers
- Build a reputation for creativity

DEMAND

BRAND

Company of the Year

COMPETITIVE POSITIONING

- Stake out a unique market position
- Promise superior value to customers
- Implement strategy successfully
- Deliver on the promised value proposition
- Balance price and value

Understanding Company of the Year

As discussed above, driving demand, brand strength, and competitive differentiation all play a critical role in delivering unique value to customers. This three-fold focus, however, must ideally be complemented by an equally rigorous focus on visionary innovation to enhance customer value and impact.

Key Benchmarking Criteria

For the Company of the Year Award, Frost & Sullivan analysts independently evaluated two key factors—Visionary Innovation & Performance and Customer Impact—according to the criteria identified below.

Visionary Innovation & Performance

　　　Criterion 1: Addressing Unmet Needs
　　　Criterion 2: Visionary Scenarios Through Mega Trends
　　　Criterion 3: Implementation Best Practices
　　　Criterion 4: Blue Ocean Strategy
　　　Criterion 5: Financial Performance

Customer Impact

　　　Criterion 1: Price/Performance Value
　　　Criterion 2: Customer Purchase Experience
　　　Criterion 3: Customer Ownership Experience
　　　Criterion 4: Customer Service Experience
　　　Criterion 5: Brand Equity

Best Practice Award Analysis for Keysight Technologies
Decision Support Scorecard

To support its evaluation of best practices across multiple business performance categories, Frost & Sullivan employs a customized Decision Support Scorecard. This tool allows our research and consulting teams to objectively analyze performance, according to the key benchmarking criteria listed in the previous section, and to assign ratings on that basis. The tool follows a 10-point scale that allows for nuances in performance evaluation; ratings guidelines are illustrated below.

RATINGS GUIDELINES

9–10 Excellent

7–8 Good

4–6 Fair

1–3 Poor
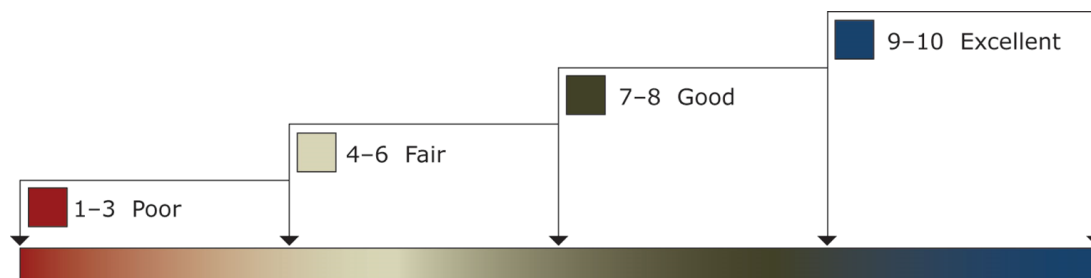
The Decision Support Scorecard is organized by Visionary Innovation & Performance and Customer Impact (i.e., the overarching categories for all 10 benchmarking criteria; the definitions for each criteria are provided beneath the scorecard).　The research team confirms the veracity of this weighted scorecard through sensitivity analysis, which confirms that small changes to the ratings for a specific criterion do not lead to a significant change in the overall relative rankings of the companies.

The results of this analysis are shown below. To remain unbiased and to protect the interests of all organizations reviewed, we have chosen to refer to the other key players as Competitor 2 and Competitor 3.

Measurement of 1–10 (1 = poor; 10 = excellent)			
Company of the Year	Visionary Innovation & Performance	Customer Impact	**Average Rating**
Keysight Technologies	9.0	8.6	8.8
Competitor 2	8.5	8.0	8.3
Competitor 3	8.0	7.3	7.6

Visionary Innovation & Performance

Criterion 1: Addressing Unmet Needs
Requirement: Implementing a robust process to continuously unearth customers' unmet or under-served needs, and creating the products or solutions to address them effectively

Criterion 2: Visionary Scenarios Through Mega Trends
Requirement: Incorporating long-range, macro-level scenarios into the innovation strategy, thereby enabling "first to market" growth opportunities solutions

Criterion 4: Implementation of Best Practices
Requirement: Best-in-class strategy implementation characterized by processes, tools, or activities that generate a consistent and repeatable level of success.

Criterion 3: Blue Ocean Strategy
Requirement: Strategic focus in creating a leadership position in a potentially "uncontested" market space, manifested by stiff barriers to entry for competitors

Criterion 5: Financial Performance
Requirement: Strong overall business performance in terms of revenues, revenue growth, operating margin and other key financial metrics

Customer Impact

Criterion 1: Price/Performance Value
Requirement: Products or services offer the best value for the price, compared to similar offerings in the market

Criterion 2: Customer Purchase Experience
Requirement: Customers feel like they are buying the most optimal solution that addresses both their unique needs and their unique constraints

Criterion 3: Customer Ownership Experience
Requirement: Customers are proud to own the company's product or service, and have

a positive experience throughout the life of the product or service

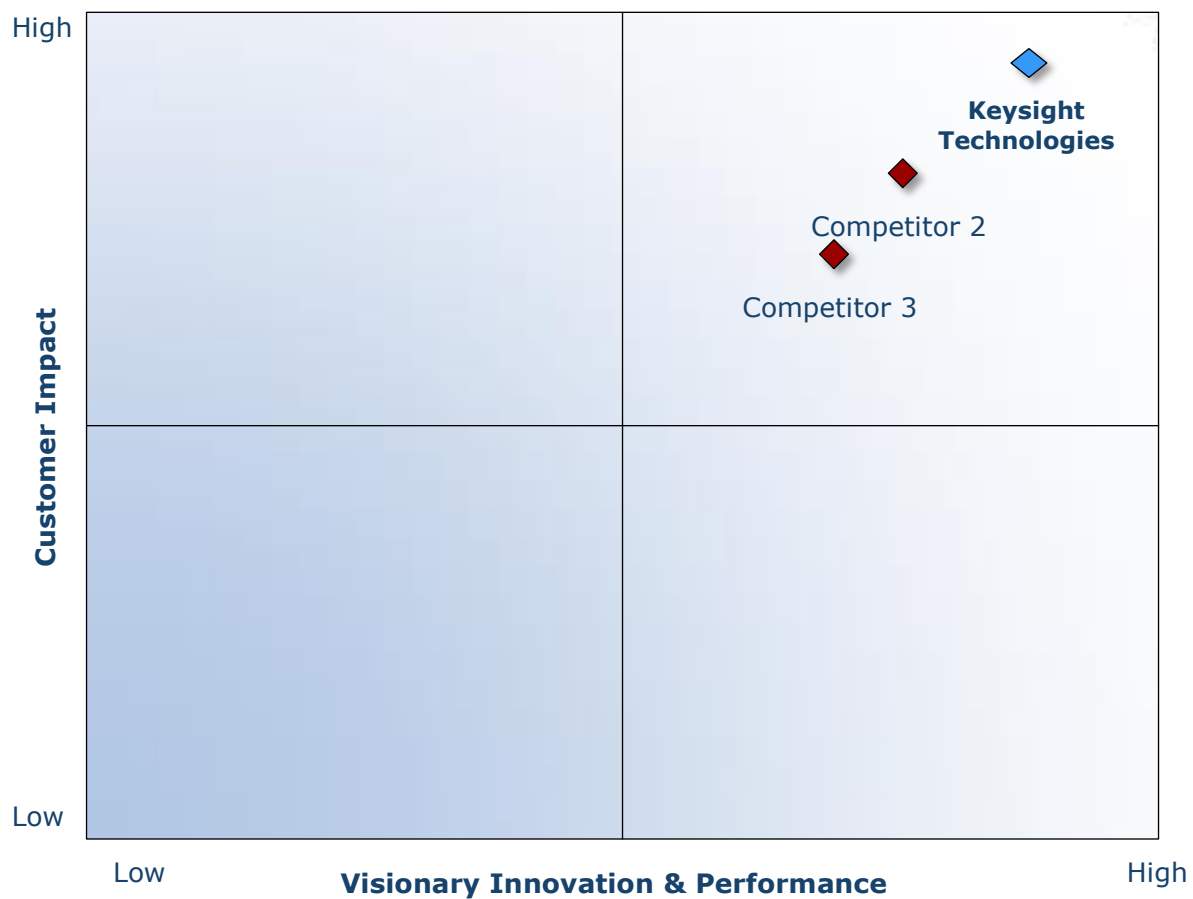### Criterion 4: Customer Service Experience
Requirement: Customer service is accessible, fast, stress-free, and of high quality

Criterion 5: Brand Equity
Requirement: Customers have a positive view of the brand and exhibit high brand loyalty

Decision Support Matrix

Once all companies have been evaluated according to the Decision Support Scorecard, analysts can then position the candidates on the matrix shown below, enabling them to visualize which companies are truly breakthrough and which ones are not yet operating at best-in-class levels.

Keysight Technologies

Competitor 2

Competitor 3

Customer Impact

Low   High

Visionary Innovation & Performance

High

Low

The Intersection between 360-Degree Research and Best Practices Awards

Research Methodology

Frost & Sullivan's 360-degree research methodology represents the analytical rigor of our research process. It offers a 360-degree-view of industry challenges, trends, and issues by integrating all 7 of Frost & Sullivan's research methodologies. Too often, companies make important growth decisions based on a narrow understanding of their environment, leading to errors of both omission and commission. Successful growth strategies are founded on a thorough understanding of market, technical, economic, financial, customer, best practices, and demographic analyses. The integration of these research disciplines into the 360-degree research methodology provides an evaluation platform for benchmarking industry players and for identifying those performing at best-in-class levels.

360-DEGREE RESEARCH: SEEING ORDER IN THE CHAOS

Best Practices Recognition: 10 Steps to Researching, Identifying, and Recognizing Best Practices

Frost & Sullivan Awards follow a 10-step process to evaluate award candidates and assess their fit with select best practice criteria. The reputation and integrity of the Awards are based on close adherence to this process.

STEP	OBJECTIVE	KEY ACTIVITIES	OUTPUT
1 **Monitor, target, and screen**	Identify award recipient candidates from around the globe	• Conduct in-depth industry research • Identify emerging sectors • Scan multiple geographies	Pipeline of candidates who potentially meet all best-practice criteria
2 **Perform 360-degree research**	Perform comprehensive, 360-degree research on all candidates in the pipeline	• Interview thought leaders and industry practitioners • Assess candidates' fit with best-practice criteria • Rank all candidates	Matrix positioning all candidates' performance relative to one another
3 **Invite thought leadership in best practices**	Perform in-depth examination of all candidates	• Confirm best-practice criteria • Examine eligibility of all candidates • Identify any information gaps	Detailed profiles of all ranked candidates
4 **Initiate research director review**	Conduct an unbiased evaluation of all candidate profiles	• Brainstorm ranking options • Invite multiple perspectives on candidates' performance • Update candidate profiles	Final prioritization of all eligible candidates and companion best-practice positioning paper
5 **Assemble panel of industry experts**	Present findings to an expert panel of industry thought leaders	• Share findings • Strengthen cases for candidate eligibility • Prioritize candidates	Refined list of prioritized award candidates
6 **Conduct global industry review**	Build consensus on award candidates' eligibility	• Hold global team meeting to review all candidates • Pressure-test fit with criteria • Confirm inclusion of all eligible candidates	Final list of eligible award candidates, representing success stories worldwide
7 **Perform quality check**	Develop official award consideration materials	• Perform final performance benchmarking activities • Write nominations • Perform quality review	High-quality, accurate, and creative presentation of nominees' successes
8 **Reconnect with panel of industry experts**	Finalize the selection of the best-practice award recipient	• Review analysis with panel • Build consensus • Select winner	Decision on which company performs best against all best-practice criteria
9 **Communicate recognition**	Inform award recipient of award recognition	• Present award to the CEO • Inspire the organization for continued success • Celebrate the recipient's performance	Announcement of award and plan for how recipient can use the award to enhance the brand
10 **Take strategic action**	Upon licensing, company may share award news with stakeholders and customers	• Coordinate media outreach • Design a marketing plan • Assess award's role in future strategic planning	Widespread awareness of recipient's award status among investors, media personnel, and employees

"We Accelerate Growth"

About Frost & Sullivan

Frost & Sullivan, the Growth Partnership Company, enables clients to accelerate growth and achieve best in class positions in growth, innovation and leadership. The company's Growth Partnership Service provides the CEO and the CEO's Growth Team with disciplined research and best practice models to drive the generation, evaluation and implementation of powerful growth strategies. Frost & Sullivan leverages over 50 years of experience in partnering with Global 1000 companies, emerging businesses and the investment community from 45 offices on six continents. To join our Growth Partnership, please visit http://www.frost.com.