FROST & SULLIVAN

INTRINSIC ID™

2017 North American Device Level Digital Authentication Technology for Technology Leadership Award

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Industry Challenges

The massive explosion of Internet of Things (IoT) devices is only accelerating, and Frost & Sullivan has determined that more than 20 billion intelligent devices will be connected globally by 2020, across a range of industries. Safe and secure management of information and device authentication, therefore, is critical, as the impact of cyber-attacks on IoT devices can be devastating. For instance, the Mirai cyber-attack that temporarily brought down Twitter, Netflix, Reddit, and CNN in Europe and the United States in October 2016 was launched using a number of IoT devices. However, integrating affordable and appropriate security measures (i.e. authentication and security key provisioning) for billions of IoT devices poses a major challenge due to the high cost and lack of flexibility and scalability of existing security key injection methods. Part of the challenge stems from the fact that IoT devices have very limited system resources, such as memory, making it difficult to have any kind of security solution running on the device itself, so these devices typically are not equipped with native authentication capabilities.

Consequently, IoT semiconductor, device, and system manufacturers need a new key provisioning method that can scale with the surging volume of IoT devices to secure their products and deliver trustworthy solutions. Under such circumstances, digital security companies that can provide device-level digital authentication technology for IoT devices and address the aforementioned challenges are expected to secure leadership positions in IoT security.

Technology Leverage and Business Impact

Commitment to Innovation

Strongly committed to protecting digital assets and intellectual property through embedded authentication solutions, Intrinsic ID provides security via the creation of unique, unclonable device identities. What largely differentiates Intrinsic ID from its competitors is its use of static random-access memory (SRAM) physical unclonable function (PUF) technology. SRAM PUF technology securely and reliably leverages the inherent manufacturing variations in silicon chips – deep submicron random variations in semiconductors such as microprocessors that are an inherent part of the semiconductor manufacturing process and make each transistor and each piece of silicon unique, comparable to a human fingerprint. This approach makes it impossible to create an exact clone of a piece of silicon. Intrinsic ID's technology uses such silicon fingerprints to generate unique IDs and cryptographic keys. The uniqueness about the key from a manufacturing point of view is that no special equipment is needed to burn it and no third party is needed to inject it.

This technology can create a unique key, from any piece of silicon that has SRAM, which will then spin from there to the rest of the security foundation. This process not only

authenticates and protects chips, data, devices, and systems, but also whatever they are connected to, whether other components or the cloud. Essentially, this SRAM PUF technology provides a way to begin a hardware-based foundation for security starting from the very lowest end devices and building all the way up to the cloud.

Frost & Sullivan analysis indicates that Intrinsic ID's technology provides a unique and one of the highest levels of security and protection available. This is because with traditional key injection methods security keys remain stored in the system (in non-volatile memory), thereby making it easy to steal, share, or duplicate. By contrast, Intrinsic ID's SRAM PUF technology is strikingly different as the security keys are not permanently stored and are present only when the device is active. This means the security keys are generated only when required and not when the device is inactive, making it impossible to guess, steal, or share the ID or key.

The SRAM PUF technology generates a security key and ID in a way that not only provides customers security advantages (compared to traditional key storage) but more importantly cost advantages. This is because the unique IDs and security keys can be extracted easily just by using the inherent characteristics of a semiconductor without having to add any hardware, thereby avoiding additional costs, which makes adding authentication and key provisioning using the SRAM PUF technology much less expensive than current methods. To be sure, the security advantages complemented by the low cost of implementation are expected to benefit the fast-growing needs of the IoT market. Intrinsic ID is one of the largest and most successful companies to have deployed PUF technology commercially, and has essentially full coverage of the microcontroller unit (MCU) universe.

Frost & Sullivan applauds Intrinsic ID for demonstrating powerful technology leadership based on SRAM PUF technology that leverages only the entropy of the manufacturing process and yet provides device-unique IoT authentication and key provisioning in the most secure, seamless, and cost-effective manner.

Commitment to Creativity

Intrinsic ID has successfully leveraged and integrated its SRAM PUF technology to enable and enhance a range of products. These products that are delivered as hardware IP or as software help customers with key storage, authentication, and key provisioning. The products are: QUIDDIKEY (secure key management solution- hardware IP family), BROADKEY (secure key management software- software IP family), FUZZY ID (silicon fingerprint device identification), SPARTAN (digital authentication software for authenticating IoT devices), QUIDDICARD (key management and anti-counterfeiting software), and CITADEL (key provisioning system for IoT security). Key storage solutions help to create, wrap, and manage keys; authentication solutions ensure reliable authenticity of the IoT devices; and key provisioning solutions generate and distribute cryptographic keys for IoT devices. Flexible HW or SW implementations, along with

symmetric and asymmetric encryption algorithms, make the aforementioned products not only lower in total cost of ownership but also scalable with IoT devices.

While the traditional methods for authentication and key provisioning not only lack security and are expensive (due to the requirement for additional authentication chips and high cost of key delivery methods), they also do not scale with the growing number of IoT devices. CITADEL, QUIDDICARD, and SPARTAN, on the contrary, can keep pace with the growing demand for authentication, device personalization, and the generation, distribution, and protection of cryptographic keys for IoT applications.

Application Diversity

The comprehensive SRAM PUF technology is scalable across a range of industries—from Industrial IoT (IIoT) to financial transactions to government and defense. By virtue of its superior functionalities, Intrinsic ID's technology solution is deployable not only in low-power IoT devices but also in high-end defense-grade and datacenter components (i.e., It can run on an array of microprocessors and microcontrollers.). The technology has been deployed in products that have passed certification by Common Criteria Evaluation Assurance Level (EAL6+), EMVCo, and Visa, to name a few; therefore, Intrinsic ID's expertise in accurately analyzing customer needs and fabricating solutions that cater to industry requirements has been instrumental in deploying the SRAM PUF technology solutions worldwide to not only authenticate IoT devices but also to validate payment systems; secure connectivity; and protect financial transactions, user privacy, and sensitive government and military secret data and systems. Some of the leading companies in mobile devices, government and defense, smart cards, and consumer electronics that have deployed SRAM PUF inside their devices to ensure security are Renesas (running on its Synergy platform RX231 Microcontrollers), Synopsys (Designware ARC EM Ultra low-power processor cores), NXP (SmartMX2), Samsung (Galaxy S6, Note 4 smartphones), Microsemi (Smartfusion 2, IGLOO2 platform for defense grade FPGA/SoC), and Intel (Altera Stratix 10 high-performance FPGA/SoC).

Growth Potential

Frost & Sullivan finds Intrinsic ID's low-cost yet powerful, innovative SRAM PUF security technology to be highly promising and here for the long haul. Growing vulnerability of IoT device manufacturers to new threats is leading to widespread adoption of the technology in commercial products ranging from tiny microcontrollers to high-performance FPGAs that enable affordable and effective security systems. Moreover, several macroeconomic indicators such as the growing number of IoT devices, increasing attacks that will involve IoT devices, and expanding security budgets devoted to IoT security are expected to accelerate Intrinsic ID's growth potential.

With regard to growth expansion, Intrinsic ID benefits from close working relationships with partners, especially with chip manufacturers, system vendors, cloud services vendors, and semiconductor companies, which enable broad deployment of its technology.

The company has built an extensive ecosystem of partners across the globe and fosters a number of relationships with integration partners. In addition, the company has forged strong ties with some of the most prominent chipset manufacturers in the industry such as Dialog Semiconductor, Inside Secure, Intel PSG, InvenSense, Mentor Graphics, Microsemi, NXP, Panasonic, Renesas, Samsung, SecureThingz, STMicroelectronics, and Synopsys, to name a few. From Frost & Sullivan's view, overall macroeconomic trends, support from investors such as Prime Ventures and Robert Bosch Venture Capital, and a strong partnership network will boost Intrinsic ID's growth potential.

Human Capital

Intrinsic ID is a 2008 spin-off of Royal Philips Electronics. One of the primary factors that contributed to the development of Intrinsic ID's SRAM PUF technology is the company's highly efficient leadership team. Its founders (CEO Pim Tuyls and CTO Geert-Jan Schrijen) have extensive experience working in the field of SRAM PUFs, digital rights management, low-power authentication protocols, and private biometrics. Its CEO is renowned for his work in the field of SRAM PUFs and security for embedded applications; he holds a Ph.D. in mathematical physics and over 50 patents.

Moreover, the company has a dedicated Technology Advisory Board that consists of PhDs in computer science and applied science as well as research professors who work toward improving SRAM PUF technology. Focusing primarily on innovation, Intrinsic ID, with its R&D office in Eindhoven (The Netherlands), has the only scalable and robust SRAM PUF technology available on the market, along with a significant patent portfolio. With such dedicated focus on advancing innovation in the field of SRAM PUF by building a strong team of engineers, growing its patents, and establishing a culture of innovation and creativity, Intrinsic ID has established a leading position for itself in the market.

Conclusion

Securing billions of IoT devices against the growing number of threats, appropriately and affordably, required a new authentication and key provisioning method that can scale. Intrinsic ID's technology for delivering IoT security via unique, unclonable device identities derived using SRAM PUF technology, successfully addresses this major industry need. The company has secured a competitive edge by delivering a strong, device-unique data security and digital authentication solution for the connected world. It provides a way to deploy its technology pervasively across numerous chipsets in a much better and more scalable way compared to traditional methods in use today. Leveraging only the natural entropy of the semiconductor manufacturing process and with no key material programmed or third party involved to inject keys, Intrinsic ID eliminates the high cost, inflexibility, and lack of scalability that hinder legacy key injection models. With its strong overall performance, Intrinsic ID has earned Frost & Sullivan's 2017 Technology Leadership Award.

Significance of Technology Leadership

Technology-rich companies with strong commercialization strategies benefit from the increased demand for high-quality, technologically-innovative products. Those products help shape the brand, leading to a strong, differentiated market position.

Understanding Technology Leadership

Technology Leadership recognizes companies that lead the development and successful introduction of high-tech solutions to customers' most pressing needs, altering the industry or business landscape in the process. These companies shape the future of technology and its uses. Ultimately, success is measured by the degree to which a technology is leveraged and the impact that technology has on growing the business.

Key Benchmarking Criteria

For the Technology Leadership Award, Frost & Sullivan analysts independently evaluated two key factors—Technology Leverage and Business Impact—according to the criteria identified below.

Technology Leverage

Criterion 1: Commitment to Innovation
Criterion 2: Commitment to Creativity
Criterion 3: Technology Incubation
Criterion 4: Commercialization Success
Criterion 5: Application Diversity

Business Impact

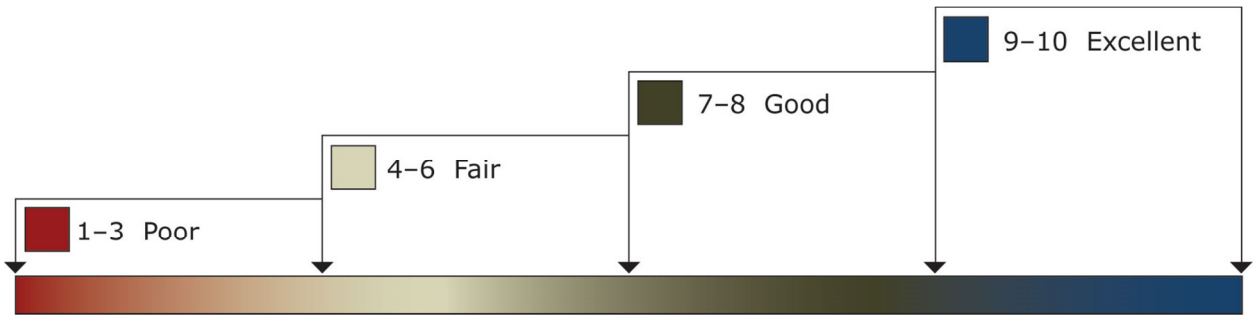
Criterion 1: Financial Performance
Criterion 2: Customer Acquisition
Criterion 3: Operational Efficiency
Criterion 4: Growth Potential
Criterion 5: Human Capital

Best Practices Award Analysis for Intrinsic ID

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



The Decision Support Scorecard is organized by Technology Leverage and Business Impact (i.e., These are the overarching categories for all 10 benchmarking criteria; the definitions for each criterion 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 participants as Competitor 2 and Competitor 3.

Measurement of 1–10 (1 = poor; 10 = excellent)			
Technology Leadership	Technology Leverage	Business Impact	**Average Rating**
Intrinsic ID	**9.0**	**9.0**	**9.0**
Competitor 2	8.0	8.0	8.0
Competitor 3	7.0	7.0	7.0

Technology Leverage

Criterion 1: Commitment to Innovation

Requirement: Conscious, ongoing development of an organization's culture that supports the pursuit of groundbreaking ideas through the leverage of technology

Criterion 2: Commitment to Creativity

Requirement: Employees rewarded for pushing the limits of form and function, by integrating the latest technologies to enhance products

Criterion 3: Technology Incubation

Requirement: A structured process with adequate investment to incubate new technologies developed internally or through strategic partnerships

Criterion 4: Commercialization Success

Requirement: A proven track record of successfully commercializing new technologies, by enabling new products and/or through licensing strategies

Criterion 5: Application Diversity

Requirement: The development of technologies that serve multiple products, multiple applications, and multiple user environments

Business Impact

Criterion 1: Financial Performance

Requirement: Overall financial performance is strong in terms of revenues, revenue growth, operating margin, and other key financial metrics.

Criterion 2: Customer Acquisition

Requirement: Overall technology strength enables acquisition of new customers, even as it enhances retention of current customers.

Criterion 3: Operational Efficiency

Requirement: Staff is able to perform assigned tasks productively, quickly, and to a high-quality standard.

Criterion 4: Growth Potential

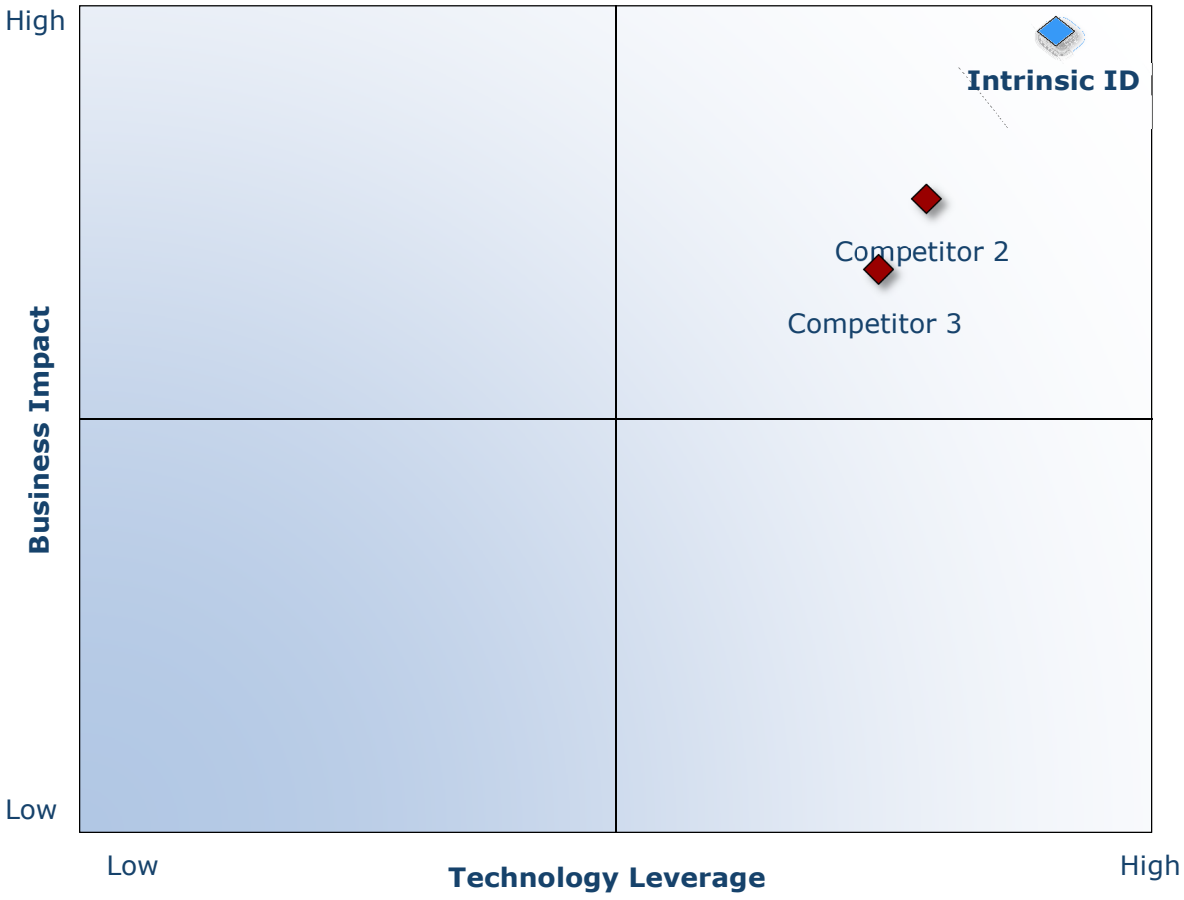
Requirements: Technology focus strengthens brand, reinforces customer loyalty, and enhances growth potential.

Criterion 5: Human Capital

Requirement: Company culture is characterized by a strong commitment to customer impact through technology leverage, which in turn enhances employee morale and retention,

Decision Support Matrix

Once all companies have been evaluated according to the Decision Support Scorecard, analysts 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.



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 of 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 recipient	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 is able to 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

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

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 more than 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.