The Skills Gap in Wireless Infrastructure Training and Education

A Strategy for Improvement

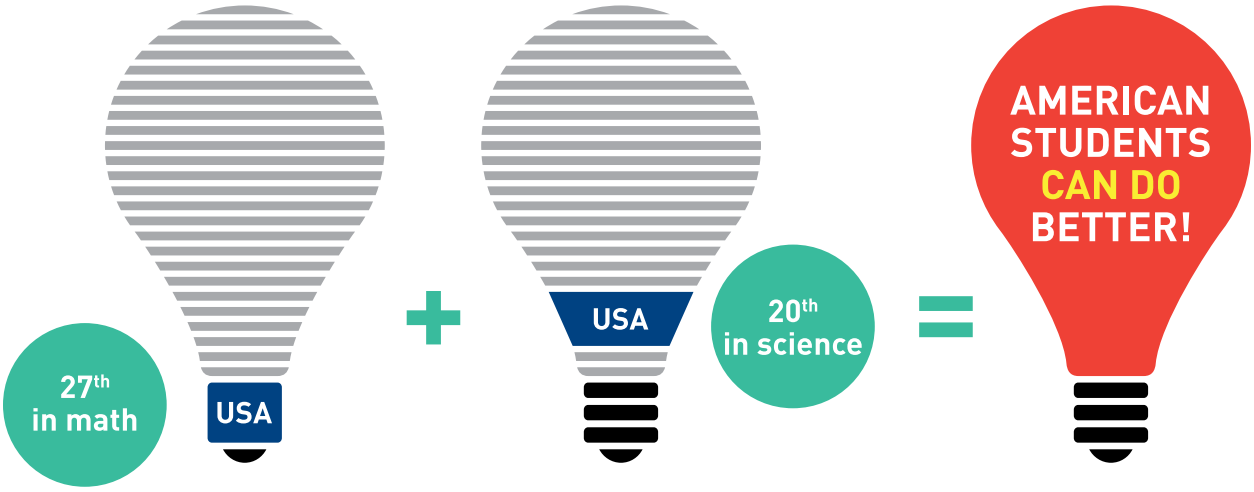
Content

Abstract

The demand for wireless infrastructure continues to outpace the industry's existing labor force of trained technology professionals, engineers and field technicians. This skills gap poses serious threats to the nation's ability to expand wireless broadband coverage in urban, suburban and rural markets. Government and industry therefore must develop training and educational programs to draw workers to the industry, and to provide the advanced skills the industry needs as wireless demand grows to improve the safety and quality of deployments.

We face a shortage of workers and students proficient in math and science.

Compared to their global peers, U.S. students recently finished ...



Source: National Math + Science Initiative

Introduction

Millennials in the United States are on track to be the most-educated generation, according to a recent report by the Educational Testing Service (ETS), a nonprofit organization dedicated to quality education.[1] Alarmingly, ETS notes that these young people are still behind the curve when compared with their peers overseas in the disciplines of science, technology, engineering and math (STEM). STEM classes are integral to the deployment of wireless infrastructure technology, which relies heavily on math, science and engineering skills. The industry also would benefit from a more diverse workforce that includes more women and minorities. Women only account for about 14 percent of all engineers, according to the Congressional Joint Economic Committee.[2] Indeed, the White House is leading a public-private sector push to get children as young as 3- or 4-years-old interested in science, technology, engineering and math, including children from low-income families and communities underrepresented in science professions.[3]

The lack of qualified workers presents a serious challenge as wireless infrastructure uses a combination of licensed and unlicensed spectrum across many frequencies using a variety of radiofrequency (RF) protocols, as well as knowledge of core networks. In the world of wireless communications, understanding the fundamentals behind RF and associated topics such as link budgets, power, decibels and noise levels are paramount for creating skilled engineers. The chasm between what knowledge is needed and what the engineer actually knows is growing by the day due to many factors: automation in the industry;[4] lack of industry-specific but manufacturer-agnostic learning platforms; and simply a lack of focus on the fundamentals.

By taking a fundamental approach to the science of wireless communications, the U.S. wireless infrastructure industry can create a strategy to bridge this skills gap, and help existing and new members of the industry. This paper examines what is required to develop training and educational programs that provide the wireless infrastructure industry with a workforce that possesses the advanced skills necessary to meet growing wireless demand.

What is at Stake: The Economic Impact of Technological Development

The United States is the world leader in the rollout and deployment of 4G technology. Because 5G technical standards are still under development, the roadmap for the next technology evolution is not yet clear. However, to keep pace as technology advances, industry will need to regularly update the training and skills of its workforce. Of note, the cost of training and staffing the telecommunications workforce in the United States is higher than the rest of the world.[5]

U.S. Department of Labor statistics show a decline of employment in the telecommunications industry of more than 200,000 since 2006.[6] Much of this can be attributed to the economic climate during this period. The negative economic impact of the loss of 200,000 telecom jobs in an otherwise booming communications industry in the United States is paradoxical, considering annual wireless revenues in the United States have grown from $148.1 billion in 2008 to $187.8 billion in 2014.[7] However, the lower cost of technological development, general employment and training overseas has been a factor in the loss of these jobs, along with increased efficiencies and automation in the wireless industry.

This trend is likely to continue and even be exacerbated in the United States because of the shortage of skilled labor versus growing demand. An Information Age Economics report released by The Wireless Infrastructure Association in September of 2013 predicted that 1.2 million new jobs would be created as a result of investments in wireless infrastructure.[8] The report also predicted a 2.2 percent increase in Gross Domestic Product (GDP) could be directly attributed to mobile broadband by 2017. Given these outsized economic impacts, it is critical to the entire economy that there is an adequate workforce to build these wireless networks to maximize economic growth for the entire economy, and to retain international economic competitiveness for the United States.

Regardless of the rate of growth in a skilled wireless infrastructure workforce, it is certain that the demand for trained, qualified and experienced labor will exceed the supply at some point in the next few years as the industry begins to deploy more advanced 4G services and eventually 5G technologies. This may contribute to a wage "bidding war" for skilled workers. It also may require the use of offshore resources, resulting in less taxable income than would be realized if the expertise were indigenous to the United States. This could also have a deleterious effect on GDP.

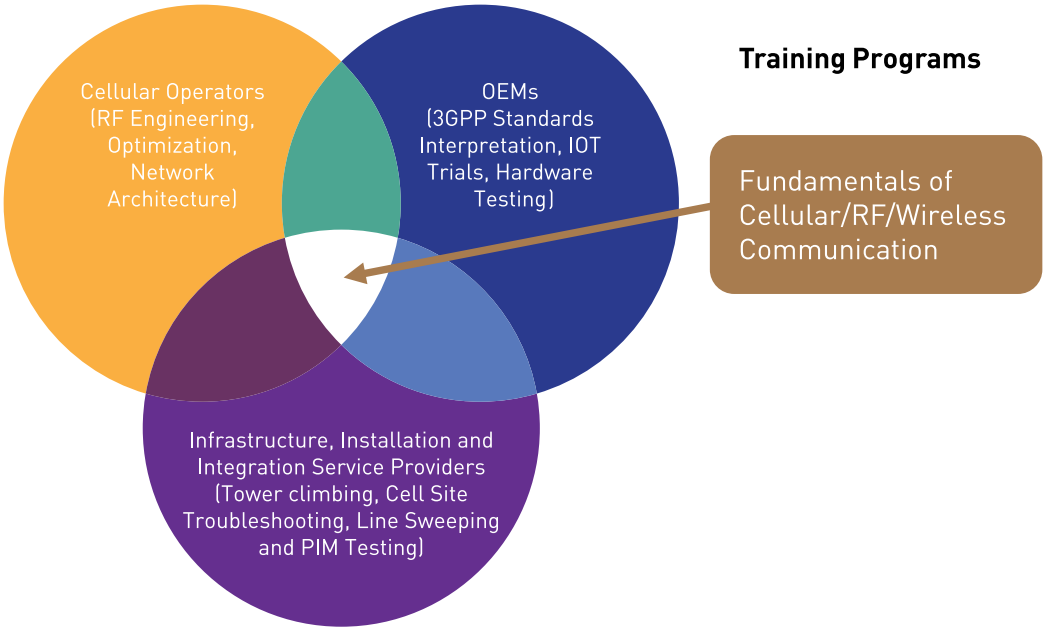
Training a qualified workforce to support the continuing development of 4G, the upcoming development of 5G technologies and the impending Internet of Things (IoT) is imperative as new technologies, spectrum and efficiencies are introduced into networks. Specific software and firmware advances include skillsets to understand self-optimizing networks, MIMO technology, millimeter-wave technology and services aggregation, among other things.

In particular, U.S. carriers will face continued pressure on their networks due to the exponential growth in wireless data and video demand, as well as the need to increase broadband penetration inside buildings and homes. This insatiable demand underscores the need for a larger and better-trained workforce.

The skills gap in available workforce runs counter to the explosion of people who have embraced mobile connectivity in the nation. Indeed, the United States still has the largest number of 4G subscribers in the world, at 62.5 million – more than twice as many as the next largest, Japan, at 26.1 million,[9] according to Statista.com.

A better workforce also would streamline the deployment process by not having to correct mistakes, a common occurrence today. No one knows when the next mobile application or device will shape how people and things communicate in the future, but a quick look to the past underscores the need for a strong wireless infrastructure foundation and a workforce that can build and maintain that foundation.

The Current State of Training and Education



At the college and university level, many wireless infrastructure communications courses are taught as part of the Electrical Engineering curriculum. At the undergraduate level, these courses are generic and cover communication theories from broader perspective.[10]

There are only a few good examples of specific RF technical courses at the graduate level. For example, the Master's program in Telecommunications at the University of Maryland recently introduced a graduate course for second-year students on Distributed Antenna Systems (DAS) and small cells. Students wishing to take this course are required to go through a foundation course on cellular communication as a prerequisite to many other electives. The course incorporates key topics on in-building RF planning – for example, RF propagation theories for in-building coverage, active versus passive DAS requirements, small cells versus DAS, and traffic dimensioning for big venues like stadiums. The above course also incorporates practical hands-on opportunities in which students get to design a DAS network for a stadium, using DAS planning software. The course has attracted attention from the industry and many companies have shown interest in sending their employees to this course.

Unfortunately, this course can only be offered to the students enrolled in the Master's program in Telecommunications at University of Maryland. New technologies such as LTE and LTE-Advanced, and innovations such as small cells are usually not taught at the undergraduate level. In addition, very few universities in the United States or abroad offer professional courses even at the graduate level in the field of wireless infrastructure communications; the latest innovations are not incorporated into course material.

In the wireless industry itself, some strides have been made to improve educational opportunities for skilled workers. Key players in the effort involve cellular carriers, Original Equipment Manufacturers (OEMs), standards-developing bodies and deployment companies.

That's not surprising. Wireless innovations are taking place in nearly every aspect of the industry. The Third Generation Partnership Project (3GPP) and International Telecommunications Union (ITU) are constantly evaluating how to improve cellular technology at the air-interface and backhaul levels. Cellular operators are making substantial investments in research and development (R&D) to understand new standards and come up with prototypes of new technologies. OEMs continually invest in ways to incorporate these evolving technologies into existing or new products to make sure they provide cost-effective solutions for cellular operators. Often, work in the wireless infrastructure industry is outsourced so companies actually deploying the networks also update their skill levels to accommodate technological evolution and to make sure they provide quality installation without jeopardizing deployment time and/or cost.

These key players need to keep up with the new technologies and products, and to document these innovations and initiatives so that they can train employees who were not involved in the R&D process. Documentation might be done properly, but transferring the knowledge from the R&D centers into effective training material can be daunting.

Consequently, training modules and material on various topics of wireless infrastructure are available through a number of OEMs and operators. Most companies aligned with the wireless infrastructure industry have some form of training available for their employees to update their knowledge base and skillsets regularly.

The training initiatives carried out by many OEMs for customer support, however, are often based on the products and services these companies offer, rather than raising the bar for technical competence universally. What's more, going through one or more of these training modules does not guarantee that workers would be able to grasp the underlying concepts of these technologies or innovations. Some OEMs require different levels of prerequisite knowledge, while others offer more modular certifications for specific tasks versus general product certification. Furthermore, the sheer number of commercial network equipment components, each with their own nuances, makes it unlikely for a worker to be properly trained on everything they need, particularly without a base of knowledge on which to build.

Because there are so many variables in training, it is daunting for someone new to industry to even be able to figure out which skillsets are needed to gain employment. The wireless infrastructure industry would benefit from establishing consistent, vendor-neutral training that details the basic fundamentals behind RF communications. Such vendor-neutral training initiatives would lead the charge for focused educational compliance standards.

The Right Direction for Improving Industry Skills

It's clear that there is a real need for vendor-neutral training in which instructors can provide foundational theories of RF topics. This training also can act as a prerequisite for existing training options available from cellular carriers and OEMs. It would help the key players of the industry reach a broader audience and provide a common platform for foundational courses.

Training must be targeted to the needs of individual members of the wireless communications industry, which is not yet the case. All too often, providers of adult education do not structure their content around a focused, measurable and repeatable objective. Like majors and specialties in academia, the wireless infrastructure industry would benefit from moving away from generic training and toward recognition of the value of specialized training.

A vendor-neutral training foundation, established within the industry, would allow OEM-specific training to be more effective. The wireless infrastructure industry should set out basic principles of DAS, small-cell and related technologies, and offer classes that uniquely relate to these principles to the specific responsibilities of different audiences. Industry should focus on individual training tracks geared specifically toward engineers, operation technicians, general industry professionals and those outside of the direct industry.

Meaningful and effective training should be specialized. For example, the principle of RF propagation is more applicable to an RF designer than it is to an operations technician. Specialized training fosters better comprehension of concepts specific to those who will actively use those skills.

Establishing a set of specialized training tracks and elevating the expectations of the professionals in the industry will gain attention and respect by industry drivers such as wireless carriers and OEMs. Furthermore, OEMs and academic leaders should be engaged contributors in developing curriculum to ensure the foundational training tracks meets their needs and the highest standards for excellence.

Industry leaders should commit to requiring vendor-neutral foundational training as a standard prerequisite for their training programs. This framework ensures that participants in individual OEM training programs have a consistent understanding of the principles involved with their respective responsibilities.

With these prerequisites satisfied, OEMs can focus their training programs on implementing, operating and maintaining their respective products in addition to how their technology is advancing to keep up with the demands and direction of the industry.

Topics to be included in a "Fundamentals of Wireless/RF Communication" training course:

- Introduction to Radio Wave – Amplitude, Frequency, Wavelength, Phase
- RF Units – Watts, mWatts, dBm, dBi, dBd
- Types of Communication – Simplex, Half Duplex, Full Duplex
- Basic Modulation Schemes – OFDM, QAM, QPSK, BPSK
- RF Behavior – Absorption, Reflection, Refraction, Scattering, Diffraction, Free Space Path Loss, Multipath
- Introduction to Cellular and Wireless Technologies – GSM, CDMA, UMTS, LTE, LTE-A, Wi-Fi
- Network Architecture – Macrocell Site Design, DAS and Small Cells Introduction
- Roles and Responsibilities – ITU, FCC, 3GPP
- Cellular Connectivity – Uplink vs. Downlink, Path Loss, Linked Budget Analysis
- Spectrum – Frequency Assignment, Licensed vs. Unlicensed Cellular Band Assignment in the U.S., Radio Channels, Capacity vs. Coverage
- Base Stations – BTS, Node B, eNode B
- Cell Site Design and Components – RF Plumbing Diagram, Co-siting Techniques, Cell Site Components, Base Station Antennas, Feeder vs. Jumper, Diplexer, Duplexer, TMAs
- RF Measurements – Insertion Loss, Return Loss/VSWR Testing, PIM Testing

A Strategy for Long-Term Vendor-Neutral Training

The industry as a whole must do what it can to expand the highly skilled, eligible labor pool qualified to perform wireless deployments. By doing so, it can enhance productivity and quality while reducing cost. That business benefit will be maximized by vendor-neutral training.
As a practical matter, however, it must be acknowledged that everyone charged with teaching a fundamentals course is not necessarily offering practical and consistent information. That inconsistency can lead to higher costs and longer time to productivity for those undergoing training.

Long-term goals for vendor-neutral training initiatives should include increasing accessibility to quality consistent training through various channels. Industry associations will need to lean on experts to deliver training content regularly at trade shows, through webinars, classroom-style trainings, on-the-job and online offerings. A training program of this nature will only be effective if it can be supported long term.

To be effective, the industry should consider establishing a body to steer the curriculum. This steering committee should be comprised of industry association leadership, manufacturers, integrators, carriers and other ecosystem partners. All stakeholders must be aligned on the appropriate set of prerequisites for employees to reduce the amount of time needed for them to be productive.

Further, industry must enroll a cross-section of stakeholders to share existing and future training content, building a best-of-breed training library with content that is not proprietary or specific to any one technology. All involved in curriculum development must regularly review the curriculum elements to ensure that content remains relevant as technologies and trends change.

To be successful, industry leaders must find ways to improve training accessibility for all. That means supporting a variety of learning modes, including classroom, virtual classrooms and eLearning. People need to be able to learn from wherever they may be, whenever they have time.

To that end, it's as important to enable mobile learning via tablets and smartphones as it is to use traditional desktops. Labs should be virtual to the extent possible, and communities should be fostered for sharing information, peer-to-peer learning and discussion and Q&A.

In online learning settings, it's especially important to embrace micro-learning, where content is taught and absorbed in short bursts rather than long marathons. This approach makes it easier to retain information – and easier to reference that information after training is finished.

In recognition of the achievements of students in completing the curriculum, industry certifications can act as employment credentials and recognized job skills to demonstrate competence to potential employers. Recertification should be part of the certification program to acknowledge rapid industry advances. Third-party involvement can simplify the verification and communication of employee credentials.

When the training is developed, companies serving the wireless industry must be encouraged to adopt the newly developed curriculum in training their own employees. It also can be used when screening potential employees to ensure appropriate certification and levels of achievement.

Partnerships with other existing programs would be integral to take advantage of resources available through government programs and private/public initiatives. For example, The Telecommunications Industry Registered Apprenticeship Program (TIRAP) is a joint venture of the Department of Labor, government agencies and telecommunications industry members invested in improving workplace safety, addressing industry workforce needs and providing employment and advancement opportunities. [11]

Potential Performance Metrics for Training

The effectiveness of any training initiative must be well defined and consistent mechanisms must be developed to document training initiatives across the industry.

Key performance indicators must be established that enable companies to track the effectiveness of training. The overall goals would be continual increases in the average number of certifications or courses completed per employee, along with increases in the percentage of employees with complete certifications.

Service providers also must keep adequate documentation of training effectiveness, preferably on an annual basis, to demonstrate the business value of training to service providers. There must be careful record keeping of improvements to first call quality complete jobs – that is, no return visits for any install issue. Reduced labor cost per hour, per technician is an important business metric, as are somewhat less tangible benefits such as the time required to fill an open technical job posting and improvements to customer satisfaction. Improvements in safety through reductions in workplace injuries and fatalities are a crucial outcome this effort can promote and help document.

Conclusion

The reality of the growing problem of the lack of skilled engineers and technicians in the wireless infrastructure industry cannot be overstated. Members of the industry should expect higher accountability from employees responsible for designing, implementing, and maintaining connectivity solutions.

Nonetheless, as previously mentioned, few accreditations in the industry are equal. An installation certification does not imply an individual is an expert in designing with a particular OEM, for example. All too often, Value-Added Resellers (VARs), integrators and the like are quick to leave problem-solving and troubleshooting to the product manufacturers after the solution has been implemented.

Training is an investment in the growth of individual companies and the industry as a whole. Rather than relying solely on OEMs to fill knowledge gaps as a result of generic training, industry partners should hold their teams accountable for being true extensions of OEMs on the equipment they deploy.

The wireless infrastructure industry should further develop training and education programs that address the most fundamental topics to the most complex.

Doing so would produce the next generation of engineers, technicians and others who could use this strong foundational knowledge to further their careers and in turn would improve safety and the quality of wireless infrastructure and networks.

Closing the skills gap that exists today in the wireless infrastructure industry would create a strong economic foundation benefitting all citizens as the nation continues to rely on a strong wireless infrastructure foundation to increase productivity at work and enhance the lifestyles of its people.

About the Authors

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Dr. Rikin Thakker is a Research Assistant Professor in the Department of Electrical and Computer Engineering at the University of Maryland (UMD) in the United States. He is also the president and co-founder of RF Academics - an initiative started by a group of elite professors to cater to industry's need of quality education and consulting services at corporate speed. He has over 15 years of experience in the field of cellular and wireless communications. He has helped design, deploy and maintain cell sites with 3G and 4G technologies for major cellular operators in the United States.
Dr. Thakker earned his Ph.D. in Mobile Systems Engineering from the George Washington University (GWU) and his M.S. in Telecommunications from University of Maryland. His Ph.D. research was focused on validating the "spectrum scarcity" notion by modeling the wireless ecosystem using System Dynamics techniques. His research interests include efficient spectrum management techniques, interference analysis and optimal allocation of spectrum, design of cell sites by employing co-siting techniques, in-building wireless capacity and coverage optimization, and system dynamics.
Dr. Thakker has designed several graduate level courses related to Cellular Network Infrastructure, Wi-Fi Technologies and DAS/Small Cells for the Master's in Telecommunication program at UMD. He received Instructor of the Year award for the program in 2014. He is also an Adjunct Assistant Professor at GWU's Ph.D. program for the Engineering Management and Systems Engineering (EMSE) department.
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Don Bach is the Vice President of Engineering for SAC Wireless. After graduating from the Electrical Engineering program at DeVry University in 1986, Don went to work as a technician in the Public Safety and LMR two way radio industry. In 1994, Don was hired as a System Performance Engineer on the iDEN Network by Fleet Call, later to be renamed Nextel. After 22 years in a variety of RF Engineering positions, Don left Sprint in 2007 to start a regional RF Engineering and implementation company focused on DAS networks. SAC wireless was purchased in 2014 by Nokia Networks and Systems.

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Nate Fuentes is business development manager, North America, for CommScope's Distributed Coverage and Capacity Solutions team, responsible for technical sales and strategic partnerships for distributed antenna system (DAS) and small cell solutions. Nate joined CommScope through the acquisition of TE Connectivity's Broadband Network Solutions business in 2015. He has served the wireless industry for 10 years in previous roles at TE Connectivity and ADC. Nate has proven technical expertise and business acumen providing advanced product application solutions to all tiers of customers. He has a Bachelor's degree in Electrical Engineering from the University of Texas–Austin and holds many industry certifications.

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Derek has rich experience with billing systems, both as a billing engineer and executive for Internet service providers United Online and GoAmerica, and as a global technical instructor for leading billing software company Portal. He is a veteran of Operation Desert Shield/Storm and Operation Joint Endeavor, serving with the United States Air Force.
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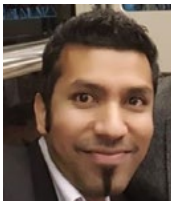

Lakshmin Thiagarajan is part of the core technical team at SOLiD and is responsible for engineering activities including training and RF design. His extensive experience with post sales and pre sales engineering activities in the industry has come from both sides of the fence; as an OEM and as a vendor. He has extensive experience with architecting and implementing complex wireless deployments in high-capacity venues globally. Lakshmin holds a Master's degree in Electrical Engineering, where he specialized in wireless communications and signal processing. His passion for education and bettering the industry has helped create one of the industry's best training programs by an OEM that focuses on the foundations of RF engineering.

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Steven Tom is Senior Vice President of Analytics, Innovation, and Learning at TESSCO Technologies, leading advanced Big Data analytics, business intelligence, the incubation of strategic initiatives, and the wireless training business units. Prior to TESSCO, Steven led the marketing strategy and analytics organization at Algeco Scotsman and was a management consultant and engagement leader with Deloitte Consulting LLP's strategy practice, driving complex engagements that transformed clients' revenue growth, strategic pricing, and analytics capabilities. Steven has an MBA from the MIT Sloan School of Management and a bachelor's degree from the University of Maryland.

Footnotes

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This white paper is meant to be an educational tool and does not reflect Wireless Infrastructure Association policy.

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