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PREDICTIONS: 2018 and Beyond

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PREDICTIONS: 2018 and Beyond

By Mike Dano

What does the future hold? That's definitely the big question.

Within these pages, we hope to provide at least a few answers.

In this, our first annual Predictions Report, we've collected four of the industry's leading, veteran, independent analysts to ask them what is going to happen next year and beyond. We gave them a few general guidelines (be as specific as possible) and a few suggested areas to focus on (M&A and 5G, for example) but otherwise we left the question relatively open so as not to influence the outcome, and, more importantly, to get a sense of what they're spending their time thinking about.

The results, which are broken up into five themed chapters, offer a look at an industry in transition. LTE buildouts are mostly finished, just about everyone already owns a smartphone, and it's not really clear where the next phase of growth in wireless might come from. Moreover, following the close of the 600 MHz auction, most expect the pace of consolidation to quicken, and new players to enter the space, though no one knows quite how the chips might fall.

And of course 5G remains on the horizon, but that impending technological evolution at this point raises more questions than answers. Will 5G replace wireline connections? Will it enable massive IoT? Or will it remain a technology searching for a business model?

In their predictions, Iain Gillott, Joe Madden, Mark Lowenstein and Monica Paolini come as close as anyone can to addressing these questions. Collectively, their options carry a significant amount of weight, heft earned through decades spent in the trenches on the cutting edge of wireless:

- **Mark Lowenstein** cut his teeth at industry analysis at the Yankee Group before briefly moving into a planning and strategy role at Verizon. Since 2002 he's been running his analyst and consulting firm Mobile Ecosystem.
- **Monica Paolini** has a PhD in cognitive science from the University of California, and in 2003 started her firm Senza Fili to dive into the depths of wireless networks.
- **Iain Gillott,** a fixture on the wireless trade show circuit, founded iGR in 2000, and has been involved in the wireless industry, as both a vendor and analyst, for more than 22 years.
- After working in strategic areas in the chipset industry, **Joe Madden** founded Mobile Experts in 2002 and gained visibility by correctly predicting the trajectory of areas including small cells and remote radio heads.

With their predictions, these analysts are shining a light on the dramatic changes occurring throughout the wireless industry – from network evolutions to business model changes to nascent but potentially explosive opportunities – to give you an idea of where things are heading.

We hope you enjoy their predictions, and we all wish you good luck in the New Year.

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M&A

Chapter 1: M&A

By Mike Dano

As of this writing, Sprint and T-Mobile have not announced a merger. In fact, that tie-up is looking less and less likely following the recent announcement by Sprint and T-Mobile that they have discontinued merger talks.

Moreover, even if T-Mobile and Sprint do eventually come to an agreement, that would just be the start of the process. The operators would also have to obtain approvals from their shareholders and, more importantly, regulators at the Department of Justice and the FCC.

But M&A in wireless won't be confined to just Sprit and T-Mobile. Cable giants Charter and Comcast earlier this year inked a partnership to jointly evaluate a potential entry into wireless. And of course Dish Network owns enough mid-band spectrum assets to build a sizable nationwide wireless network.

As you might expect, speculations into consolidation could go in many different directions, and each prediction then lends itself to a myriad of possible outcomes. (My favorite this year was that Amazon, Dish and T-Mobile will merge.) Thus, there are few who want to risk reputations on a definitive prediction in this fast-moving industry. Nonetheless, the below projections offer an informed glimpse at what might happen in 2018, and why.

M&A

A Sprint/T-Mobile Merger Still Might Happen

By Mark Lowenstein

Much hinged on whether a T-Mobile/Sprint deal would be announced this year, which many, including myself, thought would happen. I would say there's still a better-than-even chance it will be revisited in 2018.

The continuation of Sprint as a standalone entity makes it likelier that cable will seek a meaningful MVNO partnership with Sprint, like Altice has done. In order to more aggressively expand their mobile offering, Comcast and the other cablecos need better economics than they're getting from Verizon. If there continues to be four national, facilities-based competitors, we will see more aggressive courting of wholesale business.

Second, something might actually, finally and really happen with Dish Network's spectrum. Could be a wholesale deal, which would invite not only the incumbent operators but also others, such as the big internet players, who might want to bundle in wireless services of their own. A Verizon deal for Dish's spectrum is also a possibility.

Third, we could see Verizon make a major move in the service provider segment. Verizon will be under increasing pressure to "do something big," especially if the AT&T-Time Warner merger is approved. I'm not sure that Verizon's Oath is the full answer to that.

China Unicom and China Telecom Will Enter Into An Arranged Marriage

By Joe Madden

We've been saying for the past two years that a merger between China Unicom and China Telecom is possible. During 2018, the possibility of a merger becomes more likely.

Here's why: The Chinese Ministry of Industry and Information Technology will be making an announcement in roughly mid-2018 regarding allocation of 5G spectrum. The decision to allocate spectrum between three major operators is closely related to each company's deployment plans.

The Chinese central government has been reducing the number of state-owned companies since 2015, including mergers in shipping, construction, energy, and steel markets. In general, the goal is to streamline management of the economy and to create giant companies that can be more competitive on a global scale.

In mobile telecom, all three Chinese operators are state-owned, and top government officials have hinted that telecom is one area where they want to streamline. However, 2015-2016 was not a good time for a merger because China Unicom and China Telecom were still filling in the holes in their separate LTE networks. However, as the LTE investment cycle winds down and 5G is about to begin, we see an opening for the government to make a move.

It's cleaner to deploy one 5G network, with 200 MHz of spectrum, instead of two 5G networks with 100 MHz each. Note that China Mobile is already confident that it will receive at least 200 MHz of spectrum. A merger would put China Unicom/China Telecom on a level playing field with China Mobile.

Chapter 2: 5G

By Mike Dano

5G hype is inescapable. And the technology promises everything: From lightning-fast wireless connections to ultra-cheap links for billions of IoT devices.

5G is also coming sooner than expected: A technology that was initially slotted for completion in the 2020 timeframe now likely will arrive in its earliest forms next year.

Already, all of the nation's major wireless carriers – as well as a handful of leading regional operators – have tested the technology, and their findings have been successful enough to warrant accelerated deployment timetables.

But as with any generational technology upgrade, it will arrive in fits and starts, and probably not quite as initially promised.

And that's what the below predictions make clear: 5G is coming, but stay wary.

5G Will Be Hyped Before It Is Delivered

By Mark Lowenstein

The official standard is still being developed, but services marketed as "5G" will be launched in 2018.

The historians among us know that there's precedent for this with 4G, where HSPA+ services were marketed as "4G" by AT&T and T-Mobile, even though they weren't LTE. (To be to be fair, HSPA+ speeds were comparable to MetroPCS' LTE services, which launched on 5 MHz channels.)

There are those who say that launching pre-standards-based 5G, especially on the sub-GHz bands, is just "marketing 5G," not actual 5G. But services that get close to gigabit LTE, which should become more widespread in 2018, will have some of the performance characteristics of what is envisioned for 5G, particularly in its early stages.

5G Will Be Hyped Before It Is Delivered: Part 2

By Iain Gillott

The wireless industry has a reputation of hyping new technologies before they are ready. Case in point: 2.75G pushed as 3G, and 3.5G technologies marketed at 4G. And coming soon to a wireless ad near you, LTE dressed up as 5G.

The situation now is a little different though, since the standards bodies have accelerated parts of the 5G standards in order to get the new networks to market as soon as possible. So 5G New Radio will allow the first parts of the 5G air interface to work with the 4G core, in non-standalone mode.

So together with millimeter-wave technologies also being labelled as "5G," 2018 will be the year of "5G this and 5G that, but with no one knowing the difference."

5G Appetizers Will Be Served In 2018

By Joe Madden

The 5G market will only be half-baked during 2018, as the standards are still very new and products are still in the R&D lab today. However, we can expect a few key dominoes to fall during 2018:

1. The first prototype 5G handsets will be field tested in the 3-4 GHz range….and they will work pretty well, with data speeds higher than 1 Gbps.
2. Qualcomm will provide samples of a millimeter-wave front end product for 5G, that fits in a smartphone form factor. At least one of the Korean mobile operators will kick off plans to use it.
3. Verizon's 5GTF format will morph into a 5G NR implementation of fixed wireless, and will settle into a full commercial service in carefully selected locations.
4. The Chinese government will announce some gigantic 5G deployment plans at 3-5 GHz, representing more than half of the global 5G market.

So, 2018 won't include much 5G revenue, but key technologies will be coming out of the oven. And they will be some tasty appetizers while we continue to wait for the main course.

Civil War Breaks Out in 5G

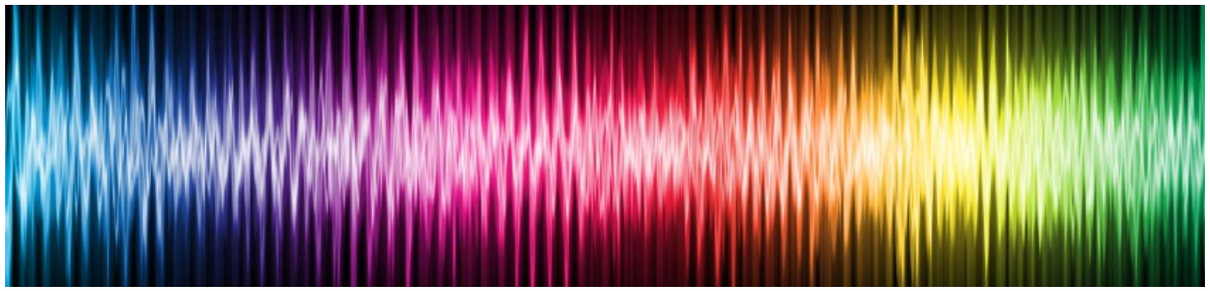
By Mark Lowenstein

In July 2014, the FCC released its Spectrum Frontiers plan, which allocated three large swaths of spectrum in the millimeter-wave bands for 5G. Verizon and AT&T have both made several acquisitions of companies with assets in the millimeter-wave bands.

But it now appears that mid-band spectrum is also likely to play an important role in 5G. T-Mobile announced it plans to use its 600 MHz spectrum for 5G, and there is considerable momentum to make the 3.7-4.2 GHz band available for commercial wireless services, as well. And there's the 3.5 GHz (CBRS) band, which will also likely be used for 5G.

Thus, there's an interesting battle shaping up, especially if T-Mobile and Sprint come together, as the combined entity will have significant assets below 6 GHz, but limited assets in the millimeter-wave bands.

I don't see this as either/or. What we might see are "islands of 5G" in the millimeter-wave bands, while the lower bands support wider coverage and mobility.



The Secret To 5G Will Be Edge Architecture

By Iain Gillott

To meet the bandwidth and latency performance goals of 5G, edge computing architectures are needed, not simply preferred. Without edge, 5G simply becomes a glorified version of 4G, with more spectrum being used to deliver more bandwidth. Fundamental changes to the network architecture will result in much lower latency, more efficient front and backhaul, and the ability to offer distinctly new services.

Edge computing is not new, of course, but 2018 will be when it comes into the limelight for mobile networks and the key for 5G success. Edge deployments are already underway in both mobile networks and in the enterprise, with many more to come.

Certainly there are challenges to be addressed, least of all the often-distant relationship between the telco and IT worlds. The good news is that multiple vendors, organizations and telcos know what needs to be done and are working on the solutions rapidly.

Chapter 3: IoT

By Mike Dano

The Internet of Things is already a big and growing opportunity for the wireless industry. As noted by analyst Chetan Sharma, cars and other IoT gadgets accounted for fully 71% of U.S. operators' net customer additions for the second quarter.

But many believe the IoT space is just getting started, and that the overall IoT opportunity will ultimately be bigger than the regular internet opportunity.

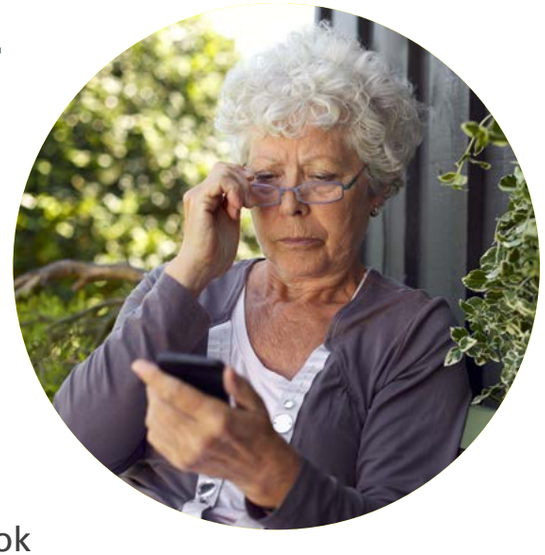
And that's why there has been so much interest in the IoT space in 2017 from wireless players. This year the nation's cellular operators either outlined IoT network upgrade plans (T-Mobile and Sprint for NB-IoT) or launched those networks (Verizon and AT&T with LTE M). Further, players like Sigfox, Ligado and Comcast entered the IoT space with their own, rival network offerings.

So what will the IoT space deliver next year, and beyond? It could certainly continue growing (as outlined by Joe Madden) and it could well create new and unique opportunities (as highlighted by Mark Lowenstein's somewhat tongue-in-cheek look at Amazon).

Whatever happens, it won't be boring.

Your Granny Will Own An IoT Device

By Joe Madden



For consumer devices, Granny normally lags behind the market by at least 10-15 years. Take smartphones as an example: The original Symbian and BlackBerry devices came out in 2000, but only 42% of U.S. senior citizens owned a smartphone in 2016. Facebook launched in 2004, but only 34% of seniors use social media today.

IoT will be different. Why? Because it won't be Granny's choice. Her IoT device will be embedded into something else that she buys, and she won't even know that she's connected.

How old is Granny's car? If it's less than three years old, then she probably has a GPRS or LTE modem in her car. Even if she has an older car, she should sign up for usage-based insurance because she drives like an old lady.

What about Granny's house? Take a look at her electric meter. About 55% of U.S. households have a smart meter today.

The point here is that the IoT is an enterprise market, not a consumer market. The adoption curve that you learned in the smartphone cycles does not apply.

Amazon Will Build The World's First Smart City to House its Second HQ

By Mark Lowenstein

About a zillion cities applied to host Amazon's second HQ. I wouldn't be surprised if even Pyongyang submitted a bid.

But in a radical and bold move, Amazon will announce that it will build the world's first truly Smart City, called AmazonAlexia, to house its new HQ. It will be a model of 21st century efficiency, with all work functions being performed by robots (Bezos did promise that the new HQ would create 50,000 jobs…but he didn't specify they would be performed by people).

It will be the first city to use exclusively driverless cars, and sensors will be underneath every road and on every light pole. Every building will be "smart." The architectural centerpiece will be a giant Amazon Echo monolith, anchoring Smart City Square, which will also house the world's largest Whole Foods. Cloud-based voice orders for goods and groceries will come into the giant Echo, which will ship goods within minutes via a fleet of thousands of drones, departing from the newly built AmazonAlexia Airport.

The entire city will be powered by AWS.

Chapter 4: Network Design

By Mike Dano

As 2018 bears down on us, perhaps the safest prediction about next year is that wireless networks are going to change – dramatically.

Of course, the transition to 5G represents a significant change, but the transition to 5G is much more than just a switchover to New Radio, the RF component of the 5G standard. To reach its potential, 5G also requires some fairly substantial changes to the layout and operation of the network itself.

And 5G isn't the only factor driving changes to the networks underpinning wireless. LTE Advanced, small cells, SDN/NFV and C-RAN are all in various stages of deployment today. Each one represents a fairly significant change – and taken together those changes add up to a substantial shift in the core design of today's wireless.

So, if substantial changes are already afoot today, what will next year bring? Read on.

Fixed Wireless Will Be Harder Than We Thought

By Mark Lowenstein

We are getting into the thick of trials of fixed wireless access using the millimeter-wave spectrum bands. These trials are being led by Verizon, AT&T and startups such as Starry. The key question is whether fixed wireless can be a viable alternative to or compete with fixed broadband, as one of the initial use cases for 5G.

I think we are learning, and will continue to learn, that this is hard. Propagation issues are a serious challenge at the higher frequencies being proposed for 5G, and there's still a lot of work to do on the technical front, with the equipment and the economics, to make this work.

Outdoor Small Cells Will Continue To Struggle

By Iain Gillott

Deploying small cells outdoors has taken longer than expected, mainly due to finding and zoning suitable locations. Small cells are being deployed, especially remote radio heads, mainly by the larger operators and tower companies, as well as other third parties.

And while small cell deployments will continue to accelerate, in order to reach the market's full potential, the zoning and location choke-point must be addressed. This is going to take a while and will likely involve federal, state and local ordinances. Some places will be more successful than others in reducing the time it takes to get small cells in the field, and there will lots of example use cases, but significantly reducing the average time for outdoor small cell installation will take a while.

For small cells, 2018 will be the year of improvement and more deployments, but significant change will come toward to the end of the year or in 2019.

Indoor Small Cells Will Boom

By Iain Gillott

While outdoor small cells will continue to be hindered by the availability of suitable locations, the indoor opportunity for small cells will continue to boom in 2018.

Rather than be funded by the mobile operators (as a few years ago with DAS in major stadiums, conference centers and elsewhere), the new in-building market will be funded by a combination of building owners/managers, third parties and other vendors. Building suitable networks, with D-RAN and C-RAN, and then leasing capacity back to the operators will be the new model. This can be coupled with data center space in the bottom of the building to provide space, connectivity and power for edge data centers, as well as baseband hosting for local small cells.

Look for new business models, technical solutions and industry players in this space in 2018.

Thanks To CBRS, Enterprises And Others Will Own Infrastructure

By Monica Paolini

CBRS is a powerful, truly innovative concept and, as long as the FCC doesn't water it down, in 2018 we will get a sense of how it will turn out to work in practice. It will be a landmark learning experience, and not just for the United States: It will show if and how spectrum sharing may work in a framework in which network operators share the spectrum with incumbents (military and satellite providers) and with enterprise and venue owners.

In a world in which we need more spectrum, the ability to share underused spectrum while preserving the access rights of spectrum owners could be transformative.

The most exciting element of CBRS may be that spectrum sharing is accomplished by empowering the enterprise and venue owners, which can use the 3.5 GHz spectrum without the need of a license. Enterprise and venue owners can gain unprecedented control over wireless infrastructure, and, with it, the opportunity to own indoor wireless infrastructure. Over the next few years, this will clear the way for new business models built around IoT, private networks and neutral hosts to finally succeed.

The Demarcation Between The Edge And The Core Will Fade Away

By Monica Paolini

The initial vision of virtualization was that of a cheap and efficient big data center in the cloud. In the process, we forgot that latency is crucial in telecoms – already, before 5G, VR and AR – and that location matters, greatly. Regardless of technology, physics is unavoidable: distance increases latency. A drive to centralization in mobile networks increases latency – and decreases the perceived speed and reliability of the network, thus affecting the quality of experience. At the same time, moving everything to the outer edge is unsustainable financially, and makes utilization of network resources inefficient.

Operators will start actively working to strike a balance between a centralized and a distributed approach, both in the RAN and in the core, which will take into account performance and cost for different functions, services, and applications. They will expand edge computing trials to gradually move functionality from the centralized core towards the edge. With C-RAN, the BBUs will retract from the edge to a centralized location, which is less expensive to operate and maintain.

As the location of functions becomes prominent to define performance and quality of experience, the physical and functional distinction between the core and the RAN will start to disappear and lose relevance. And virtualization will make it all possible by liberating operators not only from the constraints of hardware, but also from the constraints of location.

Chapter 5: Beyond 2018

By Mike Dano

In wireless, it's often difficult to predict what's going to happen next week, much less in two years. In some cases, trends that once seemed imminent (small cells, I'm looking at you) took years to actually pan out, while other hot topics (CBRS anyone?) have taken many by surprise.

Nonetheless, it's clear that there are a few issues on the horizon that likely will become important to the wireless industry in the years to come.

However, how whether those topics rise to the fore in 2019 or 2020 or some later date remains to be seen...

AI Won't Kill Us All

By Monica Paolini

Dystopian takes on artificial intelligence, a la Elon Musk, that paint a future dominated by machines and robots way smarter, more creative and more resourceful that we are have gained quite a following.

We will find out that the opposite is true.

Robots will not be taking over (but it will be great to have them do boring tasks, like vacuuming the floor, running warehouses or driving cars). Instead, we will have to work hard to get AI to work for us. AI is not at all trivial, and when it works it is fundamentally different from human intelligence – and that's a good thing: We want AI to do what we are not so good at.

In wireless, AI will become a powerful toolkit to understand, optimize and automate networks, and in doing so improve their

efficiency and extract more value from them. But, promising as this is, it is not going to be a magic wand that operators will be able to buy off the shelf. It will require hard work to figure out how AI, machine learning, deep learning and so on can help operators manage increasingly complex, virtualized and dynamic networks. And equally important, it will require a cultural shift in how people within the wireless ecosystem work. Humans, after all, will still run the show.

Automation Will Become A Requirement

By Monica Paolini

Virtualized networks evolving to 5G come with a promise of an optimized use of network resources, which allows operators to extract more value and create a better subscriber experience. The increase in flexibility, performance and cost efficiency comes with a price: increased complexity. To manage (and benefit) from complexity, operators will have to migrate to deeply automated management of their networks. In moving from current, still mostly manual practices, operators will face a technology transition that will affect the end-to-end network as well as a cultural transition that will reshape internal organizations and require new staff skill sets.

In the long term, automation will make networks operate in real-time and be more responsive to changes in demand – they will become smarter and more flexible in how they allocate resources.

Over the next year, operators will step up their efforts to transition to automated networks. And the initial challenges in doing so are to get a deeper understanding of how mobile networks work, predict their behavior in real time, develop an automation framework, and, crucially, to accept that the days of absolute control over the network are gone.

Networks Will Change – Fundamentally

By Mark Lowenstein

I am especially excited about a new era of network innovation that's on our doorstep. There's the diminishing delta between licensed and unlicensed, and between macro cell, small cell, and Wi-Fi. We're on the eve of the deployment of a national public safety network. CBRS promises a new framework for sharing spectrum, which, if successful, could become a prevalent model in the next decade. And important trials are being conducted in the millimeter-wave bands, which from a technical perspective, would have been unthinkable for commercial wireless services only a few years ago. Finally, there's the march toward NFV, SDN and network slicing.

All of these ingredients put together mean that there could be fundamental changes in networks, and network services, by early next decade. Traditional distinctions between licensed and unlicensed, fixed and wireless, and owned vs. shared spectrum, will erode. This could lead to logarithmic improvements in network economics, new models for service developments, and dramatic changes in industry structure.

Mark Lowenstein is a prominent wireless industry executive, consultant, analyst, and commentator. As Managing Director of Mobile Ecosystem, Lowenstein advises C-level executives on corporate, product, market, and industry strategy across the value chain of the wireless, communications, and digital media industries. Clients include wireless operators, equipment suppliers, device manufacturers, application and content developers, marketing and advertising firms, corporate end-users, and key members of the investment and venture capital communities.

From 2006-2007, Lowenstein was Vice President of Market Planning and Strategy at Verizon Wireless, where he led the company's efforts in long-term business planning, national pricing, market segmentation, and customer intelligence for the consumer and enterprise markets.

Lowenstein's consulting career began at the Yankee Group, where he founded and led the company's top-ranked global wireless practices. As Executive Vice President, he supervised a global team of analysts, authored dozens of influential reports, and headed large-scale strategy consulting projects. As a member of the Yankee Group's executive management committee, Lowenstein also oversaw the growth of the company's Canada, Latin America, and Asia-Pacific practices, and led early stage electronic content and commerce initiatives.

As one of the wireless industry's senior thought leaders, Lowenstein is a frequent keynote speaker at corporate and industry events worldwide and is broadly quoted in the print and broadcast media. He writes a monthly opinion column, Lowenstein's View, for FierceWireless, the leading on-line publication for the wireless industry with a circulation of 85,000, and regular columns for TechPinions, which is syndicated to Re/Code. His Lens on Wireless newsletter is read by more than 10,000 industry executives and enterprise decision-makers. Mr. Lowenstein has provided testimony to the FCC and has been retained as an expert witness in several cases pertaining to the wireless industry.

Lowenstein has served on the advisory boards of several prominent firms, including Telephia (acquired by Nielsen), Advanced Technology Ventures, and Seapoint Ventures. He has been cochair of the Wireless Innovation Council. He has been lecturer at Tufts University, and has served as a judge in numerous business plan competitions. He founded the Boston Wireless Braintrust, a group of the 20 senior-most executives and thought leaders related to the wireless industry in New England.

Lowenstein has authored several running-related books, and currently runs the website Great Runs—the ultimate guide to the best places to run the world's major cities and destinations. He is on the Boards of the Boston Jewish Film Festival and the Brookline Music School, and is an elected Town Meeting Member. Mr. Lowenstein holds a B.A. from Tufts University and an M.A. from the Fletcher School of Law and Diplomacy. He lives with his wife and two children in Brookline, MA.

MEET THE ANALYSTS

Iain Gillott, the founder and president of iGR, is an acknowledged wireless and mobile industry authority and an accomplished presenter. Mr. Gillott has been involved in the wireless industry, as both a vendor and analyst, for more than 22 years.

iGR was founded in 2000 as iGillottResearch, Inc. in order to provide in-depth market analysis and data focused exclusively on the wireless and mobile industry. In recent years, research has expanded to cover broadband telecom services to the home, as homes and businesses have become more connected.

Over the past 14 years, iGR has analyzed and published on a wide range of wireless and mobile technologies, subjects and markets including:

- Consumer behavior
- Enterprise IT managers and mobile workers
- Wireless interface technologies including EV-DO, LTE, WiMAX, WiFi, HSPA/HSPA+
- Small cell architectures and Hetnets
- Smartphones, tablets, embedded devices, handsets and other device types
- Mobile bandwidth demand
- Mobile application developers and app demand and consumption
- Network architectures and technologies, including IMS, SIP, VoIP, VoLTE

Mr. Gillott is a frequent speaker on industry issues and trends and has addressed audiences around the world and at many of the leading industry trade shows, including CES, PCIA, CCA, 4G World, 4G Americas, and CTIA. He has also been a guest lecturer on the wireless industry at the University of Texas and at Thunderbird. In addition, he is frequently quoted in various publications, including Investors Business Daily, the Wall Street Journal, Telephony, RCR, Newsweek International, Wireless Week, and Business Week and has appeared on NPR, CNN, CNBC, and TechTV.

Before founding iGR, Mr. Gillott was a Group Vice President in IDC's Telecommunications practice, managing IDC's worldwide research on wireless and mobile communications and Internet access, telecom brands, residential and small business telecommunications and telecom billing services. Prior to joining IDC, Mr. Gillott was in various technical roles and a proposal manager at EDS (now HP), responsible for preparing new business proposals to wireless and mobile operators.

Mr. Gillott has a BSc (Hons) degree in Computer Systems Engineering from the University College of North Wales, Bangor, Wales, with a concentration in hardware and software design.

MEET THE ANALYSTS

Joe Madden is the Founder and Principal Analyst at Mobile Experts Inc. Mr. Madden focuses on 5G and IoT vertical markets, leading a team of 6 analysts to triangulate on accurate market forecasts.

Over 28 years in mobile communications, he accurately predicted the rise of 5G Fixed Wireless, Small Cells, Digital Predistortion, and Remote Radio Heads. He validates ideas with mobile and cable operators, as well as hardware suppliers to find the match between business models and technology.

Mr. Madden holds a Physics degree from UCLA. Despite learning about economics at Stanford, he still obeys the laws of physics.

Monica Paolini, PhD, is the founder and president of Senza Fili. She is an expert in wireless technologies and has helped clients worldwide to understand new technologies and customer requirements, create and assess financial TCO and ROI models, evaluate business plan opportunities, market their services and products, and estimate the market size and revenue opportunity of new and established wireless technologies. She frequently gives presentations at conferences, and writes reports, blog entries and articles on wireless technologies and services, covering end-to-end mobile networks, the operator, enterprise and IoT markets. She has a PhD in cognitive science from the University of California, San Diego (US), an MBA from the University of Oxford (UK), and a BA/MA in philosophy from the University of Bologna (Italy).

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