Only the Connected Survive.

How 5G and Local, Edge Computing Data Centers
Will Maximize the Future of Distributed Workforces
in Smart Cities

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*"In this paper, the focus is on **examining the connectivity value of an ecosystem set up around 5G** to advance the access to groundbreaking technology and in doing so directly improve **training and education** for benefiting all constituents."*

Introduction

A sea shift is happening in the world of technology and those just floating along are about to be capsized. This goes for companies, cities and governments of all sizes. 5G will improve many things in our lives but only if enabled to allow it to optimize data flow. Time is not the friend here because the world is demanding advances that allow workers to be productive remotely, students to be educated at home and equality to be advanced toward bringing all in alignment.

In essence, a tsunami is about to hit and cities like San Francisco, Los Angeles or New York City are in a direct path. The way to higher ground lies in advancing connectivity technology so that business has a global competitive edge and through a superior educational and training system that is available to all, regardless of race, gender, age, geolocation or any current "separator". 5G and the critical infrastructure supporting its use such as Edge Computing and Local Data Centers will bring about generational change to allow success at the personal, company, institutional and governmental level.

In this paper, the focus is on examining the connectivity value of an ecosystem set up around 5G to advance the access to groundbreaking technology and in doing so directly improve training and education for benefiting all constituents. It will explore how technology advancements like artificial intelligence, virtual reality and blockchain will fundamentally change how we do business and learn and engage with things and other humans.

It will also weave how Edge is where a good amount of data and processing will occur and why the rollup from the hyperlocal to the local to the cloud will create an environment of growth.

Another aspect of equality will be explored; aligning physical and virtual security within communities through access to systems and training that improve organically. Whether that is empathy training around race biases using virtual reality and see-through-their-eyes or using local data to enable artificial intelligence to create a scenario for best outcomes in handling emergency situations, enabling 5G is a key to success in these initiatives.

A goal of Fortress Data Centers (FDC) is to connect the dots and help accelerate the move to data democracy with 5G's speed and low latency benefits. With 5G connectivity through multiple carriers at 274 Brannan in San Francisco, Fortress Data Centers is at the center of the Bay Area integration efforts to drive a technological infrastructure for advancing the constituents discussed above. FDC is uniquely positioned for connecting the Edge to Mission Critical Colocation to the Cloud and keep all boats rising.

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*"Considering that in high concentration areas like financial centers or large cities, **there could be a million or more IoT devices per square mile.**"*

5G: What is All the Hype About?

The speed of light. It sounds impressive and it is. With a globally enabled 5G network where everything has 5G from point of creation to the last mile, the ability to get to the speed of light is possible. Until then, it is a bit of a stretch. But consider that the 100x improvement from 4G will set the next stage of a technology evolution with massive data increases as a result.

Which leads to a discussion about the impact data has on clogging the pipes. 4G often gets overloaded and 5G will be the same without extensive investment in local infrastructure. Considering that in high concentration areas like financial centers or large cities, there could be a million or more IoT devices per square mile, all offloading data 24/7, the potential for a blank screen is inevitable. Imagine being driven around Los Angeles in an autonomous vehicle and the data is interrupted. The highways there are already a mess and stalled, driverless cars would be a nightmare.

On the positive side, the ability to have near real-time critical support using augmented reality glasses such as in heart surgeries or bomb diffusing can be a major advancement in those areas. A surgeon may even do the surgery using a robot that they control while they are a thousand miles away.

Speed and latency are the two primary components of 5G.

5G Components

- Improved speed is a big reason 5G can deal with more data. Consider a car racing team where the car is the fastest on the track. The advantages are clear. More speed, more potential to be in front. But speed alone does not win.

- Latency is about how efficient data can move and complete an action. Speed is a part of latency and vice versa but consider the racing analogy again. If the fastest car also has the most stable suspension, great tires, a pit crew that is fast with no mistakes and a process that cuts back on time to change tires and gas up along with a driver who is savvy and knows how to keep an edge in each race, you have a winner.

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*"Key to **5G success** are local equipment nodes that act as small cell antennas for getting the **speed and latency** solved to the final point of use."*

There are many papers that talk about the benefits 5G will bring to the public and private sectors and here, the discussion revolves around how tying local Edge Data Centers to Edge Computing and hybrid cloud environments is the future of a robust ecosystem.

Key to 5G success are local equipment nodes that act as small cell antennas for getting the speed and latency solved to the final point of use. All global has to be local as well for the promise of 5G to be realized to its full extent. To get to the last 1,500 feet (or last mile), the connections have to be in place upstream. Locations like Fortress Data Centers 274 Brannan which has carrier neutral direct peering and rooftop satellite feeds offer a key piece of the local/global connectivity need.

Technology Focused Cities Need to Act Fast to Secure Base

For cities like San Francisco, the current times represent huge challenges as the world shifts to remote working and learning methods. Co-working spaces are at risk of losing their base of entrepreneurs and corporate innovation groups. As a technology driven city, the potential to see significant movement away from the city to work-at-home methods means city policies have to be carefully crafted to avoid long-term impacts.

Ensuring that 5G and Edge Computing infrastructure buildout is a top priority will gain the city an advantage in keeping residents and business intact.

Smart city initiatives to connect IoT devices for improving city services will also help position a city like San Francisco as a strategic city for business and institutions.

Is 5G Going to Meet the Demands of the Next Generation Worker, Business and Education?
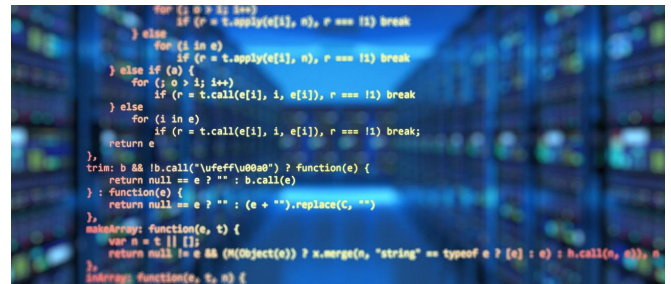
Distributed Workforce and Students at All Levels

As a fundamental shift toward remote work and learning happens all over the globe, the demands for fast network speeds and low latency efficiency will increase incrementally. While it may seem that a wide distribution of workers and students may lessen the strain on a network, the need for small cell antennas to optimize the network effects of 5G may create an even higher level of investment needed to cover every business and residential area.

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*"**Edge Computing and AI** are compatible technologies that will accelerate in a 5G enabled environment."*

For cities that move quickly to ensure all residents are covered by a 5G connection and small cell wireless mesh, they will drive incremental advantages for living there. See Smart Cities discussion about how Verizon has partnered with pioneer smart city Lake Nona, Florida for how they are prepared for all that 5G offers.

For education, the need to prepare our students for a combination of in-classroom and at-home work has never been more profound. A generation of our youth is at risk of losing fundamental experiences in learning that will manifest in the potential for a slowing in global competitiveness years from now. On the contrary, the opportunity to use immersive and situational technologies like virtual reality, augmented reality and artificial intelligence could expand learning such that our students are even better prepared to face the challenges a globalized economy.
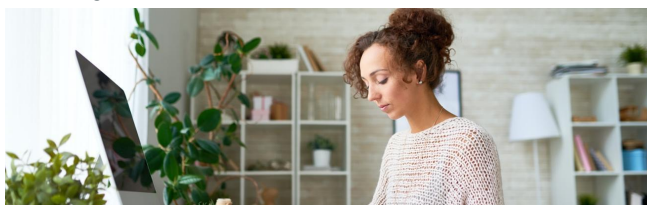
Artificial Intelligence (AI)

Edge Computing and AI are compatible technologies that will accelerate in a 5G enabled environment. Per Wikipedia, artificial intelligence "sometimes called **machine intelligence,** is intelligence demonstrated by machines, unlike the **natural intelligence** displayed by humans and animals."

AI is being developed to make life safer, more productive, more enjoyable and better in ways that are societal and personal.

With the promises also come the challenges because bad data in, can lead to less than expected outcomes and in some cases, even dangerous situations. Imagine drone surveillance for social distancing and enforcement. Several programmed and machine-to-machine scenarios could be initiated for drones to identify and enforce social distancing such as:

- Area wide surveillance from higher altitudes to narrow on groups that are closer together than requirements allow
- Close in hovering to perform group temperature checks to narrow on higher level temperature individuals (HLTI)
- Digital tagging of HLTI for authorities to stop and further determine potential for infection
- Ability to digitally attach a tracker to the phone of a HLTI for tracer purposes.

In this example, the potential for misuse or false positive identification leads to many societal issues including an increasing mistrust in the government, "here to help you" dichotomy. With 5G, data access is better which should lead to more positive outcomes. The wireless mesh allows for faster and lower latency machine-to-machine data exchange and offloads much of the computations to Edge devices with the expectation that the larger processing capability is more intelligent.

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"The more complex the experience, the more ***processing power*** *is needed with* ***5G, Edge Computing and hybrid networking*** *coming to the forefront of supporting this need."*

Drones in day-to-day citizen surveillance may never be a good idea but the active and passive surveillance using cameras is already happening. With 5G, the ability to quickly identify abnormalities in scenes can provide significant value in keeping the public safe, secure and confident in our day-to-day activities. AI has millions of use cases and 5G is an enabler of making it a key part of our lives.
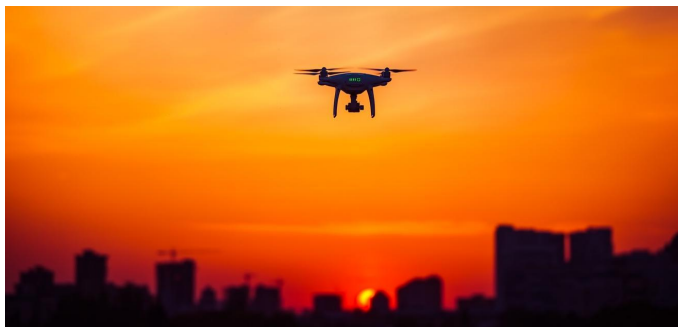
Augmented Reality (AR)

One of the first uses of AR was in Air Force pilots' helmets as a heads-up display. More recognized is the use of on-screen AR for sports such as Hockey's glow puck or the yard marker line in American football. The definition of AR varies depending on the "expert", but the general characteristic is as a digital overlay on a real visual. The fact is that most AR is contrived AR in that there is typically a video stream with a digital overlay on that.

The purest example is with a glasses-type device with digital images served in the lens or projected on the lens while the user sees reality through the lens.

There are other ideas on AR such as the introduction of artificial experiences within the reality space including artificial smells or subliminal sounds that "augment" the reality experience. Regardless, the ability to enhance our environment in work, education and entertainment has many uses and benefits. And the more complex the experience, the more processing power is needed with 5G, Edge Computing and hybrid networking coming to the forefront of supporting this need.

With major companies like Apple putting significant investment in bringing AR mainstream, the expectation is that within the next five (5) years, AR will be widely used by consumers for entertainment, social networking and communications. Google released GLASS with much fanfare but was not able to get past the negative appearance of losing individual privacy and the overall stigma of geekiness. For glasses devices, the next generation will need to be fashion-first, or it will be sidelined quickly like GLASS for consumers. Snapchat's Spectacles are another example of a glasses device that is yet to prove success or failure.

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*"The highest potential for VR lies in the **education and training** sectors."*

AR on the phone has been growing in popularity since Apple opened up the access to the camera SDK (software development kit) on the iPhone to developers in 2009. Many projects have had success but the Pokémon Go phenomenon took AR to a different level with consumers.

Quietly building momentum has been the use of AR in enterprises and defense. Applications like See-What-I-See and guided instructions create work efficiencies and job performance improvement that significantly improve productivity. Key to these gains is the ability to keep the hands free from holding a device, allowing the user to coordinate the visual with the task. Google GLASS has been reborn as an industrial and job tool. Numerous head mounted devices (HMD) sometimes called heads up displays (HUD) have been developed for enterprise use and the technology is advancing rapidly.

Like AI, AR performs best with fast wireless speeds and low latency. When all the processing is put into the frame of an HMD, the devices get bulky, heavy and can overheat with use. Offloading to Edge Computing or up to the cloud needs infrastructure enabled by 5G for getting data to where it can be used. Tethering to a phone or other wearable device allows for local process improvements and by connecting other Edge and Cloud platforms, the ability to render images on glass provide value to the user in many ways. The result, more productive workers, better educated students and higher value to the community.

With Fortress Data Centers, technologies like AR are at the core of planning the next generation of

Edge Data Center.

Utilizing a carrier neutral approach with 5G enabled, dark fiber to other data centers, SDN (Software Defined Networks) connections and mission critical colocation, the capability to maximize 5G for AR is in place.

Virtual Reality (VR) is another transformative technology that is currently underestimated by major consumer brands. For gaming, immersive experiences are becoming the norm. Being inside the game is the ultimate way to move through scenes. Outside of gaming, advances in virtual shopping, virtual concerts and other "digital twin" applications are being developed. he highest potential for VR lies in the education and training sectors, such as:

Traditional Methods	Immersion/Simulation with AR and VR
Memory retention decline by up to 50% within days of learning something new.	VR has 80% retention after a year.
Traditional training methods can require long hours and large facilities.	VR is retained like a MEMORY as it puts you in the situation.
Training is provided at the beginning of the learning cycle with little or no follow up.	Learners are 2^X more likely to remember the details.
Existing training videos and lecture rely on passive observation techniques to teach.	AR is 25% faster to comprehend than traditional instructions.
Current immersive learning distribution is cumbersome, expensive and time consuming.	AR reduces error by 90% for first time tasks.

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*"**Immersion using Simulation** is second only to real-life experience training."*

Immersion using Simulation is second only to real-life experience training. And people can practice with it as much as practical without the typical downsides of doing the physical or emotional task in person. It provides safety in training dangerous tasks, creates embedded experiences for long-term memory, associates imagery in ways that video or still images can't provide and can be connected to remote trainers and local IoT devices for dynamic variability.

Imagine a student using 3D VR content associated with event-based experiences to learn the Periodic Table? Jurassic Park meets the Classroom as an element on the ground that can be picked up and thrown at the dinosaur.

Or an ability of an airline pilot to practice flying the Boeing Max 737 while on layover at an airport. Putting people through experience training using simulation will create a new, higher level of competency in practically everything.

With simulation comes the need for higher levels of image rendering and processing. Getting to Reality using Simulation takes a lot of bandwidth. 5G will drive advances here because the networks will be able to handle the higher load. Higher Education Institutions will need to differentiate themselves by having an on-campus and off-campus strategy to connect students with more intensive experiences through private networks and other methods, while 5G is deployed across regions.

At Fortress Data Centers, one way these needs are being addressed is by using zero trust SDN networking providers like [NetFoundry](#) to give customers a way to spin up private environments. Combined with a 5G carrier such as Verizon, AT&T or T-Mobile, an SDN provider can further provide speed and low latency solutions for current 4G networks as well as the ultimate with full, 5G deployment. [Fortress Data Centers works with a number of providers](#) to help accomplish the goals of mission critical colocation and Meet-Me Room (MMR) customers.

Blockchain

One of the most exciting newer technologies is Blockchain. It takes decentralization to a new level and fits very well with local Edge Computing and Edge Data Centers. There are various types of blockchain protocols that have similarities but are unique with their own advantages and disadvantages.

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*"Most promise scalable and low-cost transactions which can work well for **international monetary exchange** and in providing ways for the unbanked to make payments without having a bank account."*

Most promise scalable and low-cost transactions which can work well for international monetary exchange and in providing ways for the unbanked to make payments without having a bank account. Third-world countries in Africa and other parts of the world will be able to use certain transaction apps with their phones that bypass traditional banking. It is like [bartering](#) a cow for three pigs only you don't need the three pigs because you get paid in a digital currency that you can use to buy other things.

Without going into detail, there are various types of protocol systems such as [Proof of Work, Proof of Stake, Proof of Authority](#), etc. They all act to enable transactions (monetary and otherwise) by ensuring that the transactions are legitimate between parties. In the traditional financial system, third parties typically ensure that the transaction can be made such as credit card processors, bank foreign exchange systems, stock exchanges, etc. In Proof of Work, each transaction requires a small amount of mathematical work to be done by a [miner which goes into a block](#). Miners get rewarded with cryptocurrency for helping approve the transaction. The term mining cryptocurrency takes its name as an analogy to miners of precious metals where they work to get the gold, silver or other metal out and get rewarded with what they mine.

Miners typically use high powered computers specifically made for these activities. However, new Proof of Work platforms are emerging such as [Pi Networks](#) where miners can use their mobile devices to "mine" Pi Tokens.

Pi Network is not completely related to mining major cryptocurrencies like [Bitcoin](#) or [BitcoinSV](#) as it is more of a reservation system at this time and the true work goes on at the node level.

Proof of Stake and Proof of Authority are basically set up to validate transactions based on the stake that people have in owning the cryptocurrency or the authority they have based on how the community ranks them. These types of protocols typically get paid in transaction fees and participants can participate in Proof of Stake one day and withdraw from it the next. The system is always looking to match up the holder's stake with participation in the validation process. As such, cost to do transactions can vary widely and may take time to confirm if the there is significant holding versus locking up for transaction validation. [Ethereum](#), originally a Proof of Work protocol is working on Proof of Stake implementation as [Ethereum 2.0](#) because it offers advantages such as significantly lower electricity versus mining hardware. It also allows for a much more decentralized validation environment. Where Bitcoin mining is being done by large organizations with access to low costs of energy, the disadvantages are that mining may be done in areas that can put risk into the operation due to geopolitical issues. With Proof of Stake, moving to local [Nodes](#) for validation of transactions means this can be done anywhere and it can lower risk factors outside of the validation process so it does not interfere with the capability to complete a transaction.

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"Security can be broken into several categories. For this paper we focus in two: Network Security and Community Care Security."

Enter [Edge Computing, 5G and an Edge Data Center like Fortress Data Centers](#). The interconnectivity of the Meet-Me Room with carriers and other participants in the Fortress Data Centers Fiber Hotel can flow data through a network from nodes scattered across their service area. Local nodes can pull data from various file storage systems and also access distributed data environments such as in development by groups like the [Filecoin Team](#). In the future, the potential to make all things man-made into a data storage system will mean that local nodes will aggregate data they have access to and roll that up to a larger node or set of nodes located in Edge Data Centers, then up to the Cloud. The common threads here are speed, low latency and a robust network so that failure points are eliminated, or data is rerouted through another direction to ensure systems stay online and transactions happen.

Smart City

Nearby to the Orlando International Airport is the Lake Nona community. Developed by billionaire [Joe Lewis](#) and his [Tavistock Group,](#) Lake Nona was envisioned over 25 years ago as a community for the future; a Smart City. It is an example of how future planning for technology must be a core part of a Smart City framework.

The Tavistock Group built Lake Nona from the ground up with a purpose of bringing a combination of residential, business and educational institutions forward into technology by having the most progressive infrastructure possible.

They laid their own fiber in anticipation of a future where improving generations of connectivity could be capitalized on. They have added dense small cell antennas to support the wireless mesh needs using 5G today and 6, 7, 8 G of the future.

Lake Nona's [partnership with Verizon](#) is now bringing the capability for a fully enabled 5G community that is a test lab for technology such as [autonomous vehicles](#) and advanced health care practices. Lake Nona is just seventeen square miles, but it provides a glimpse of what every community from large to small needs to envision and implement to take advantage of the 5G advancements. It can be a massive challenge for cities like Los Angeles, San Francisco and New York City but the alternatives are to see your industry and residential base move away to more aggressive cities that are investing heavily in connectivity infrastructure.

Security and Community Care

Security can be broken down into several categories. For this paper, the focus is in two areas:

- Network Security – how protected the data flow is from penetration and attack
- Community Care Security provided by law enforcement, healthcare institutions, government and others – how secure and confident we are in the ability of the local and regional governments and others to ensure our persons, residences, businesses and institutions are protected and unencumbered by issues that present threats

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*"**Edge Computing, Blockchain and 5G** enable this data flow based on individual permission to happen seamlessly."*

There may be questions on how these intersect but the basic premise is that with better training, analytics and data flow to point of need, first responders and others in roles of societal support can create a better environment of trust and confidence in the system to work as intended.

Network Security is one of the essentials of maintaining data integrity. With billions of new IoT devices coming online every year, each becomes a potential failure point for network security. At the home level, devices connect to many different environments; mostly cloud platforms from the company providing that device. An individual's data and usage patterns flow with little thought on how that data will be used or on whether that data can be intercepted. The reliance is on the network and faith in the device providers to ensure that data integrity is maintained.
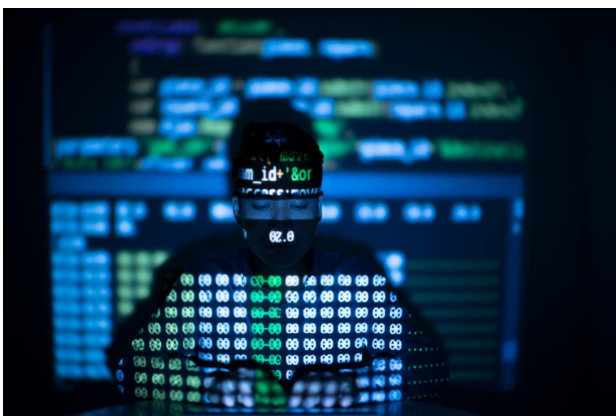
In the near future, this reliance will shift to a base control by the individual of their data before it goes up to a myriad of cloud platforms. Blockchain may be the primary technology that allows this to happen as it will create a distributed ledger of personal information on nodes close to the creation location that allows for personal permission decisions on how and what data is shared. Incentives by companies to access that data can then flow down to the owner as rewards, discounts or other compensation.

Edge Computing, Blockchain and 5G enable this data flow based on individual permission to happen seamlessly. Network Security is enhanced at the local event level and through other methods of data security up the line, confidence in data integrity can grow for both provider and user.

Community Care Security has been tested with the recent COVID-19 pandemic and civil unrest. Like Network Security, in order to create confidence in the public that the system works, and things won't break when needed, technology is advancing to provide the tools for supporting a harmonious community.

Referring to the Virtual Reality discussion above, simulation training will advance skills before field situations arise in need of those skills. Law Enforcement cultural empathy training, hospital patient experience training, first responder training on severe trauma care and firefighter training on chemical fire mitigation are just a few on the immersive simulation trainings that will improve Community Care.

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*"The future of a connected and protected society will be driven with a focus on the local because in the end, **We Are All Here.**"*

All of the technologies discussed can be integrated into a cohesive, community care initiative to improve relations and support which cities, states and the national government need to provide for positive community environments.

Local to Cloud and Back; With the assumption that all data starts from a local action, the need for speed and low latency protected by network security is more critical with every device that gets put on a network. Fortress Data Centers and other Edge providers deliver critical components in the infrastructure around Security. This in turn leads to personal and community care security that propels a locality to a positive future.

Summary: Connecting the Dots

A Smart City can be of any size. It should not only be guided by a progressive technology focus but also by a principle that humans are the reason technology is developed. Humans reap the rewards of 5G and Edge Computing and Simulation Training and Network Security and all else. Humans are invariably local and with the massive number of devices and their data output coming online, local is the new priority.

Local rolls up to regional and then to national and eventually global. But it all starts at the local.

At Fortress Data Centers, the mantra is "We Are Here" and it stands for the physical infrastructure but more importantly, the people that support customers and partners. The growth of IoT is creating a new level of requirements to deal with data and the rise of Edge Computing can only be supported by a significant 5G enabled ecosystem in the near term. Communities will rise or fall based on whether they are aggressively preparing for the sea change that is happening.

Working from home, learning from home, remotely performing a surgery with robots and guiding a local resource through see-what-I-see capabilities are shifting the shores of where a person lives and works.

The future of a connected and protected society will be driven with a focus on the local because in the end, **We Are All Here.**

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