Smart Homes and Smart Cities: Why Don't They Exist Yet? An Analysis of "Smart" Paralysis

November 11, 2016

There is no shortage of city officials and IT experts who want to turn their city into a Smart City. But despite 2+ decades of talking about smart cities, and -at last count- 5 gazillion smart city solutions, what has been achieved till date?

A cute sensor-network here, an interesting alert-system there, a nice lighting solution here, a successful refuse-collection sensor deployment there; that's all great, but it's nothing special. We've read many "vision statements", plans of action, RFPs et cetera, coming from a range of involved people, ranging from giant tech firms to industry analysts to IT guys. Also very nice, but aren't they forgetting something?

Network and Infrastructure Challenges

Smart City solutions are ready to be implemented, but those solutions need to communicate to/with systems and/or to/with the Internet. There are a few ways how existing solutions can communicate (or in more technical terms: backhauled):

- Satellite
- Fiber
- Wireless (Fixed [FSO, micro/mm-wave], Wi-Fi)
- 3G mobile data
- 4G mobile data (usually LTE, but in certain markets also with WiMAX)
- TV White Spaces (still in embryonic phase)

Solutions that require low to medium capacity or speed can work perfectly fine over 4G, and maybe even 3G. But the minute you need higher capacity/speed for your solution to operate well, you'll be helpless. The only reliable way to transport/backhaul IoT/Smart City solutions at high capacity/speed is… fiber optics. This will be even more of a pressing issue due to the monthly, ever-increasing data consumption – by consumers, households, businesses, law enforcement, working people, connected (smart) homes, connected cars, (link) etc. There is a multi-layered infrastructure to consider:

1. Access (today it's usually Cable or DSL, Fiber to the Home/Premises, Leased Lines).
2. Local backbone (in your street, neighborhood)
3. Metro backbone (in your city)
4. Long Haul (intra-city, nationwide – connecting to Data Center)
5. IP transit (connecting to the Internet at Data Center)

At one or more of those levels, most likely there will be bottlenecks that limit the data throughput to and from your devices which you use at work, on the move, or at home.

Let say, for example, your city council or an ISP decides to roll out Fiber to the Premises. They promise you 1 gigabit speeds. There will be two options when they roll out: dedicated and shared.

© 2016 Angie Communications International B.V. – Angie Communications USA, Inc. Copy and use by third parties in whole (not in part) is permitted.

And let say the ISP promises you dedicated 1 Gigabit service. The technology is there, it could *theoretically* work. Alas, there are two major problems for operators: investment and operational cost, and technological capability.

While the FTTP industry has two deployment options, PON (Passive Optical Networking) and AON (Active Optical Networking) technologies, we would rather not waste our time discussing PON. The conclusion below is even worse for PON than for AON. Angie is integrating AON solutions in its next-generation telecom/smart cities projects, which can overcome existing limitations within PON in terms of speed as well as bandwidth in a future-proof infrastructure.

Network technological limitations and economics

The local backbone, where the fiber from your premises gets connected to the (metro) fiber optic network (in order to then connect to systems and the Data Center), most likely can't handle more than 1 gigabit speed. The equipment that they have placed at the local level is most likely max 1 gigabit or a multiple of it, maybe even 10 gigabit. There you go, while you may have a dedicated 1 gigabit connection at your premises, the bottleneck is now at the local backbone level. You'll get to share that 1 gigabit connection with hundreds of others.

Then there is the other level where your ISP may throttle you. The IP transit. Netflix recommends a steady 25 Mbps connection for Ultra-HD streaming. Ultra-HD TV sets will become more common in the coming months and years (and 8K is also coming). So, in a few months more people in your street/neighborhood will start watching their streams in Ultra-HD, and more people will start using content and services in Virtual Reality, Augmented Reality or Mixed Reality. It will start with gamers, but soon enough even mom will want to experience a cooking lesson in a virtual class, and dad will want to start jogging on a virtual track, together with his pub pals who are also connected from their own homes. Depending on the kind of interaction (application mix: VR, UHD etc.), a typical family will need approximately 100-200 Mbps (if not much more – link). Now, let's do the math:

- Let say your local backbone can handle 10 gigabit speed (highly unlikely, but for posterity)
- There are 400 premises connected to/served from this local backbone (possibly much more, but OK)
- The sustained (guaranteed) speed would be 10,000 Mbps / 400 = 25 Mbps
- At peak time, each premise (family) needs 100 (if not 200 or more) Mbps
- The required sustained speed is: 400 premises x 100 Mbps = 40,000 Mbps (40 gigabit per second).

Now, this means that even if there is a 10 gig/sec local backbone from your FTTP service provider or other ISP, the minimum requirement at peak time would be 4 times as high if those families are online at the same time, and online they will be – who watches broadcast TV these days? And while 100 Mbps sounds a lot today, we are confident that within 3 to 5 years, families/offices will require

© 2016 Angie Communications International B.V. – Angie Communications USA, Inc. Copy and use by third parties in whole (not in part) is permitted.

more than 1 or 2 Gigabit per second sustained speeds, each – during peak time.

While the term ISP means Internet Service Provider, the majority of ISPs will not be able to promise you a quality Internet Service in 2 or 3 years from now, let alone 5 years. You'll be crying your eyes out while trying to get a decent Netflix UHD stream, mark these words. Mind you, while improvements will be had by system upgrades (for example for the cable industry from DOCSIS 3.0 to 3.1 to 4.0), these won't help much because data traffic (the need for capacity and speed) is growing at a much higher rate than the system improvements can handle. Thus, there are huge challenges for operators to deliver you some decent internet service today, let alone in a few years from now. There is no way that existing networks and systems will be able to deliver the upcoming required speeds, not even DOCSIS 4.0 or NG-PON and even FTTP based on xPON systems or yesteryears' active Ethernet. Your bandwidth will still be contended, shared or divvied one way or the other, somewhere.

Wherever you have nice connectivity, be it on fiber or cable or DSL, congestion is awaiting you, sooner or later, one way or the other, the minute Ultra-HD and VR applications become available. If it's not at the access level, it will be at the last mile/local backbone level.

A whole new parallel network needs to be build, at the access level and last mile/local backbone level. This has industry-devastating implications; system upgrades won't suffice and the existing Outside Plant will have to be ripped out and completely replaced. Anything less will be just a connectivity disaster in the making. And no, upcoming 5G mobile connectivity won't make those issues magically disappear either. 5G may improve access level (just like 4G is an improvement from 3G), but (especially) then the local backbone backhaul capacity needs to be in terms of multi-ten gigabit speeds. The arrival of 5G will make machine to machine communications and autonomous driving a reality for the masses. (The biggest challenge is latency, but that is a whole other story.)

This, then, brings us back to the Smart City ambitions and visions of city councils and their advisors. The danger for them is the severe lack of understanding of how operators work, and -more importantly- how next-generation communications systems really are built or configured. Why would operators voluntarily share their technological, business and deployment models anyway?

Sure, city councils will have great external advisors in the form of consultants, vendors and suppliers, but there will be major incentives for the latter to push their own goods. Frankly, we have rarely ever met a single smart city expert who knows how next-generation infrastructures work, from end to end. These experts maybe know the technological side very well, but then they most likely lack know-how of operators' networks and systems *and* their business models.

There is a 99% chance that your Smart City initiative will flop!

As explained briefly, above, homes and offices are not ready for the upcoming explosion in data traffic, let alone the city as a whole. A light version of a Smart Home may already be an option today, but in a few years you'll need multi-gigabit speeds. Your city being smart,

© 2016 Angie Communications International B.V. – Angie Communications USA, Inc. Copy and use by third parties in whole (not in part) is permitted.

Internet of Things (IoT) being a real city-wide solution, implementing future-proof networks? That's an almost impossible option if the good people at city hall keep believing the fantasies from consultants, vendors and tech firms that they are being fed today.

First we have to identify what a Smart City really is. In her great report, "What is a Smart City?", Sophie Quinton, fiscal and economy writer for Stateline, quotes a few people:

> "The concept of a smart city is somewhat amorphous, but it's focused on cities leading with technological innovation," said Brooks Rainwater of the National League of Cities.
>
> "It's just using digital technology to improve community life," said Jesse Berst of the Smart Cities Council.
>
> "It's a paradigm shift in the way we think," said Kate Garman, the innovation analyst for Kansas City.

See? Again the talk centers around technology and innovation and all those interesting things. They don't mention the communications and networking infrastructure. As said before, usually the vision doesn't reach beyond 4G mobile connectivity as the means of data transport. For CCTV they may use fiber optics or Fixed Wireless, but that is never an option for the entire city with hundreds of Ultra-HD cameras per square mile. That is a massive challenge, right there.

So, the primary problem for a successful Smart City, that could make every means of data traffic possible, is at the access and transport level. But another *much* bigger problem is now lurking.

Local Backbone or Last Mile

A massive effort is being taken by Mobile Operators and their network partners to relieve their mobile networks from data users. They have two options these days:

1. Wi-Fi offload, and 2. Small cells

The minute you get home or at the office (or restaurant), you want to connect to Wi-Fi. Mobile operators love that! Because instead of being a constant liability on their network, you are now eating data from your own ISP, connecting to the Wi-Fi router.

Small cells could be deployed by mobile operators in your neighborhood to increase coverage and more equally distribute mobile bandwidth among a smaller number of users.

Now herein lies a huge challenge for the mobile industry and fiber network operators: they need to find locations to install those small cells, and – worse of all, they need to bring fiber to all those small cells.

Again, cute local Smart City (pilot) projects can be very successful in most cases due to 4G mobile connectivity. But that's based on today's deployments and technologies, and unable to handle applications that require reliable, fast data transmission.

Most city councils have been very hesitant in dealings with mobile operators and their small cell desires. They think it's those huge companies' problem and not theirs. Wrong. Deployment of small cells, backhauled on fiber, is a necessity. The mobile operators are

© 2016 Angie Communications International B.V. – Angie Communications USA, Inc. Copy and use by third parties in whole (not in part) is permitted.

willing to invest in small cells because it improves coverage and reliability, but it will be most beneficial to residents and businesses. If this won't happen, your neighborhood, your city will go to the dogs within 5 painful years. People with higher disposable income and modern, Internet-powered companies will flee your city and seek greener (better connected) pastures. Tax revenues will fall and because it becomes a vicious circle, your city spirals down to the drain. Playing power games against those behemoth operators may give city officials a nice feeling about themselves, their residents and businesses bear the brunt.

But even when the city council wants to work with the mobile operators and fiber network operators, what can they offer as distribution points? Rooftops? Walls? Street lights? That won't cut it.

The main problem is that the huge, explosive growth of communications traffic will mean that many devices must be installed. In the 5G mobile industry we're already talking about Heterogenous Networks, where all kinds of technologies and equipment gets installed as close as possible to the mobile and wireless user. Installing those devices on rooftops and walls or street lights can't be relied on for most of the network/infrastructure. Let's make an estimate:

1. Radios: 2 units
2. Wireless Access Points: 2 or 3 units
3. Small cells: 2, 3 or 4 units
4. Pico cells: 1 or 2 units
5. IoT/Smart devices: 1, 2 or 3 multi-sensor, multi-purpose units.
6. Smart TV screens: 1, 2 or 3
7. Fiber wiring
8. Electricity wiring

The Smart City of the future must have screens everywhere, especially in residential neighborhoods -where it is currently often not even considered/allowed-, for instant updates, alerts and other forms of real-time city-2-citizens communications. There must be electric charging points at every other parking spot, not just 2 per 2 streets. Thus, besides a from-scratch access infrastructure, a from-scratch backhaul and smart, future-proof infrastructure needs to be build.

The major question is: Does the city want the Smart City-enabling devices and technologies scattered around the neighborhood, or does it want to organize it in a way that everybody benefits?

Who stands to benefit from an organized Smart City infrastructure?

Imagine that every 200 or 300 meters one pole would be raised, around 10 meters high, where most of the things described can come together, connected to a multi-10 gigabit local backbone. It would solve the zoning headaches and the scattering of the upcoming onslaught of small cells and IoT deployments. Who will benefit?

1. The City (on the screens: city updates, alerts, announcements; zoning: concentration and organization of all devices that *must* be deployed for residents and businesses in order to give them an equal chance to enjoy and compete with the rest of the evolving smart and intelligent cities)

© 2016 Angie Communications International B.V. – Angie Communications USA, Inc. Copy and use by third parties in whole (not in part) is permitted.

2. City institutions (sensor based, IOT solutions for a multitude of applications that will benefit citizens and the city in terms of monetary savings and operational efficiencies)
3. Residents and businesses (on screens: residential and business users will be informed instantly through the city and general news feed,; time on screen can be reserved for local content makers; gigabit connectivity - either over wireless or fiber)
4. Law enforcement (CCTV in Ultra-HD quality video -, footage stored for 1 year; instant sharing of Ultra-HD videos amongst fellow officers, with control room and with relevant authorities; this would also allow VR-enabled research by investigators etc.)
5. First responders (instant sharing of Ultra-HD videos amongst fellow first responders, and fellow authorities)
6. Advertisers (70% of the screen time will be reserved for advertising)
7. Media (10% of screen time will be reserved for news feed)
8. Mobile operators (small cells and pico cells deployed on the structures)
9. Locals, tourists and visitors (free one-hour Gigabit Wi-Fi access through the HotSpot)
10. Fiber operators (interconnection of the new local backbone to existing fiber network)
11. Building owners (making a building smart [biometric access, smart access, smart metering/monitoring, etc.], in-building connectivity will improve in major ways, and in-building equipment can communicate to and be backhauled on the local backbone – view article)
12. IoT/Applications/Solutions providers (the infrastructure could be open access for IoT/Smart solutions providers)
13. Electric car charging (wherever possible, the poles should have an electric car speed charging points - for at least 2 cars)

Depending on the ultimate configuration of the infrastructure, the CapEx per square mile could range from $750,000 to $2 million. It would take between $50 million and $60 million, for example, to build this future-proof local backbone infrastructure in Manhattan's 30 square miles. Los Angeles has approximately 300 square miles of residential, recreational and commercial area. It would cost anywhere between $300 and $600 million to future-proof Los Angeles as a Smart City. That is excluding the eventual cost of rolling out Fiber to the Premises. The same goes for NYC or London.

Who is going to build all that brand-new access and local/last mile infrastructure, or the Smart City infrastructure? Which technologies to use? Which solutions to enable? Which business model? Who is going to pay for it? Who is going to operate it? This is where Angie comes in play. We offer to take away the financial, operational and business risks, and to build entire cities into Ultra-Intelligent Cities, not just Smart Cities (link).

Angie's Vision Statement

Angie wants to be the enabler of a consciously connected world for citizens, businesses, institutions and cities. Our vision is to empower

© 2016 Angie Communications International B.V. – Angie Communications USA, Inc. Copy and use by third parties in whole (not in part) is permitted.

them and offer innovative, compelling telecommunications and digital-world services, while transforming and enriching peoples' lives and society as a whole.

Angie's Mission Statement

Since March 2014, Angie has realized a working relationship with hundreds of companies, ranging from some of the world's largest builders and technology firms to some of the world's most exclusive boutique advisors, that have passed all requirement criteria. Angie has access to (hundreds of) thousands of buildings, rooftops, masts, street lights and other structures all over the USA, UK and the Netherlands, with many more countries on its roadmap. To take on this gargantuan task, Angie has gathered a large collection of international as well as local firms in special purpose consortiums, is tasked with the permitting, design, engineering, construction, and operational parts of building true Ultra-Intelligent cities.

Problem Statement

Besides the infrastructural challenges, there is, however, another major difficulty: the present attitude of some city officials and their advisors. If they are not restricted because of some pre-existing "relationship" with the incumbents, they still may be stuck in the past, thinking that rents and revenues will immediately begin to flow into city coffers from allowing Smart City enablers to install IoT infrastructure. They cannot mentally step back to see the massive gains their city will reap from such infrastructures. Or they use zoning laws as a powerful negotiation issue. We are aware of mobile operators being stopped in their tracks in efforts to deploy small cells. How will these city officials ever get a satisfied citizenry or autonomous cars (let alone autonomous flying cars) and a sensor-based infrastructure in place? By insisting on their outdated requirements, and by demanding operators to bend over backwards in order to do what they are supposed to do (deliver the best service possible), old-school city officials and their advisors only achieve that their city will be stuck with insufficient bandwidth and capabilities, most likely being bypassed by neighboring cities with a more forward-looking council, which then gets its Smart City credentials first.

City officials and their strategic advisors have to start realizing that the world is changing, fast. Their assistance and guidance towards a real transformational society is required, but that means they have to come off their high horses and think past their serving years. They have to make real efforts to make their city a full-fledged Smart City. They have to create a model where innovative, disruptive organizations like Angie are welcomed and facilitated to develop and build the infrastructures of the 21st century. If they don't, the next few years will place them on the losing side of history while their neighboring cities and communities may flourish beyond imagination.

For more information on Angie's Smart City/Ultra-Intelligent Cities approach, please visit www.ang.ie/news or view Angie's extensive document linked at the bottom here.

Authors: Neal S. Lachman, Group CEO, Angie Communications; Dr. Mahmoud El-Sherif, Group CTO; Gregory Nemitz, Group COO; Farooq Malik, COO Americas; Bob Chatta, COO Europe; Nirmal

© 2016 Angie Communications International B.V. – Angie Communications USA, Inc. Copy and use by third parties in whole (not in part) is permitted.

Gharial, International Director Network Design & Engineering, Diepak Kasi, Special Advisor; Ian Browde, Special Advisor

About Angie

With its massive projects in multiple countries, Angie is the world's largest telecoms startup (link). The company has projects underway in UK (www.angiewireless.co.uk), USA (www.angiewireless.com) and Netherlands (www.angiewireless.nl).

Angie was founded by a team of highly qualified technology professionals with proven track records. Angie's team includes renowned visionaries and industry pioneers who have helped shape the 4G mobile, 5G wireless and Fiber-To-The-Premises industries. Angie's founding team has a combined 500+ years of experience in business; its executive team consists of industry pioneers and experts with a combined 300 years of telecom experience, including Neal Lachman, Gregory Nemitz, Nirmal Gharial and Dr. Mahmoud El-Sherif.

Team members have experience (salaried or projects) with: 360 Communications, Agilent Technologies, Alcatel-Lucent, Apple, Arqiva, Atlantic Telecom, ATT, Bell Labs, BT, Cable & Wireless, City Reach, CityFibre, Colt, euNetworks, Ericsson, Hibernia Networks, HP, Kcom, KPM, Interoute, Level3 Communications, Lucent, MOD, Motorola, NASA, Nokia, Numericable, O2, Openreach, Orange, Quest, Telefonica, TeliaSonera, Sky, SSE Telecoms, Stentor, Sycamore, Tata Communications, Three, Viatel, Verizon, Virgin Media, Vodafone, Zayo.

Over the past 16 years, members of Angie's team wrote numerous critical analyses, sanity-checks and consultations on FTTP, 4G mobile, city-Wi-Fi projects, etc. This trend started in 1999 with satellite broadband and includes; in 2000 on power-line communications; in 2001-2003 on PON technologies; in 2004 and 2005 on the shortcoming of WiMAX and city-wide Wi-Fi plans; in 2007, the team wrote "the book" on next-generation communications; in 2009, they wrote a critical analysis on KPN (Dutch incumbent) ambitious announcement for 100% nationwide fiber rollout; in 2011 on CityFibre Holding's grand plans to connect 1 million households in 3 years; in 2012 the team wrote a critical analysis and sanity check on Google Fiber; and in early 2015, they wrote consultation papers for the 5G mobile access/services inquiry of the USA's FCC and UK's Ofcom.

Angie specializes in Next-Generation Communications Infrastructure and is dedicated to realizing the convergence of brand-new infrastructures in order to provide a seamless, ubiquitous customer experience, as well as to enable Internet-of-Things, smart-city solutions and services. By building these next-generation MB/WA and FTTP infrastructures from the ground up, without being encumbered by ownership of any legacy systems and operations, Angie creates a fully converged nationwide infrastructure, operating ultra-high-speed MB/WA networks.

Angie's team conceived the concept for a different kind of telecommunications company. One that would bring about next-generation innovations and offer corresponding premium services to all, with the central remit of ensuring customer happiness, through transforming and enhancing people's everyday lives, and by creating a true lifestyle convergence company. Together with partners, we are realizing this vision within our first international markets where we will offer a major step-change in wired, wireless, mobile, and associated content services – to enable seamless convergence and lay a solid foundation for emerging application areas such as smart cities, internet of things, and immersive digital worlds, among others. We act in the true spirit of our motto – *Going Beyond Imagination*.

© 2016 Angie Communications International B.V. – Angie Communications USA, Inc. Copy and use by third parties in whole (not in part) is permitted.