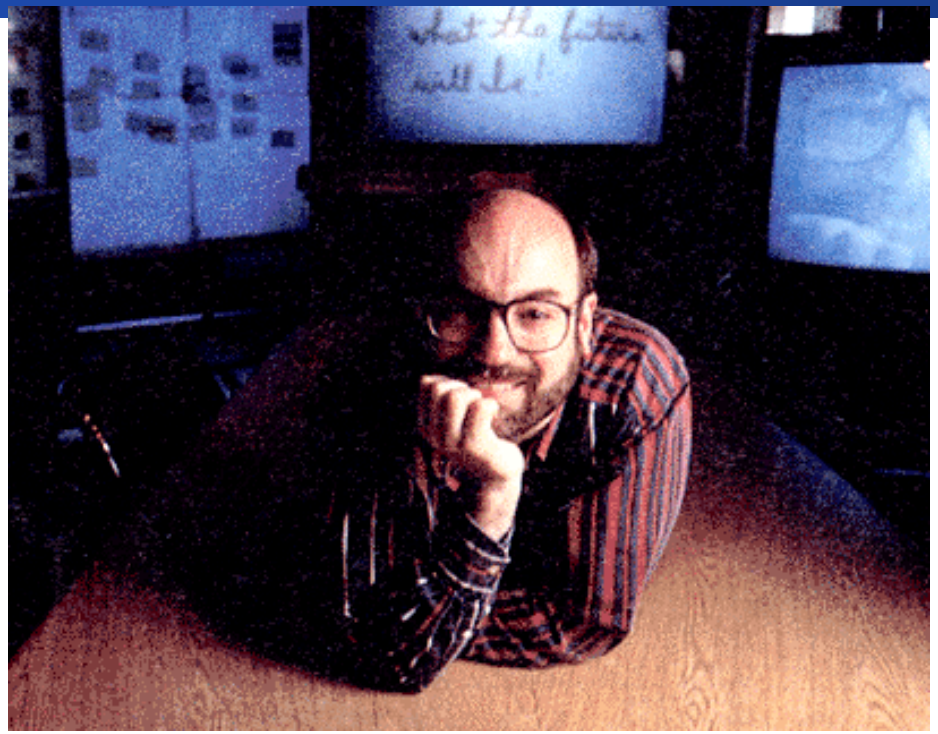
Presented by: Rick Merritt
Silicon Valley Bureau Chief, EE Times

9.30.2015

IoT Networks in Smart Cities

A guide to the new digital urban warfare

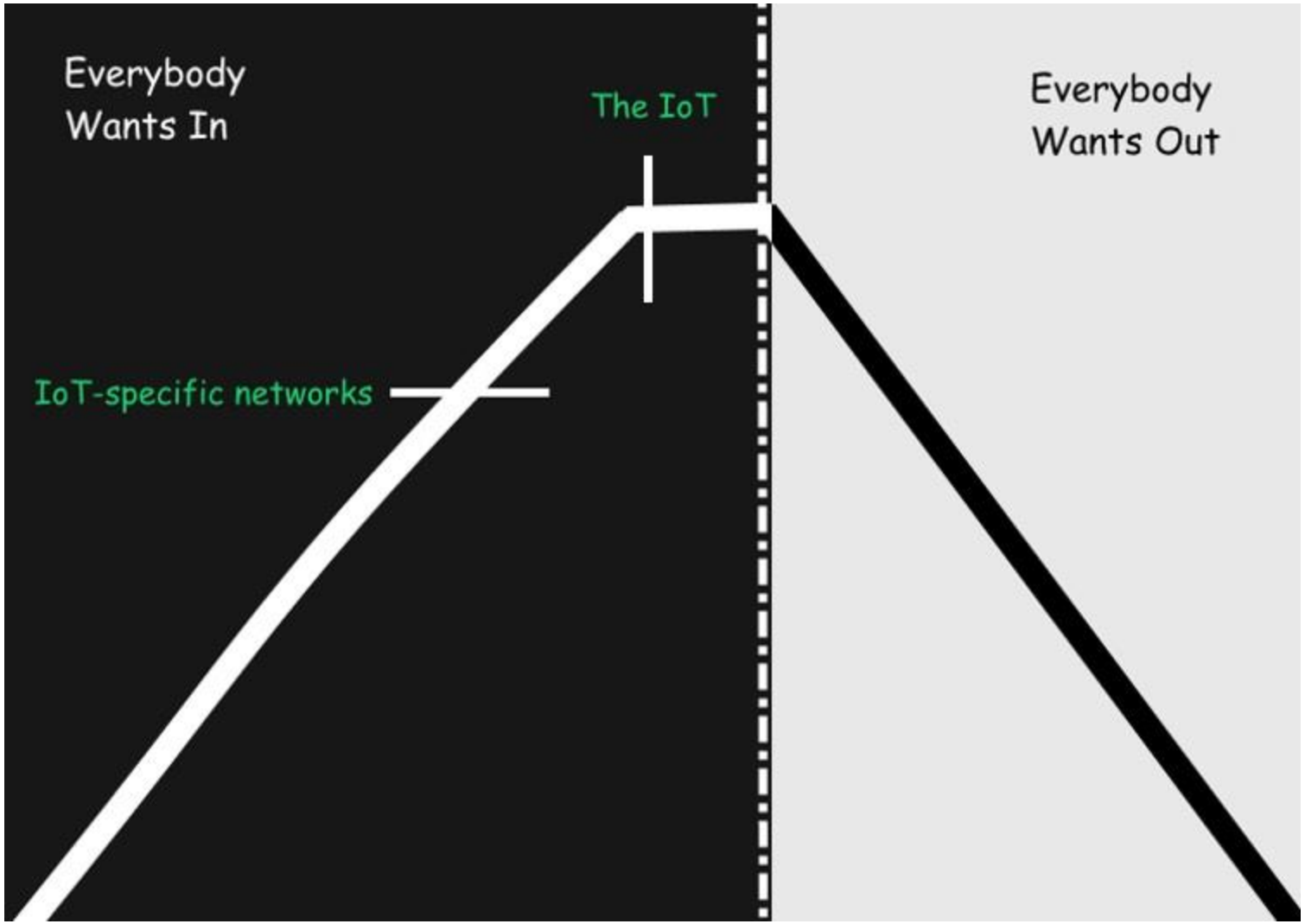
The Internet of Things is not new



"The third wave of computing is ubiquitous computing…[computers] will be embedded in walls, chairs, clothing, light switches, cars - in everything."

--Mark Weiser, Xerox Parc, Oct. 1996.

Beware the hype cycle



Cellular M2M: The reigning champion

Pros

- Wide coverage
- Managed service
- High data rates

Cons

- High cost
- Power hog
- Inflexible

The Road Map

- GE-RAN, Cellular IoT
- LTE Category 0
- LTE Category 1
- LTE Category M, NB-LTE

Wi-Fi: The known, near rival

Pros

- No data plan
- High data rates
- Flexible

Cons

- Do it yourself
- A power hog
- Limited range

The Road Map

- 802.11ah

Eight of a dozen players…so far

EDN NETWORK

Low power wide-area networking alternatives for the IoT

Richard Quinnell · September 15, 2015

Wireless network technologies such as WiFi, ZigBee, and Bluetooth are fine for consumer applications of the Internet of Things (IoT), but many civic, industrial, and other IoT applications need to operate over vastly greater territory than these technologies can handle. Cellular and satellite machine-to-machine (M2M) technologies have traditionally filled the gap, but cost, power, and scalability concerns make these choices less appealing for the future. A number of low-power, wide-area networking (LP-WAN) alternatives have arisen that need careful consideration by developers looking to address these wide-ranging IoT applications.

The uses for wide-area IoT technology are legion. Civic infrastructure systems such as parking resources, traffic control, utilities monitoring and distribution control, and environmental monitoring are only a beginning. Agricultural uses such as monitoring of crop conditions and livestock movements need wide-area coverage. Asset monitoring and tracking, from taxicabs to refrigerated produce shipments need regional, national, or even worldwide coverage.

Name of Standard	Weightless			Sigfox	LoRaWAN	LTE-Cat M *	IEEE P802.11ah (low power WiFi)	Dash7 Alliance Protocol 1.0	Ingenu RPMA	nWave
	-W	-N	-P							
Frequency Band	TV whitespace (400-800 MHz)	Sub-GHZ ISM	Sub-GHZ ISM	868 MHz/902 MHz ISM	433/868/780/915 MHz ISM	Cellular	License-exempt bands below 1 GHz, excluding the TV White Spaces	433, 868, 915 MHz ISM/SRD	2.4 GHz ISM	Sub-GHz ISM
Channel Width	5MHz	Ultra narrow band (200Hz)	12.5 kHz	Ultra narrow band	EU: 8x125kHz, US 64x125kHz/8x125kHz, Modulation: Chirp Spread Spectrum	1.4MHz	1/2/4/8/16 MHz	25 KHz or 200 KHz	1 MHz (40 channels available)	Ultra narrow band
Range	5km (urban)	3km (urban)	2km (urban)	30-50km (rural), 3-10km (urban), 1000km LoS	2-5k (urban), 15k (rural)	2.5-5km	Up to 1Km (outdoor)	0 – 5 km	>500 km LoS	10km (urban), 20-30km (rural)
End Node Transmit Power	17 dBm	17 dBm	17 dBm	10μW to 100 mW	EU:<+14dBm, US:<+27dBm	100 mW	Dependent on Regional Regulations (from 1 mW to 1 W)	Depending on FCC/ETSI regulations	to 20 dBm	25-100 mW
Packet Size	10 byte min.	Up to 20 bytes	10 byte min.	12 bytes	Defined by User	~100 -~1000 bytes typical	Up to 7,991 Bytes (w/o Aggregation), up to 65,535 Bytes (with Aggregation)	256 bytes max / packet	Flexible (6 bytes to 10 kbytes)	12 byte header, 1-20 byte payload
Uplink Data Rate	1 kbps to 10 Mbps	100bps	200 bps to 100 kbps	100 bps to 140 messages/day	EU: 300 bps to 50 kbps, US:900-100kbps	~200kbps	150 Kbps ~ 346.666 Mbps	9.6 kb/s, 55.55 kbps or 166.667 kb/s	AP aggregates to 624 Kbps per Sector (Assumes 8 channel Access Point)	100 bps
Downlink Data Rate	1 kbps to 10 Mbps	No downlink	200 bps to 100 kbps	Max 4 messages of 8 bytes/day	EU: 300 bps to 50 kbps, US:900-100kbps	~200kbps	150 Kbps ~ 346.666 Mbps	9.6 kb/s, 55.55 kbps or 166.667 kb/s	AP aggregates to 156 Kbps per Sector (Assumes 8 channel Access Point)	–
Devices per Access Point	Unlimited	Unlimited	Unlimited	1M	Uplink>1M, Downlink<100k	20k+	8191	NA (connectionless communication)	Up to 384,000 per sector	1M
Topology	Star	Star	Star	Star	Star on Star	Star	Star, Tree	Node-to-node, Star, Tree	Typically Star. Tree supported with an RPMA extender	Star
End node roaming allowed	Yes	Yes	Yes	Yes	Yes	Yes	Allowed by other IEEE 802.11 amendments (e.g., IEEE 802.11r)	Yes	Yes	Yes
Governing Body	Weightless SIG			Sigfox	LoRa Alliance	3GPP	IEEE 802.11 working group	Dash7 Alliance	Ingenu (formerly OnRamp)	Weightless SIG
Status	Limited deployment awaiting spectrum availability	Deployment beginning	Standard in development. Scheduled release 4Q 2015	In deployment	Spec released June 2015, in deployment	Release 13 expected 2016	Targeting 2016 release	Released May 2015	In Deployment	In Deployment

UBM

The LPWA Contenders

EE Times

News & Analysis

IoT Network Snags $115M

Sigfox attracts three cellular carriers

Rick Merritt

2/13/2015 02:45 PM EST

5 comments

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SAN JOSE, Calif. — In the race to build out wide-area networks for the Internet of Things, Sigfox (Toulouse, France) this week raised as much as $115 million from investors including three cellular carriers. The company founded in 2009 is seen as the leader of a handful of dark horse candidates aiming to provide less expensive and power-hungry alternatives to cellular networks.

Sigfox said it closed a $93 million round with a $22 million extension, and said it will spend it on building out networks especially in the U.S. and Asia. Its narrowband, 900 MHz network is already widely deployed in France and Spain and has some coverage in the Netherlands and the U.K.

SIGFOX

One network A billion dreams

Pros

- Battery life
- Euro deployments
- U.S. funding

Cons

- Data rates, limits
- Proprietary protocol
- Bi-directionality?

The LPWA Contenders

EE Times

News & Analysis

IoT Net Gets New Leader

LoRa Alliance names Mulligan as chairman

Rick Merritt

7/27/2015 07:00 AM EDT

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SAN JOSE, Calif. – The LoRa Alliance will name Geoff Mulligan as its chairman effective August 1. The veteran communications engineer and evangelist said he wants to expand use of the group's 900 MHz networking technology and promote interoperability broadly in the Internet of Things.

LoRa is one of a handful of emerging options for low cost, wide area IoT networks, competing with other 900 MHz nets including SigFox and Weightless-N (N-Wave). It also faces competition from lower cost versions of LTE and a 900 MHz variant of Wi-Fi on the road map.

LoRa™ Alliance

Pros

- Big company support
- Open protocol
- Flexible data rates

Cons

- Unclear deployment path (Orange)
- Requires Semtech chip
- Battery life?

The LPWA Contenders

EE Times

News & Analysis

IoT Nets Snag Wide-Area Player

On-Ramp launches U.S. net, new name

Rick Merritt

9/9/2015 08:00 AM EDT

2 comments

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SAN JOSE, Calif. -- The horse race to build a low-power, wide-area network for the Internet of Things just got a new contender. On-Ramp Wireless (San Diego) changed its name to Ingenu Networks and announced it is raising funds to roll out a public IoT network in the U.S. by the end of 2017.

Ingenue's 2.4 GHz technology will compete with as mnay as a half dozen separate 900 MHz offerings from groups including Sigfox, NWave and the LoRa Alliance founded by Semtech. They are all racing to beat versions of cellular and Wi-Fi networks tailored for IoT that are expected to hit the market in about two years.

The Ingenu launch is "one of the biggest news stories in IoT networks this year, and it will help them build scale," said Aapo Markkanen, an analyst for Machina Research following the area

INGENU

Pros

- U.S. network in '17
- Existing private nets
- Higher data rates?

Cons

- Lower battery life?
- Shorter reach?
- Proprietary ASICs

The LPWA Contenders

EE Times

News & Analysis

Weightless Expands Wide-Area IoT Spec

Rich Quinnell

8/10/2015 08:00 PM EDT

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SEATTLE – The Weightless SIG is working on a new standard for a low-power wide area network (LP-WAN) scheme targeting a class of applications for the Internet of Things (IoT) that cannot be served by established wireless networks such as WiFi or ZigBee. The Weightless-P standard aims to provide bi-directional communications between mobile, battery-powered devices and base stations over distances up to 2km in a challenging urban environment. Based on field-proven technology developed by SIG member M2Communication (M2COMM), the standard is expected to be ready for release in Q4 of 2015 with first hardware available in early 2016.

WEIGHTLESS

Pros

- Fully open spec
- Long battery life

Cons

- 3 specs, 2 PHYs
- Few deployments
- Lacks strong backing

UBM

Other players here or on the way

--Since May 2015, <167 Kbits/s

Telensa

--Turnkey private nets in 30 countries

--Enhanced 802.15.4 for 900/2.4 GHz

nwave

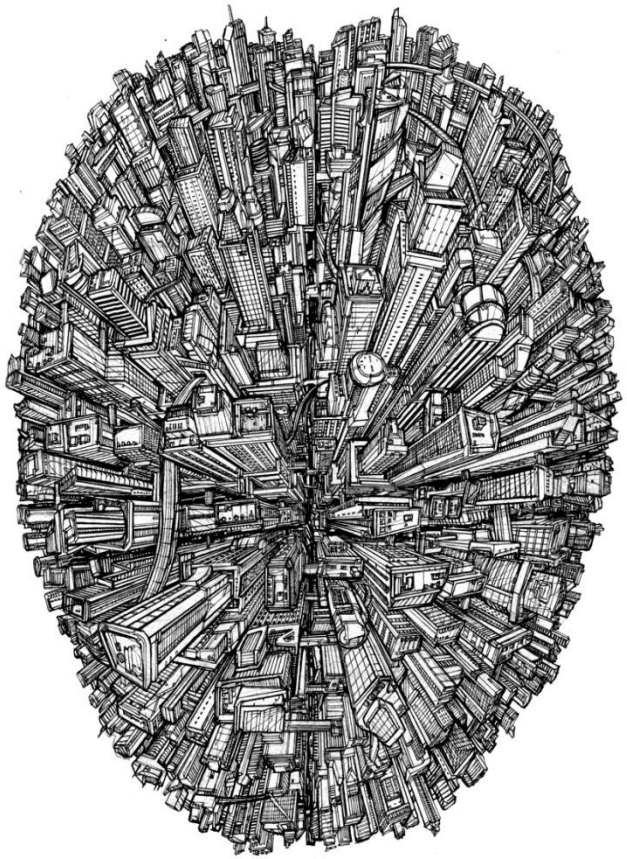
--900MHz Weightless, proprietary nets

--2015 startup, $25M, seasoned team

M2M SPECTRUM NETWORKS

--Building national net across multiple freqs

So what's a smart city to do



Know yourself

- How much risk can you tolerate?
- How much time do you have?
- What do you want for your citizens?
- What's your budget?

Some options

- Let a thousand flowers bloom
- Stage a contest
- Wait 2-3 years for a near-term winner to emerge
- Wait until 2021 and pray for 5G

The credits

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Stories used in this talk
(in order of appearance)

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Also worth noting
IoT's Wireless Horse Race
http://www.eetimes.com/author.asp?section_id=36&doc_id=1327130
IoT Networks Debated at ESC
http://www.eetimes.com/document.asp?doc_id=1327381