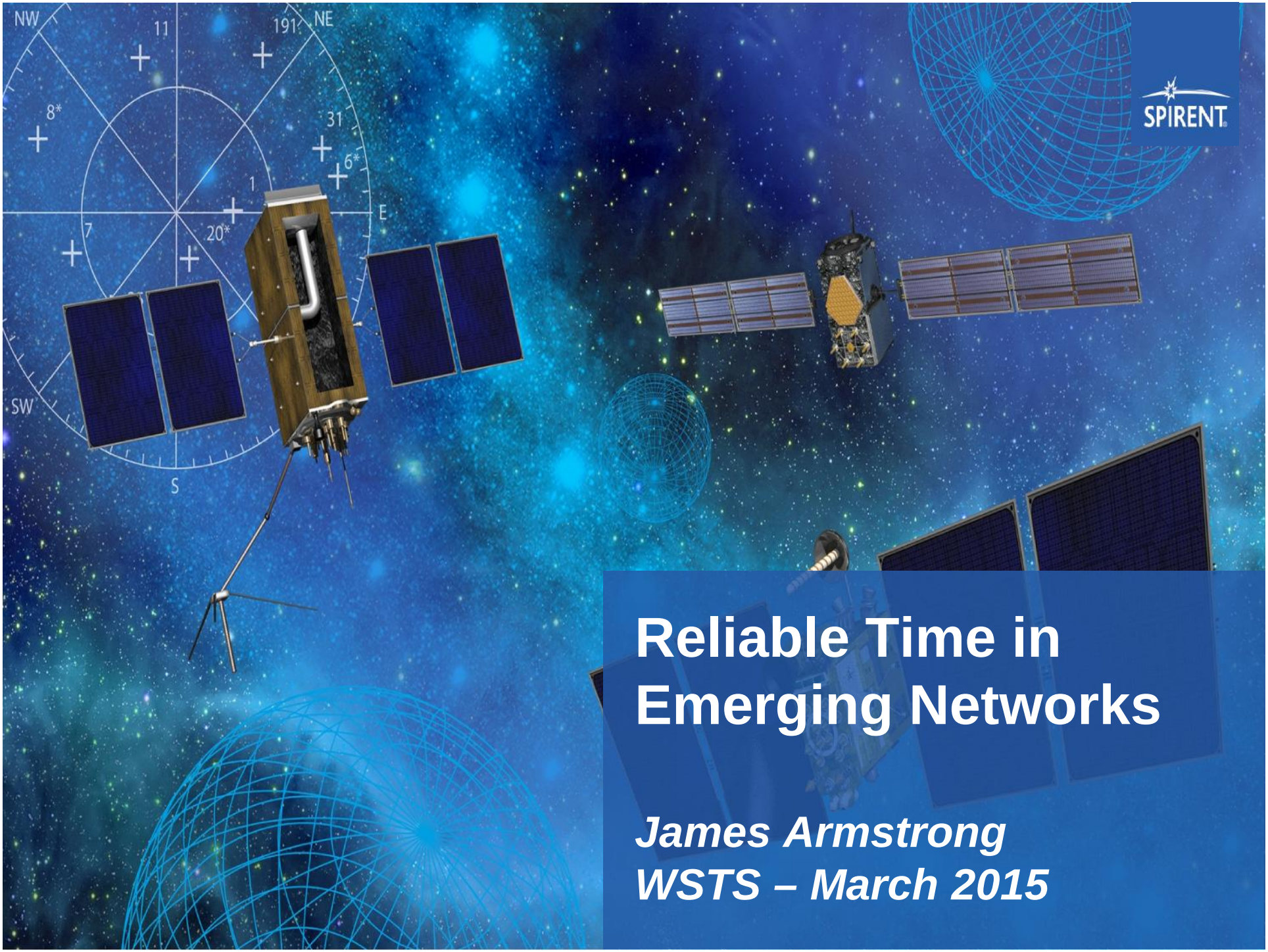


Reliable Time in Emerging Networks

James Armstrong

WSTS – March 2015


SPIRENT

IoT In Action

Health

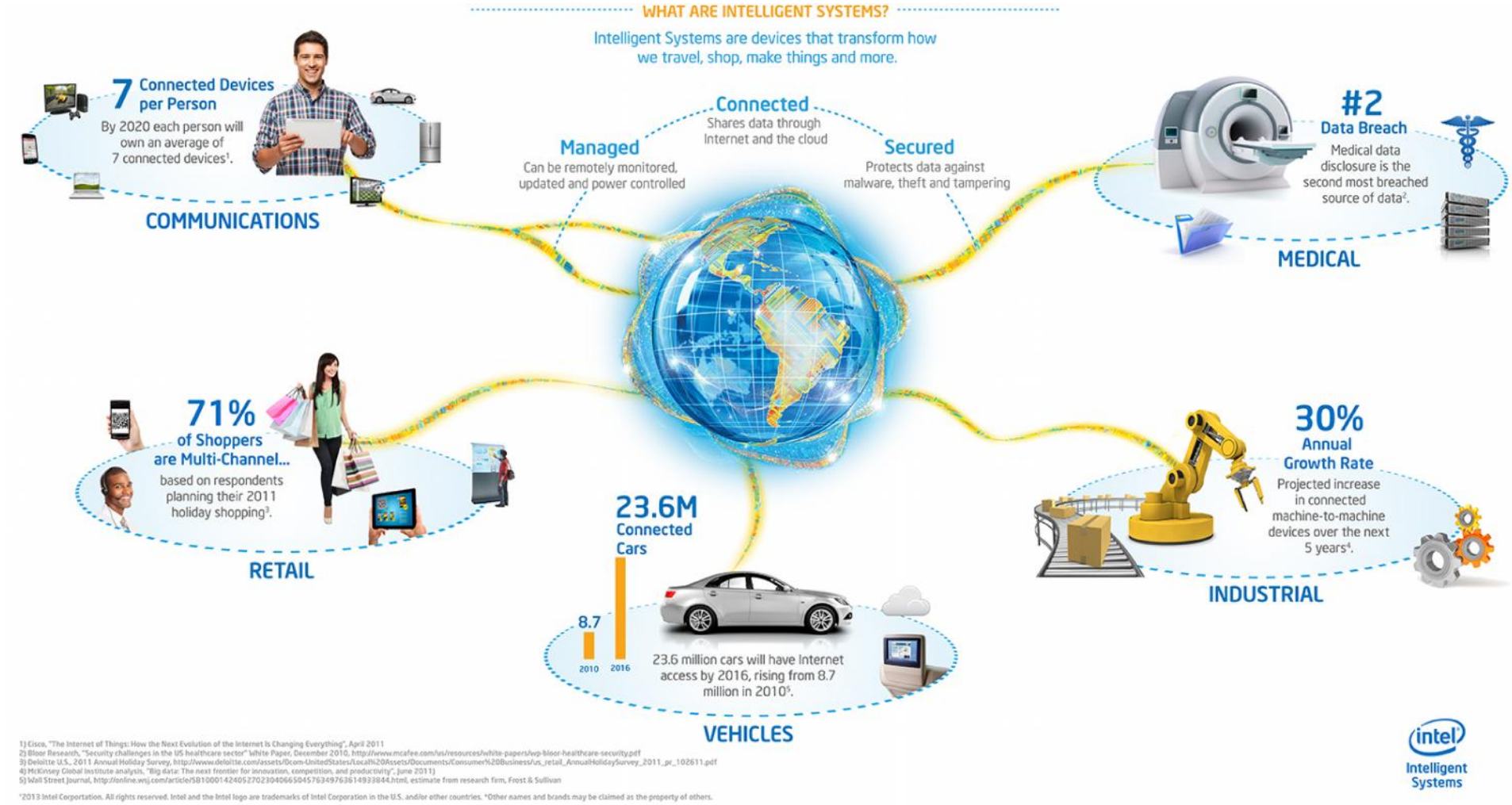
Retail & Vending

Google

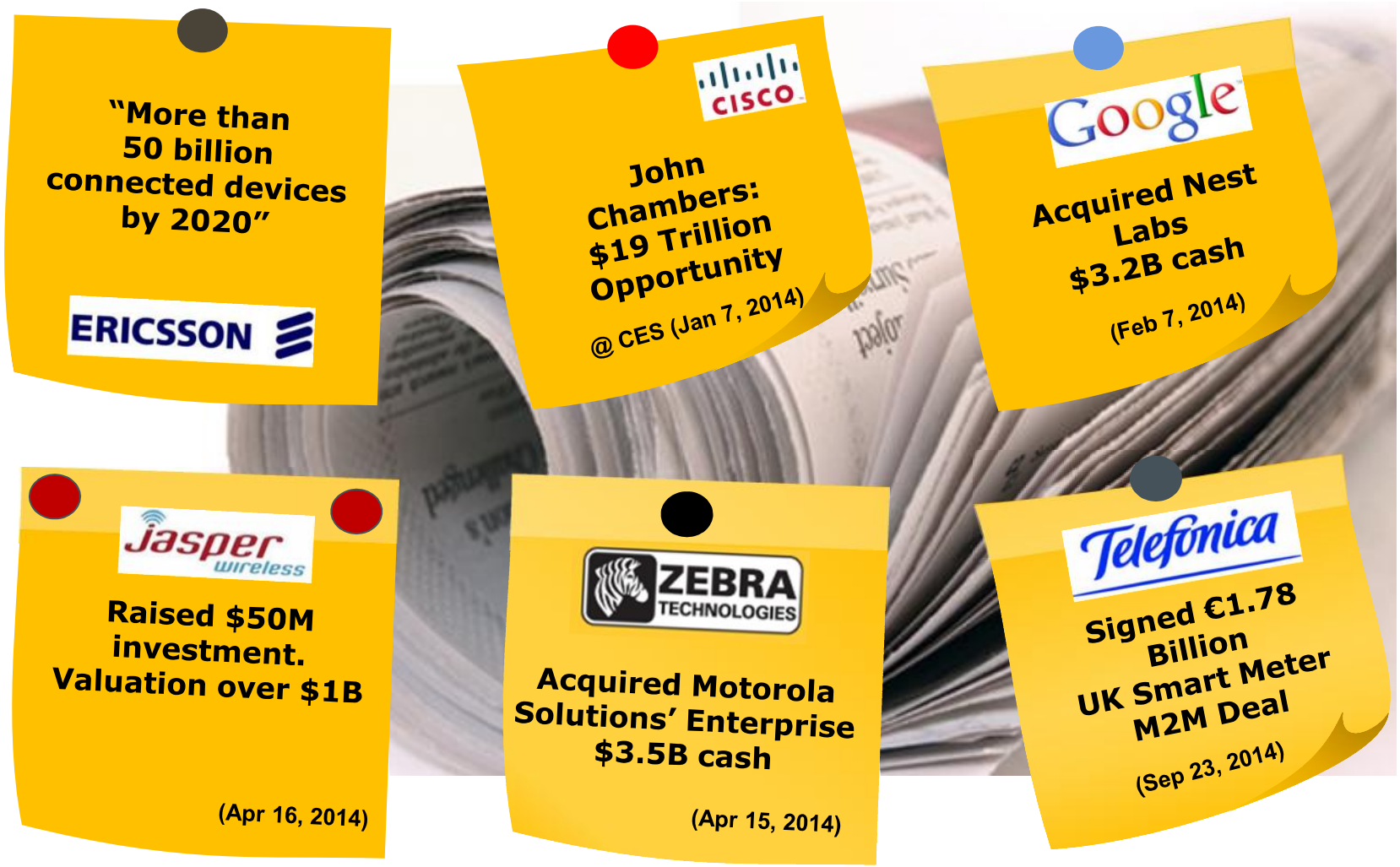
Energy

Lifestyle

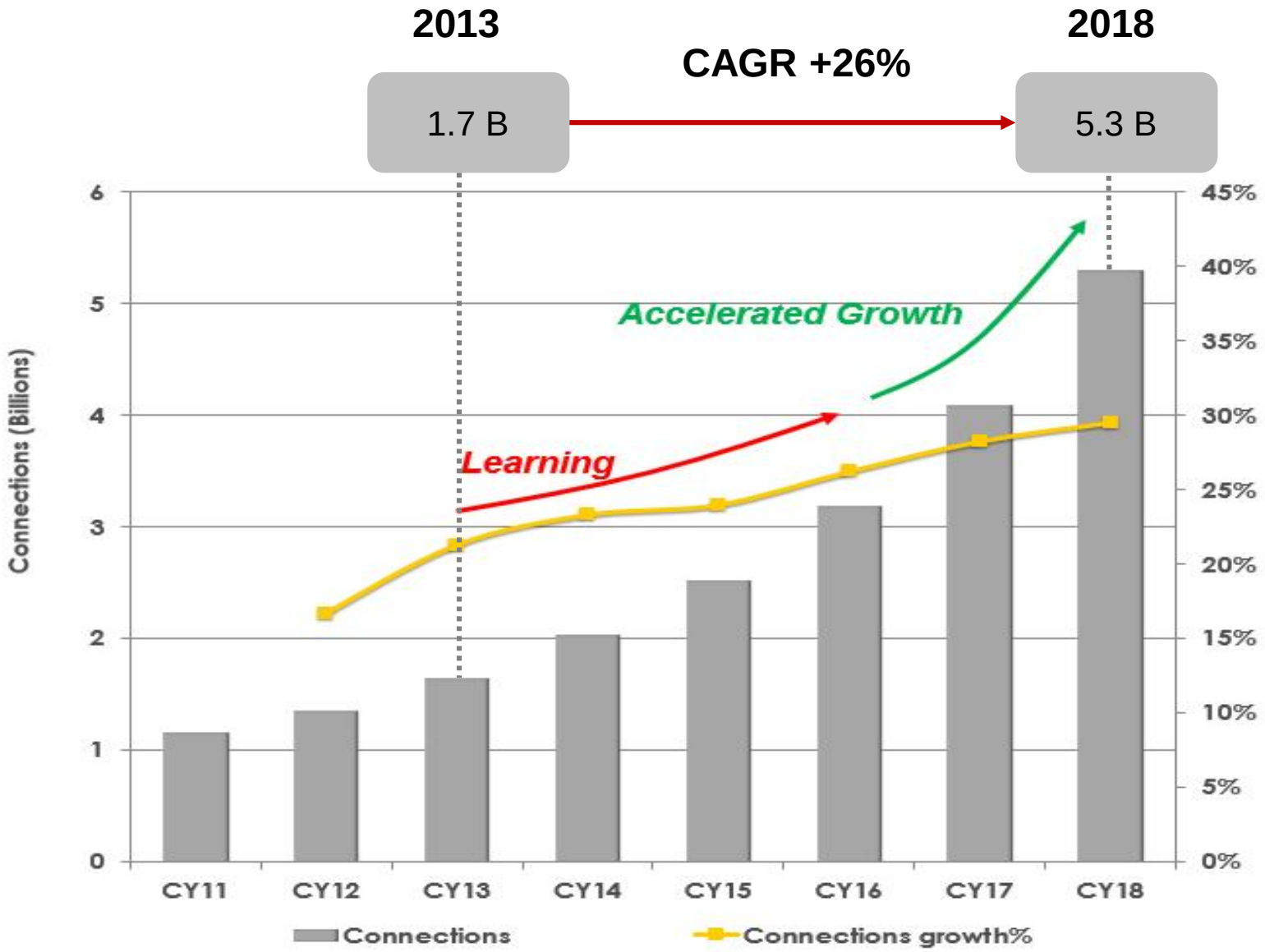
Internet of Things (IoT)



IoT “The Buzz”

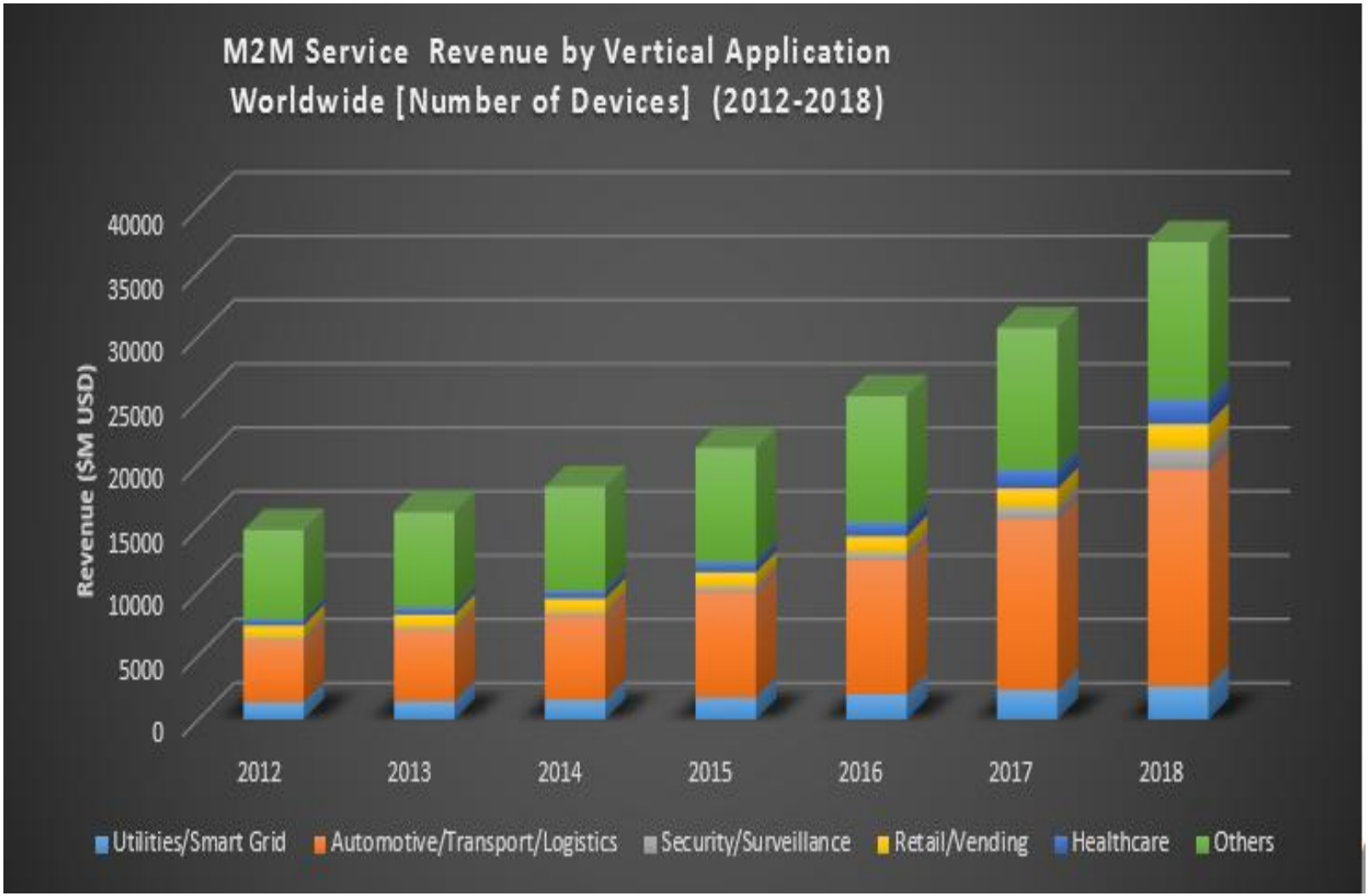

“More than 50 billion connected devices by 2020”
ERICSSON
John Chambers: $19 Trillion Opportunity
@ CES (Jan 7, 2014)
CISCO
Acquired Nest Labs $3.2B cash
(Feb 7, 2014)
Google
Raised $50M investment. Valuation over $1B
(Apr 16, 2014)
Jasper wireless
Acquired Motorola Solutions’ Enterprise $3.5B cash
(Apr 15, 2014)
ZEBRA TECHNOLOGIES
Signed €1.78 Billion UK Smart Meter M2M Deal
(Sep 23, 2014)
Telefónica

IoT Connections Growth



Source: Infonetics Research, "M2M Connections & Services by Vertical" (April 3, 2014)

Service Revenue by Vertical Application



The Rise of the Mega DataCenter

"60% of IT leaders are concerned that cloud providers don't appreciate how complex legacy ICT systems are, and fear migration to the cloud could fail."

Forbes: CIOs on Cloud Computing Adoption

Managing the complexity of ever expanding demands on a shared infrastructure

- Software Defined Networking
- Virtualized Network Functions
- Elastic Performance

- Service Availability
- Virtual Infrastructure
- Multi-Tenancy

The Rise of the Mega DataCenter

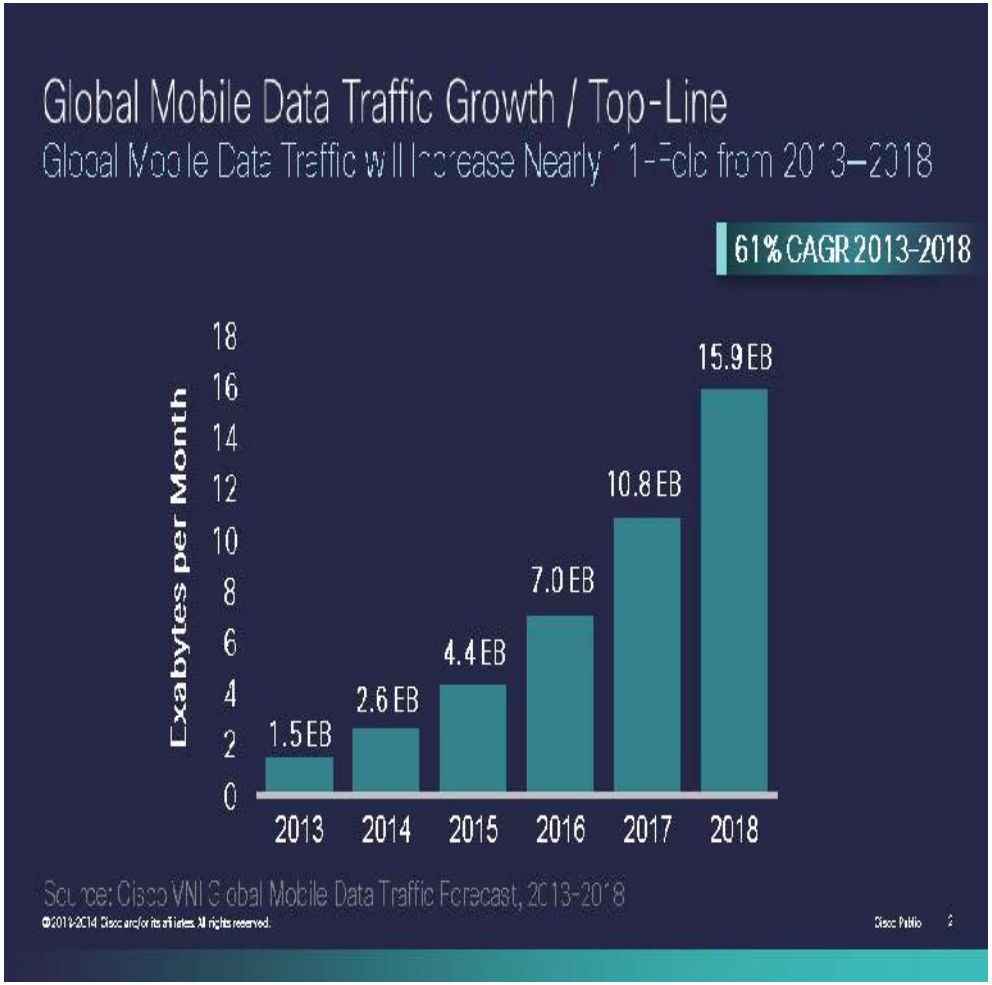
Google Spans Entire Planet With GPS-Powered Database
Wired 9/9/12

‘One aspect of our design stands out: The linchpin of Spanner’s feature set is TrueTime.’
— Google

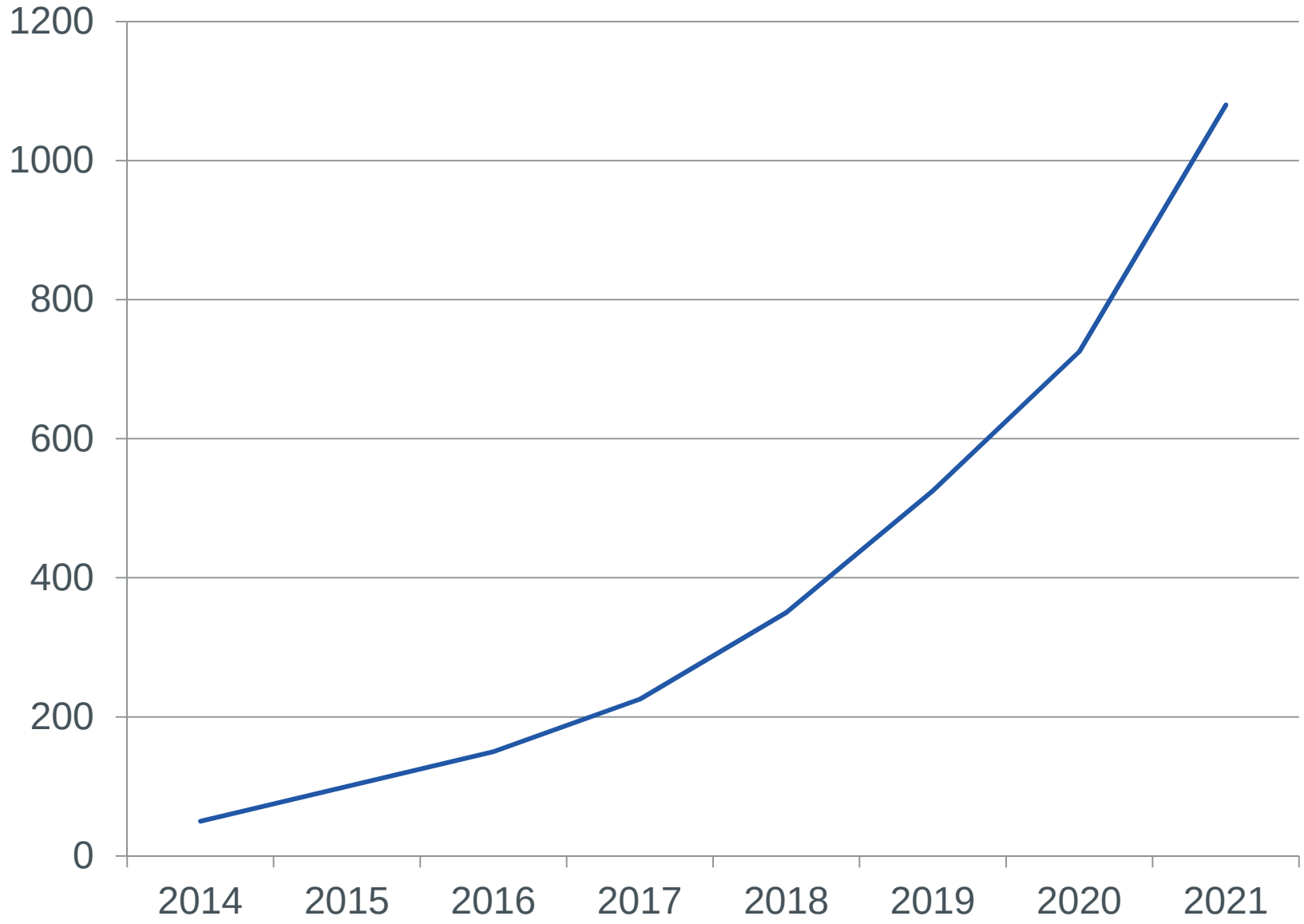
“Rather than try to improve the communication between servers, Google spreads clocks across its network. It equips various master servers with GPS antennas or atomic clocks, and — working in tandem with the TrueTime APIs — these time keepers keep the entire network in sync. Or thereabouts.”

Network Speeds Increasing 4-Fold

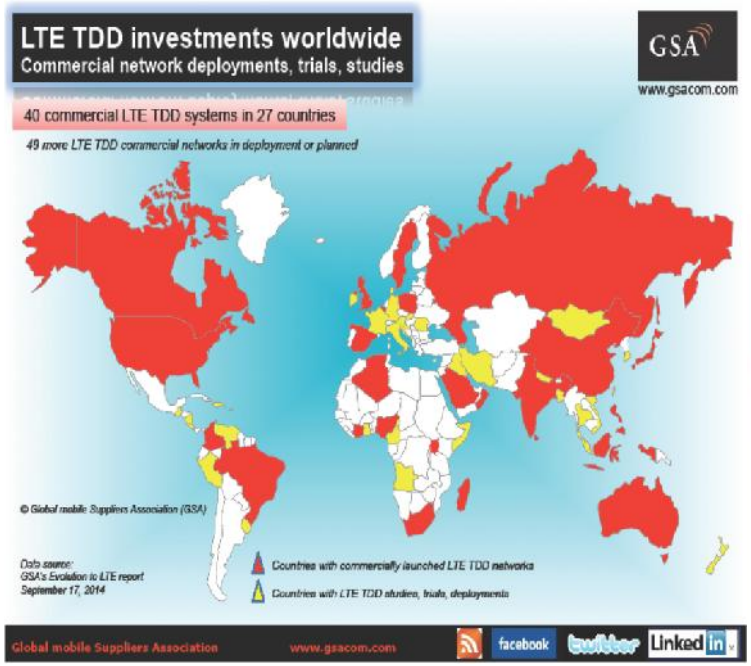
- 40G -> 100G -> 400G links
- (Dis)Aggregation challenge
- Network errors impact QoE
- Precision equipment and expertise needed
- Picosecond timing accuracy



Value of Market for 400G Transport Equipment ($Millions) (Communication Industry Researchers)



Time Requirements for Mobile Networks



SYNCHRONIZATION REQUIREMENTS FOR DIFFERENT TYPES OF LTE		
Application		
LTE (FDD)	16/50 ppb	NA
LTE (TDD)	16/50 ppb	±1.5 µs
LTE MBSFN*	16/50 ppb	–1 to 32 µs
LTE-A CoMP (network MIMO)**	16/50 ppb	±500 ns (0.5 µs)
LTE (residential)	100/250 ppb	None

* MBSFN = Multimedia Broadcast Multicast Service (MBMS) over a single-frequency network

** CoMP = Coordinated Multi-point Transmission/Reception

LTE-A Commercial Launches
January 2015

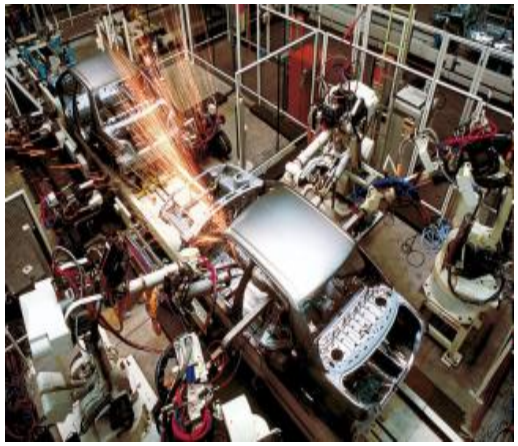
Status of LTE-Advanced Commercial Launches as of January 23, 2015		
	Country	Operator
1	Australia	Optus
2	Australia	Telstra
3	Australia	Vodafone
4	Austria	A1 Telekom Austria
5	Canada	Rogers
6	Czech Republic	O2 / Vodafone
7	Czech Republic	T-Mobile
8	Denmark	Hi3G
9	Estonia	EMT
10	Estonia	Tele2
11	Finland	TeliaSonera
12	France	Bouygues
13	France	Orange
14	France	SFR
15	Germany	DT
16	Hong Kong	CSL
17	Italy	Telecom Italia
18	Italy	Vodafone
19	Japan	KDDI
20	Kenya	Safaricom
21	Latvia	LMT
22	Lithuania	Omnitel
23	Netherlands	KPN
24	Netherlands	Vodafone
25	Philippines	Smart Communications
26	Portugal	Meo
27	Portugal	Vodafone
28	Qatar	Ooredoo
29	Romania	Orange
30	Russia	Megafon
31	Russia	Vimpelcom
32	Saudi Arabia	STC
33	Singapore	M1
34	Singapore	SingTel Mobile
35	Slovenia	Si Mobile
36	South Africa	Telkom
37	South Korea	SK Telecom
38	South Korea	LG U+
39	South Korea	KT Corp
40	Spain	Movistar
41	Spain	Vodafone
42	Switzerland	Swisscom
43	Switzerland	Orange
44	Taiwan	CHT
45	Taiwan	FarEasTone
46	Taiwan	Taiwan Mobile
47	UK	EE
48	USA	AT&T
49	USA	Sprint

DETERMINISTIC ETHERNET ("DETNET")

IEEE 802.1 standards for real-time process control, industrial automation, and vehicular networks

IEEE 802 tutorial
Tutorial-Deterministic-Ethernet-1112
November 12, 2012

DETNET Applications


IEEE 802 tutorial
Tutorial-Deterministic-Ethernet-1112
November 12, 2012

Deterministic Ethernet

- Existing (audio/video streams) and new (industrial and vehicular control) applications

  Time synchronization

  Rich Quality of Service offerings

  Choices for network resiliency

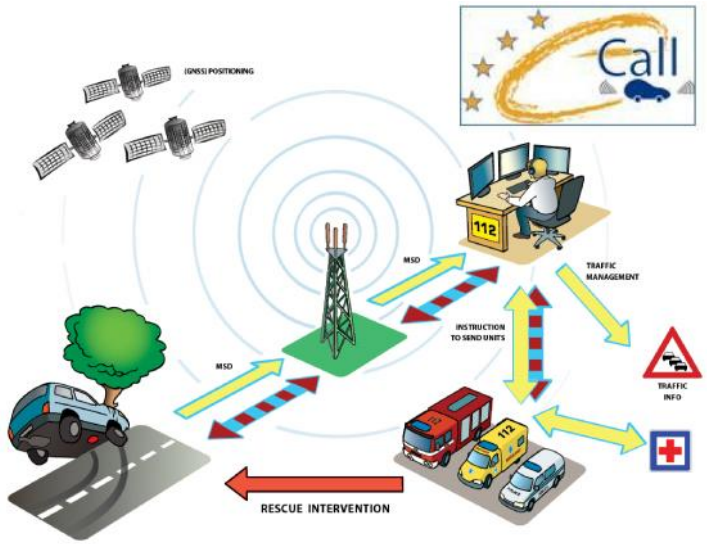
  Widely deployed (hence, cheap) switching elements

  Foundation for cooperation among standards organization

- Enables converged networks where real-time and bulk data can be comingled without disrupting the mission critical tasks.

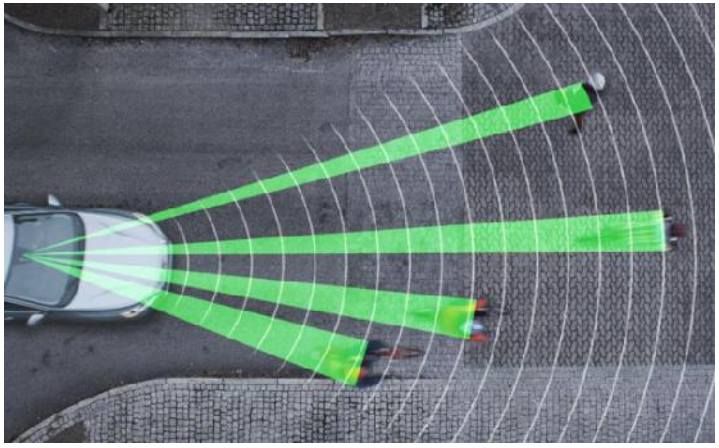
IEEE 802 tutorial
Tutorial-Deterministic-Ethernet-1112
November 12, 2012

“Connected Car”



Automatic Emergency Call (eCall)

Infotainment



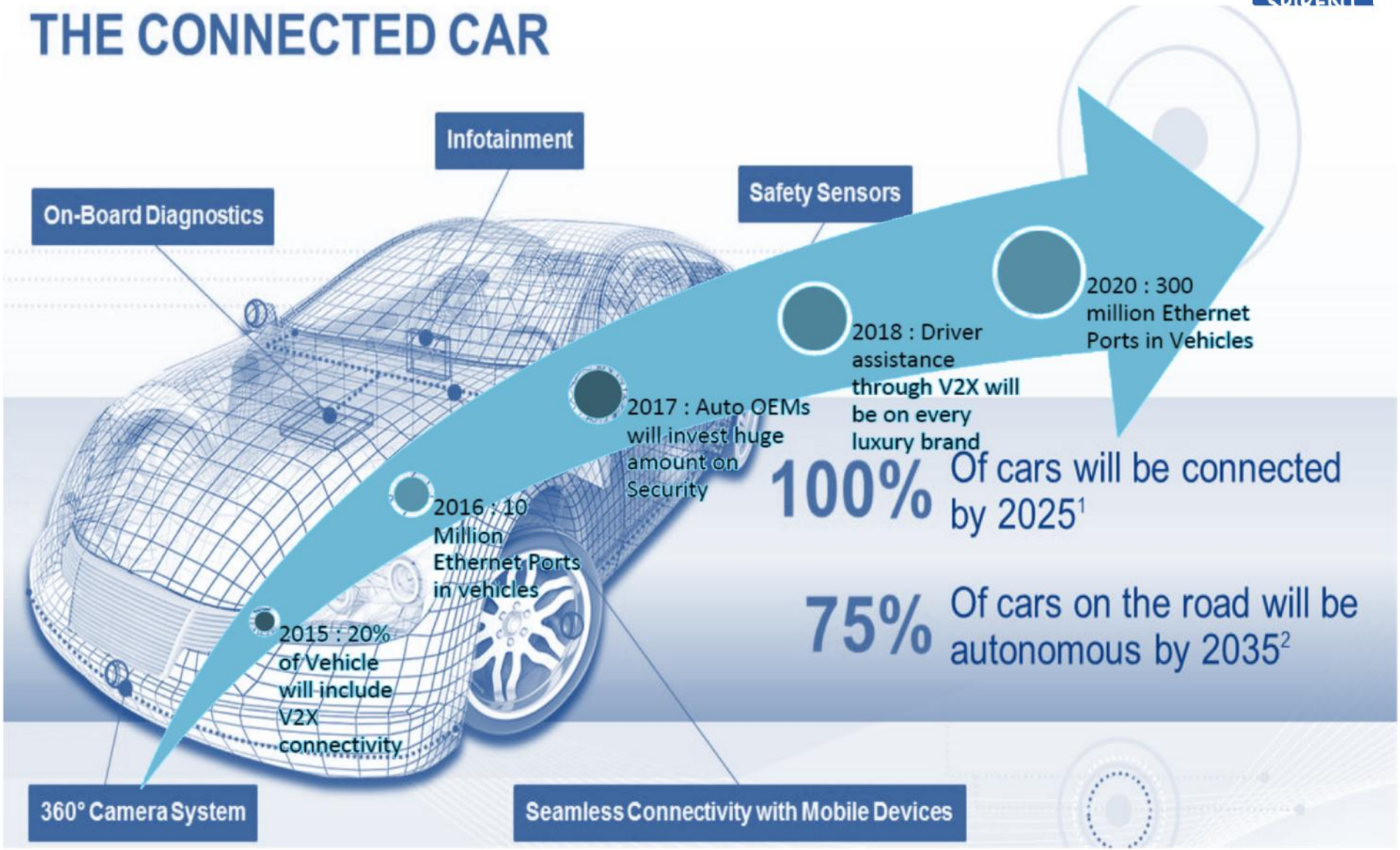
Drive Assistance/ Autonomous Driving

Stolen Vehicle Tracking


SPIRENT
LTE
WLAN

Senator: Car hacks that control steering or steal driver data way too easy (*ars technica 2/9/15*)

THE CONNECTED CAR



100% Of cars will be connected by 2025[1]

75% Of cars on the road will be autonomous by 2035[2]

IEEE 802.1 Time Sensitive Networks (TSN) standards under way (Work In Progress)

- P802.1ASbt* “Timing and Synchronization: Enhancements and performance improvements”
  - Amendment to 802.1AS. Will be a complete rewrite, called “P802.1AS-REV,” instead.
- P802.1Qbu* “Frame Preemption”
  - Amends 802.1Q to support 802.3br
- P802.3br “Interspersed Express Traffic”
  - One level of transmission preemption – interrupts transmission of an ordinary frame to transmit an “express” frame, then resumes the ordinary.
  - 802.3 document, not an 802.1 document.
- P802.1Qbv* “Enhancements for Scheduled Traffic”
  - Runs the 8 port output queues of a bridge on a rotating schedule.
- P802.1Qca* “Path Control and Reservation”
  - Enhances 802.1 ISIS to create multiple paths through a network.
- P802.1CB* “Seamless Redundancy”
  - Defines the sequence-split-recombine method for reliability improvement.
  - Stand-alone document. NOT an amendment to 802.1Q.
- P802.1Qcc* “Stream Reservation Protocol (SRP) Enhancements and Performance Improvements”
  - For more streams, faster convergence, less chattiness, and maybe more.

Our Dependence on GNSS

Dr. Nam D. Pham, a principal economic researcher for the U.S. Chamber of Commerce Foundation, estimated in 2011 that the U.S. economy will incur $96 billion in losses annually, or 0.7% of the U.S. economy, during large-scale GPS disruptions
http://www.marinelink.com/news/safeguarding-positioning382149.aspx

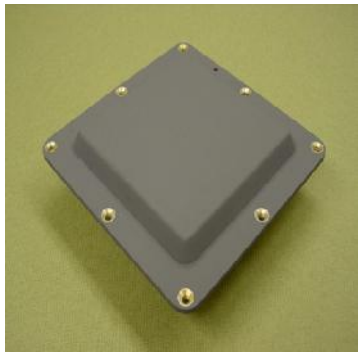
Known vulnerabilities of GPS

- Natural threats – Multipath, Availability, Solar weather

- Man-made Threats – Poor installation, EMC (e.g, illegal TV transmitters), Cyber attack (jamming or spoofing).
  - e.g. Hannover Airport, Germany, 2012, San Diego 2007…

- No confirmed examples of a spoofing yet, but…

Mitigation against jamming/spoofing



Null steering antenna– Currently Military only

Chip Scale Atomic Clock

eLoran

Other mitigation techniques

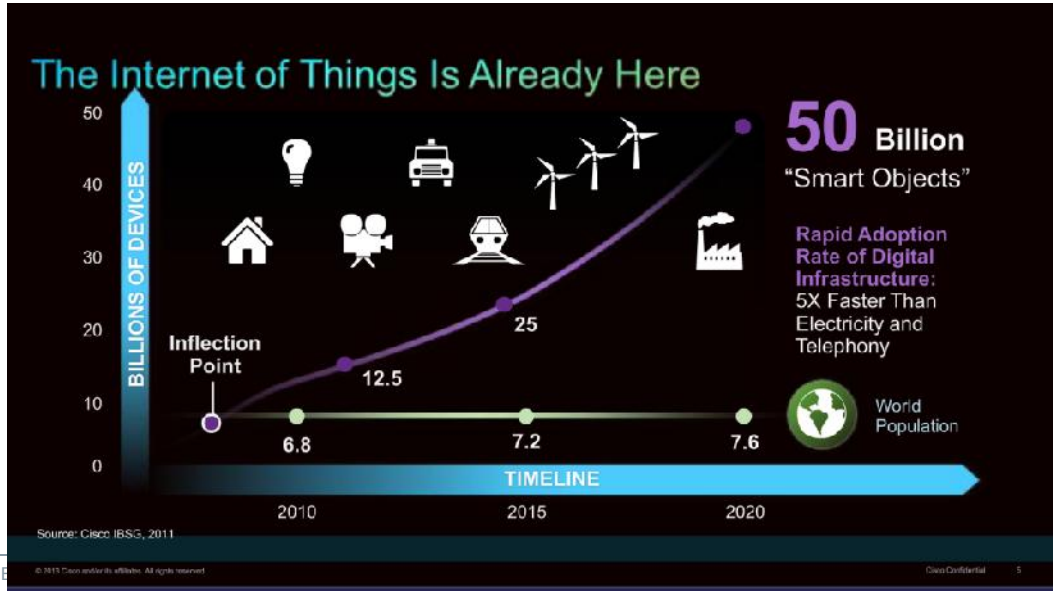
- Hardening of GPS Receivers – RF front end and DSP (notch filtering, additional frequencies and constellations, Receiver Autonomous Integrity Monitoring (RAIM))

- PROTECT, TOUGHEN, AUGMENT

4 Takeaways for the Sync Experts

- Network Devices and Types are exploding
- Certain class of Apps will always require Sync

- GPS MUST work reliably
- WSTS future is secure!!!




TESTED
WITH
SPIRENT