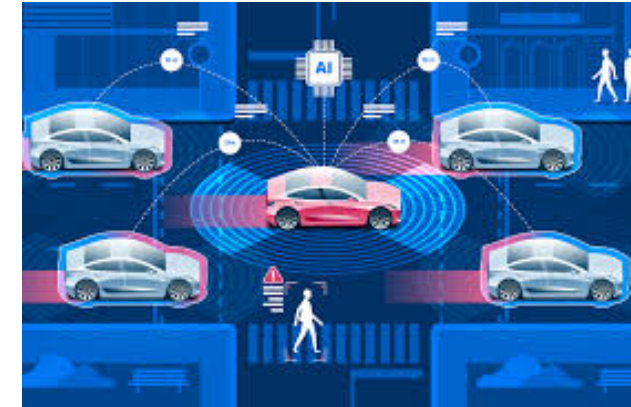


SPINTRONIC

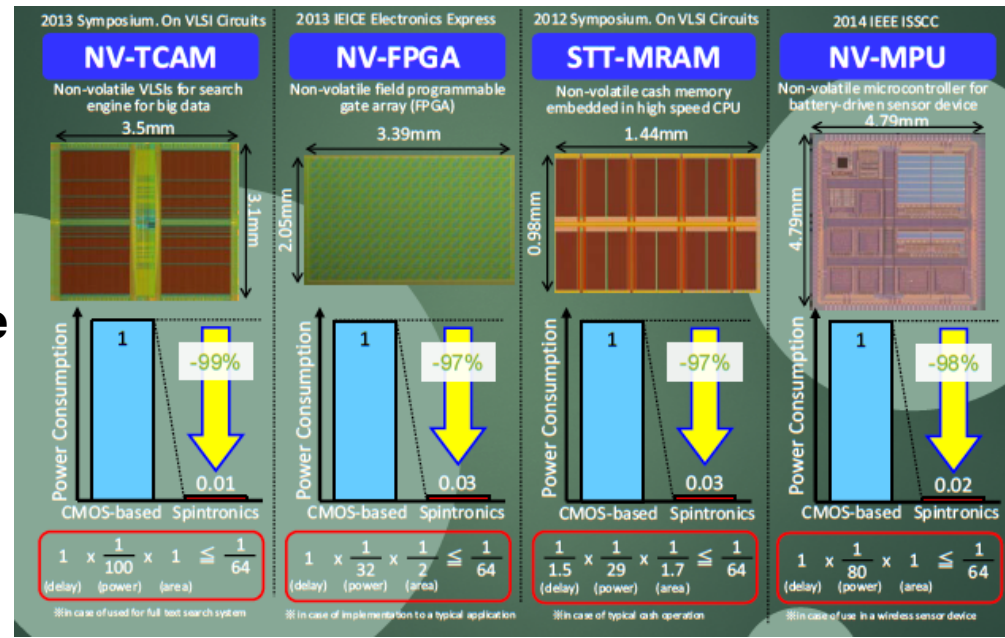
Big data (sens, store, compute) = Big Energy



Interconnected device produce 4% global emission Today – 15 % in 2040

Digital world consume 10% of world electricity Today – 100 % in 2050

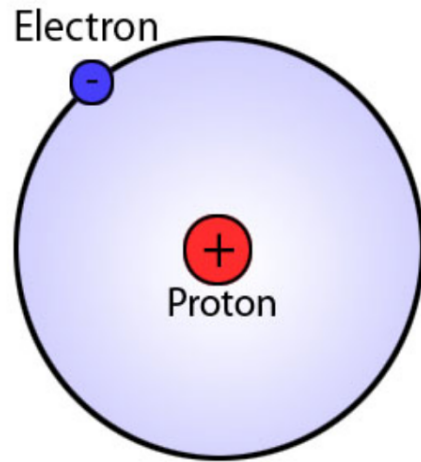
Spintronics to reduce energy consumption for data usage/storage



SPINTRONIC ?

ELECTRONIC

- Electron : 1897 (JJ Thomson)

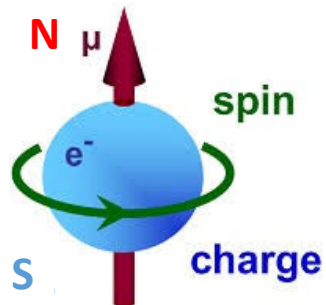


- First transistor : 1947 (Bell Lab)



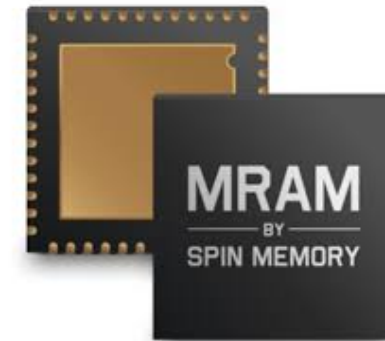
SPIN ELECTRONIC : SPINTRONIC

- Spin : 1924 (W. Pauli)

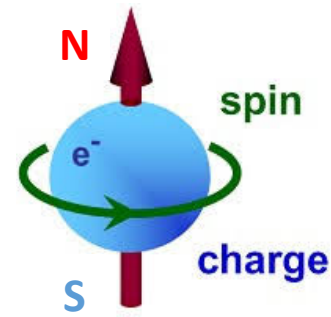


- Spintronic: 2007 Nobel (A Fert / P Grunberg)

- Freescale : 2006
First commercialisation

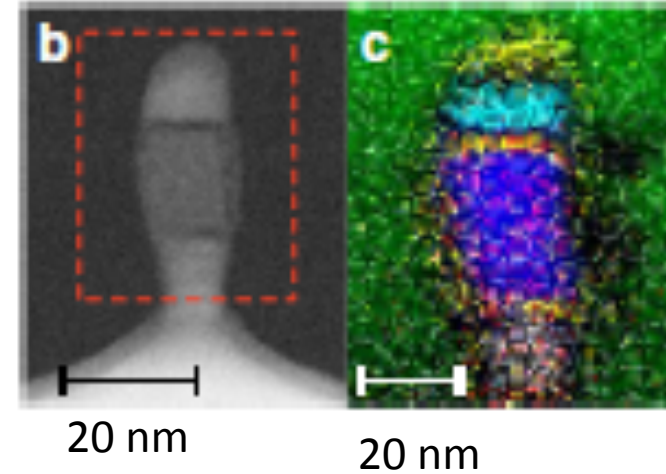
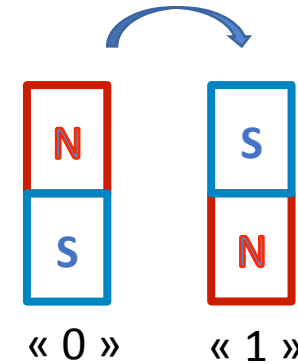
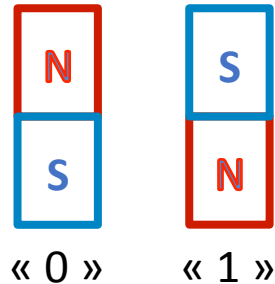


SPINTRONIC

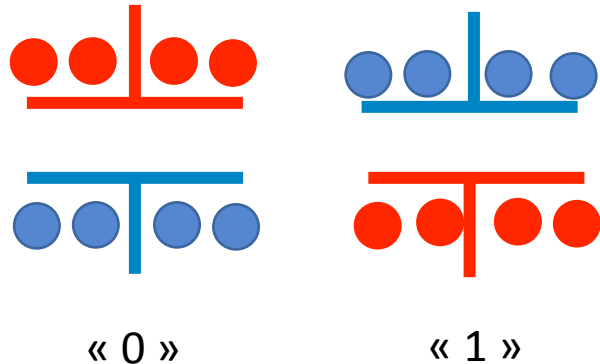


Spintronic allows

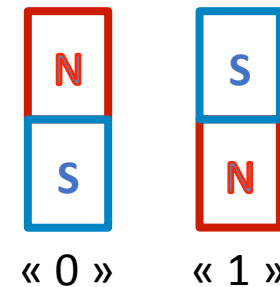
- To read magnet
- To read information
- To manipulate magnet
- To write information



Energy gain



Needs Energy to be maintain
Volatile- Memory



Needs NO Energy to be maintain
Non Volatile- Memory

SPINTRONIC

Memory

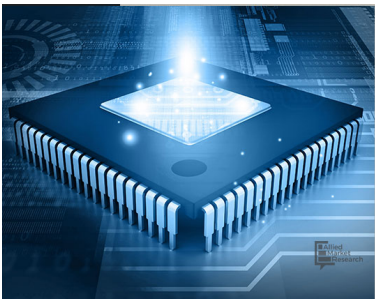
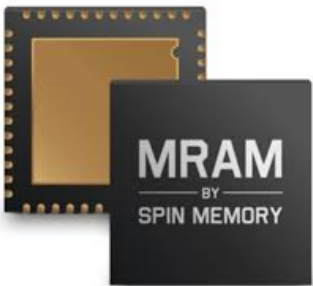
Logic

Sensors

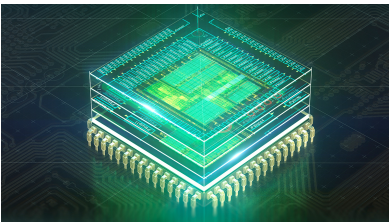
Computing

Energy

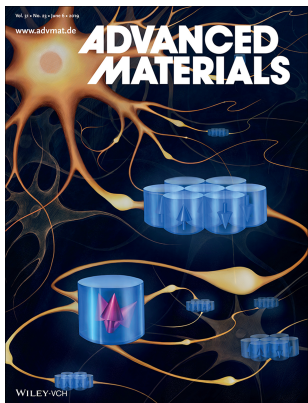
RF devices



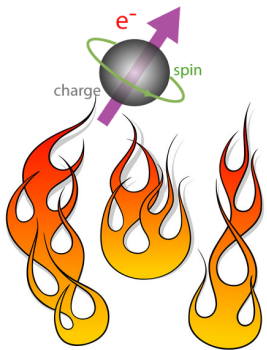
\$ 21.89 Bi by 2026
(CAGR: 34,7)



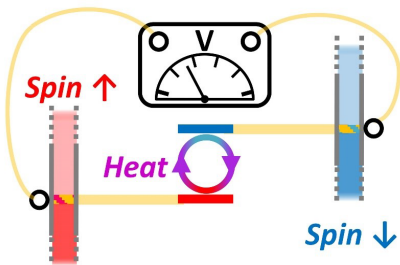
Quantum Computing



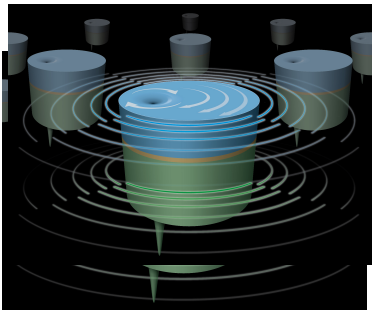
neuromorphic
computing



Spin caloritronic



Spin driven electrical
power generation



Example 1: AI chips for autonomous driving

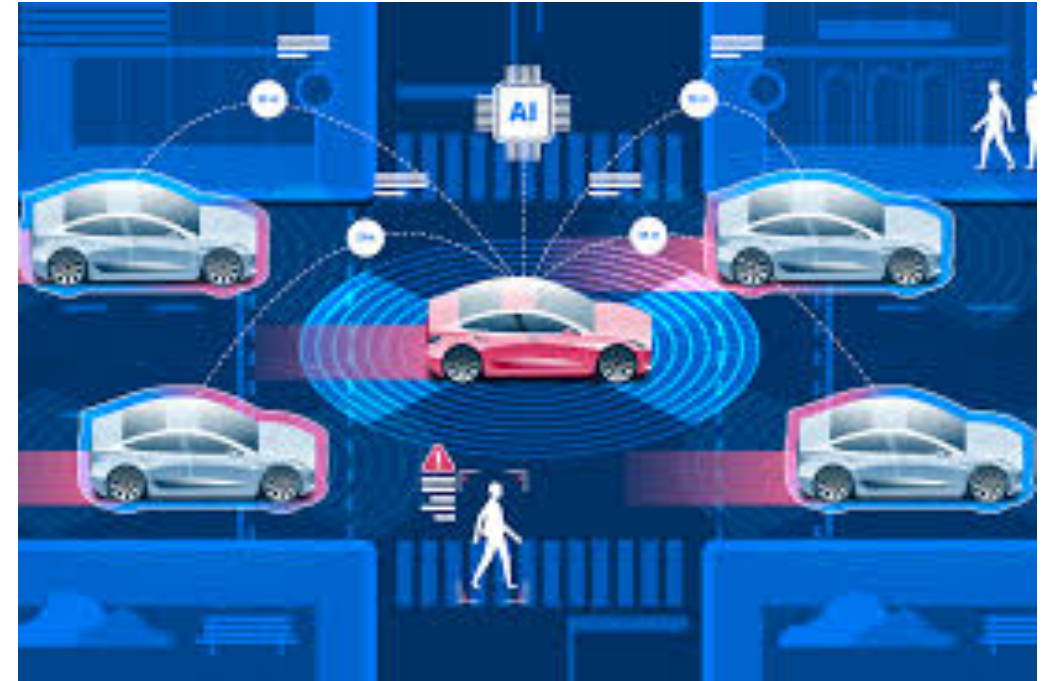
Fully autonomous requires 1000 TOPS (trillion operations per second) to safely guide the automobile :

Today the energy required : **1000 W**

AI chip using spintronics technology

10 W by 2030

1 W by 2040



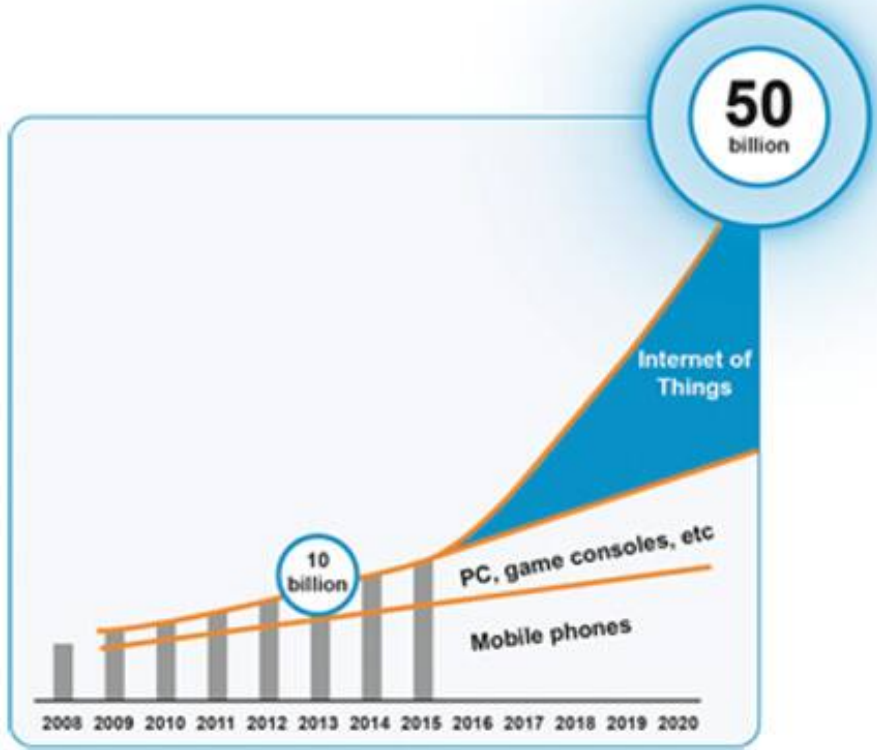
SPINTRONIC

Example 2: Internet of things

Sensors – collecting data

Memories – Store data

Computers – To analyse Data



Year	Mobile phones (billions)	PC, game consoles, etc (billions)	Internet of Things (billions)
2008	~1.5	~0.5	~0.1
2009	~2.0	~0.7	~0.2
2010	~2.5	~0.9	~0.3
2011	~3.0	~1.1	~0.4
2012	~3.5	~1.3	~0.5
2013	~4.0	~1.5	~1.0
2014	~4.5	~1.7	~1.5
2015	~5.0	~1.9	~2.0
2016	~5.5	~2.1	~3.0
2017	~6.0	~2.3	~4.0
2018	~6.5	~2.5	~5.0
2019	~7.0	~2.7	~6.0
2020	~7.5	~2.9	~50.0

Spintronic could bring 50% energy reduction compared to conventional electronic expected by 2030.

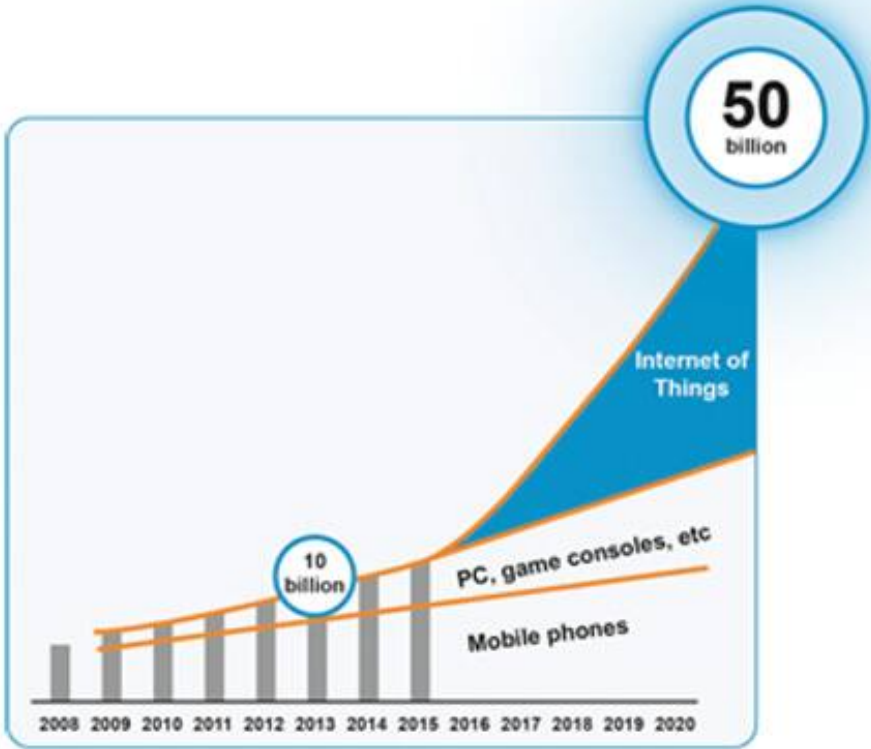
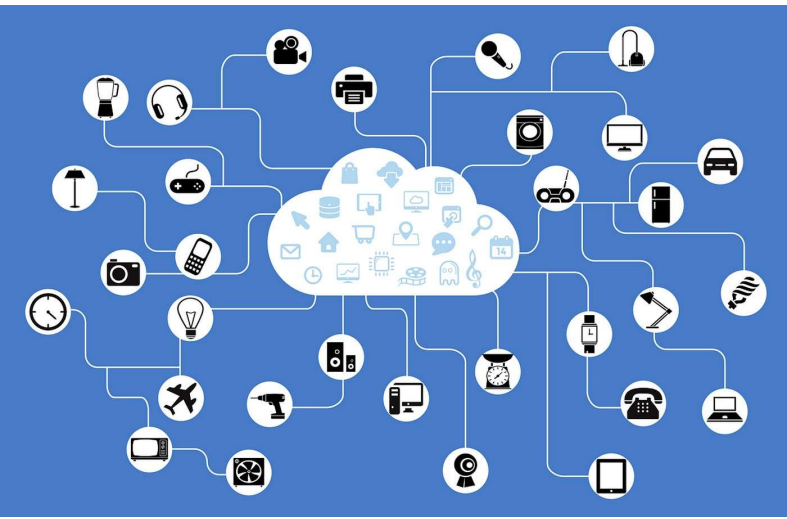
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SPINTRONIC

Example 2: Internet of things

Sensors – collecting data
Memories – Store data
Computers – To analyse Data



Year	Internet of Things (billions)	PC, game consoles, etc. (billions)	Mobile phones (billions)
2008	~1	~1	~1
2009	~1.5	~1.5	~1.5
2010	~2	~2	~2
2011	~3	~3	~3
2012	~4	~4	~4
2013	~5	10	~5
2014	~7	~12	~6
2015	~10	~14	~7
2016	~15	~16	~8
2017	~25	~18	~9
2018	~40	~20	~10
2019	~50	~22	~11
2020	50	~24	~12

Spintronic could bring 50% energy reduction compared to conventional electronic expected by 2030.

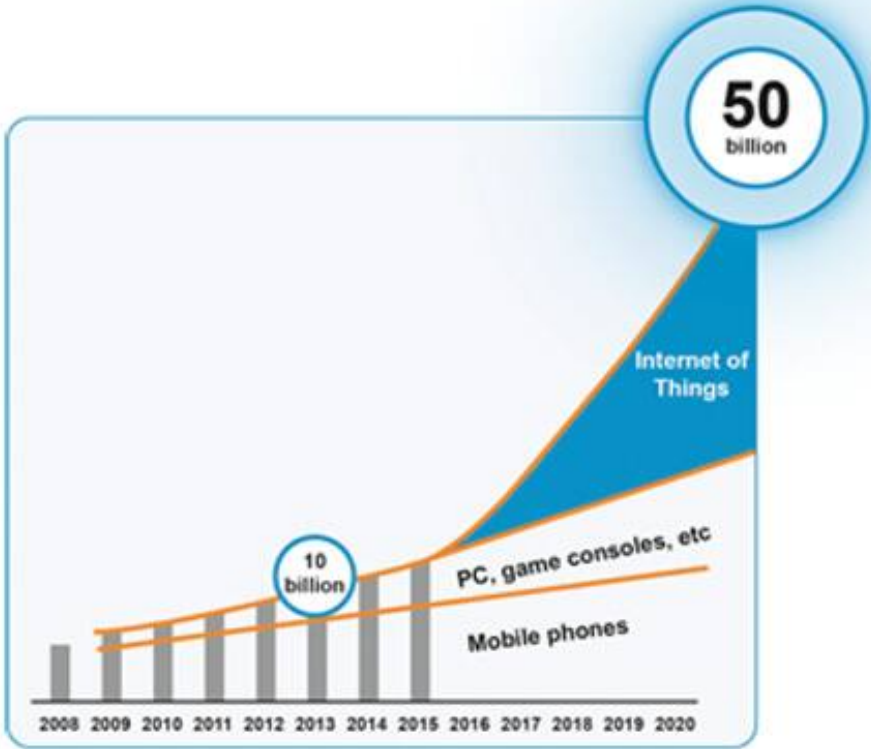
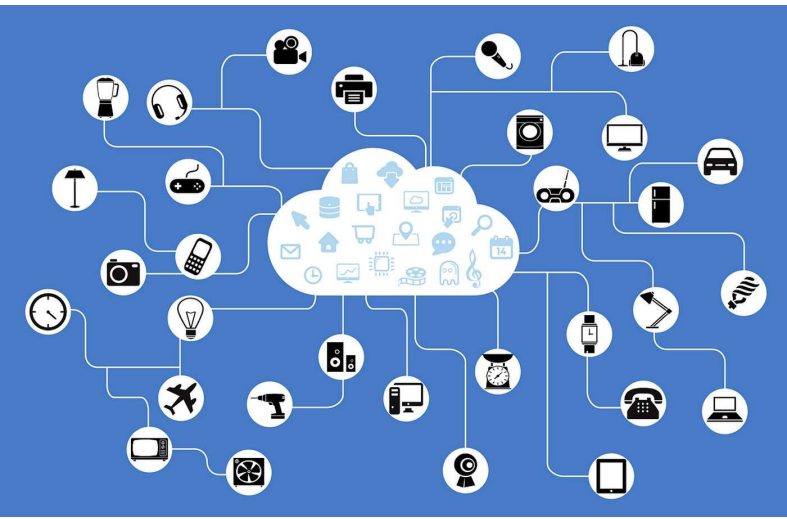
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SPINTRONIC

Example 2: Internet of things

Sensors – collecting data
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Year	Internet of Things (billions)	PC, game consoles, etc. (billions)	Mobile phones (billions)
2008	~0.5	~1.0	~0.5
2009	~0.8	~1.5	~0.8
2010	~1.2	~2.0	~1.2
2011	~1.8	~2.8	~1.8
2012	~2.5	~3.5	~2.5
2013	~3.5	~4.5	~3.5
2014	~5.0	~5.5	~4.5
2015	~7.0	~6.5	~5.5
2016	~10.0	~7.5	~6.5
2017	~15.0	~8.5	~7.5
2018	~22.0	~9.5	~8.5
2019	~32.0	~10.5	~9.5
2020	~50.0	~11.5	~10.5

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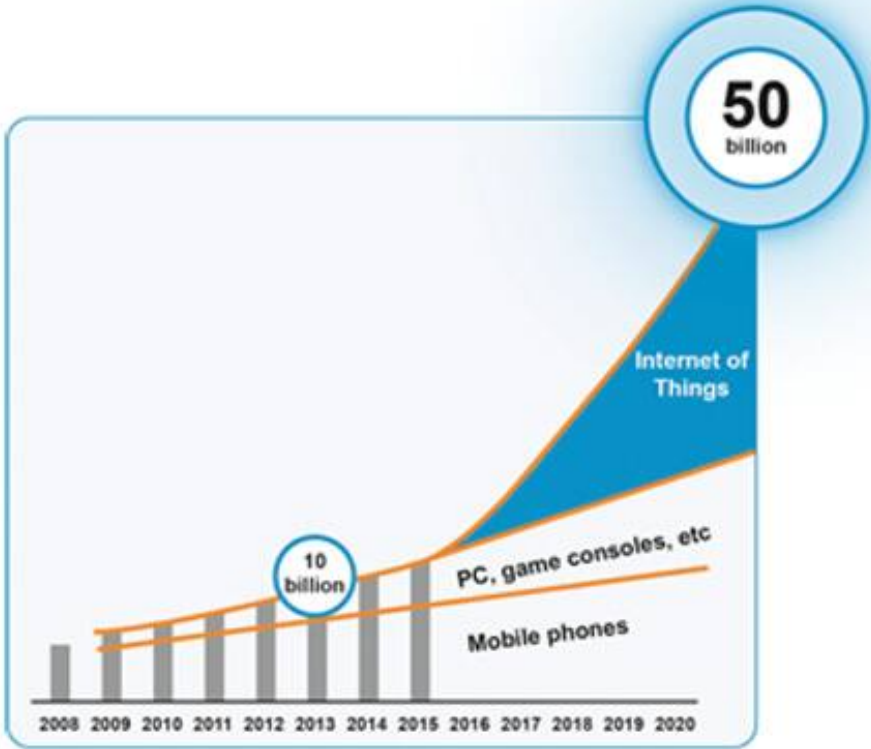
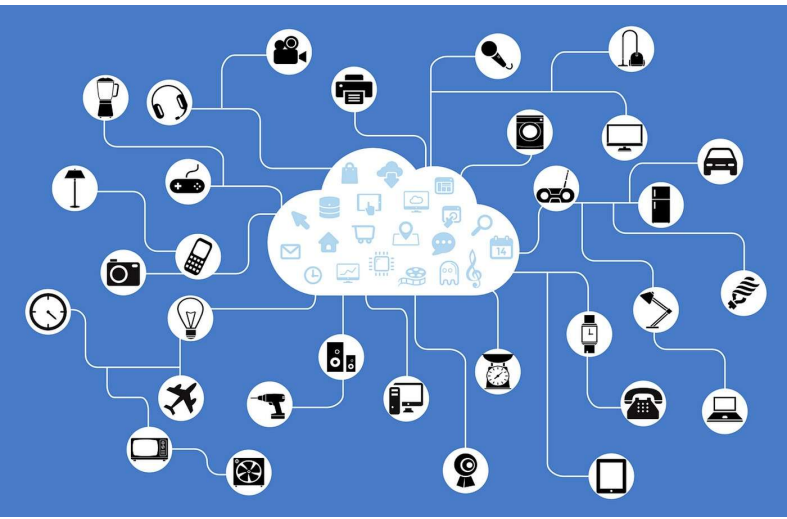
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2010	~1.2	~1.2	~1.2
2011	~1.8	~1.8	~1.8
2012	~2.5	~2.5	~2.5
2013	~3.5	~3.5	~3.5
2014	~5.0	~5.0	~5.0
2015	~7.5	~7.5	~7.5
2016	~12.0	~10.0	~10.0
2017	~18.0	~12.0	~12.0
2018	~25.0	~14.0	~14.0
2019	~35.0	~16.0	~16.0
2020	~50.0	~18.0	~18.0

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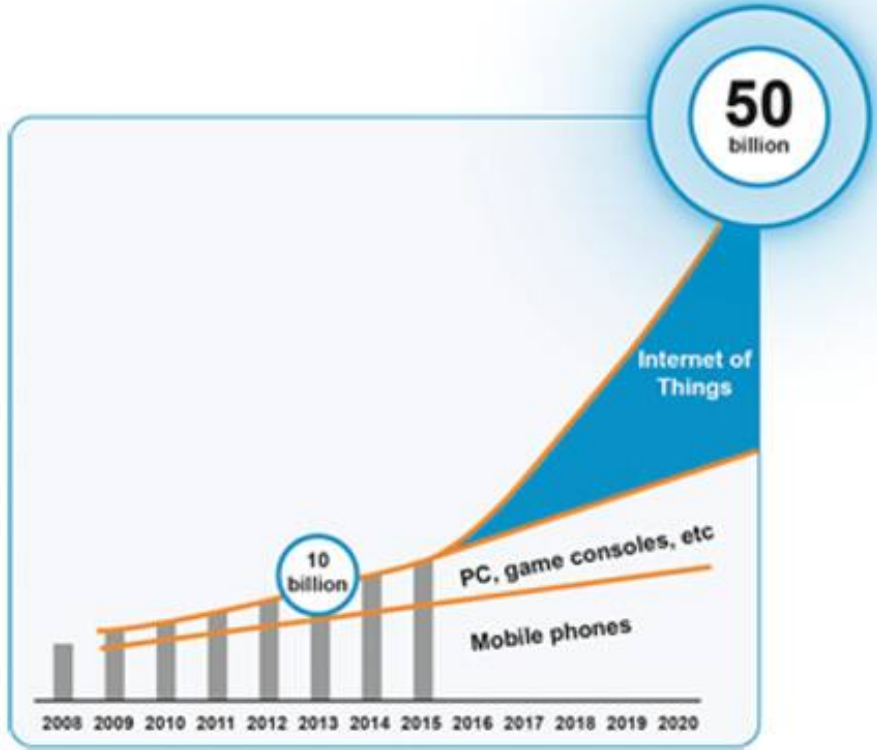
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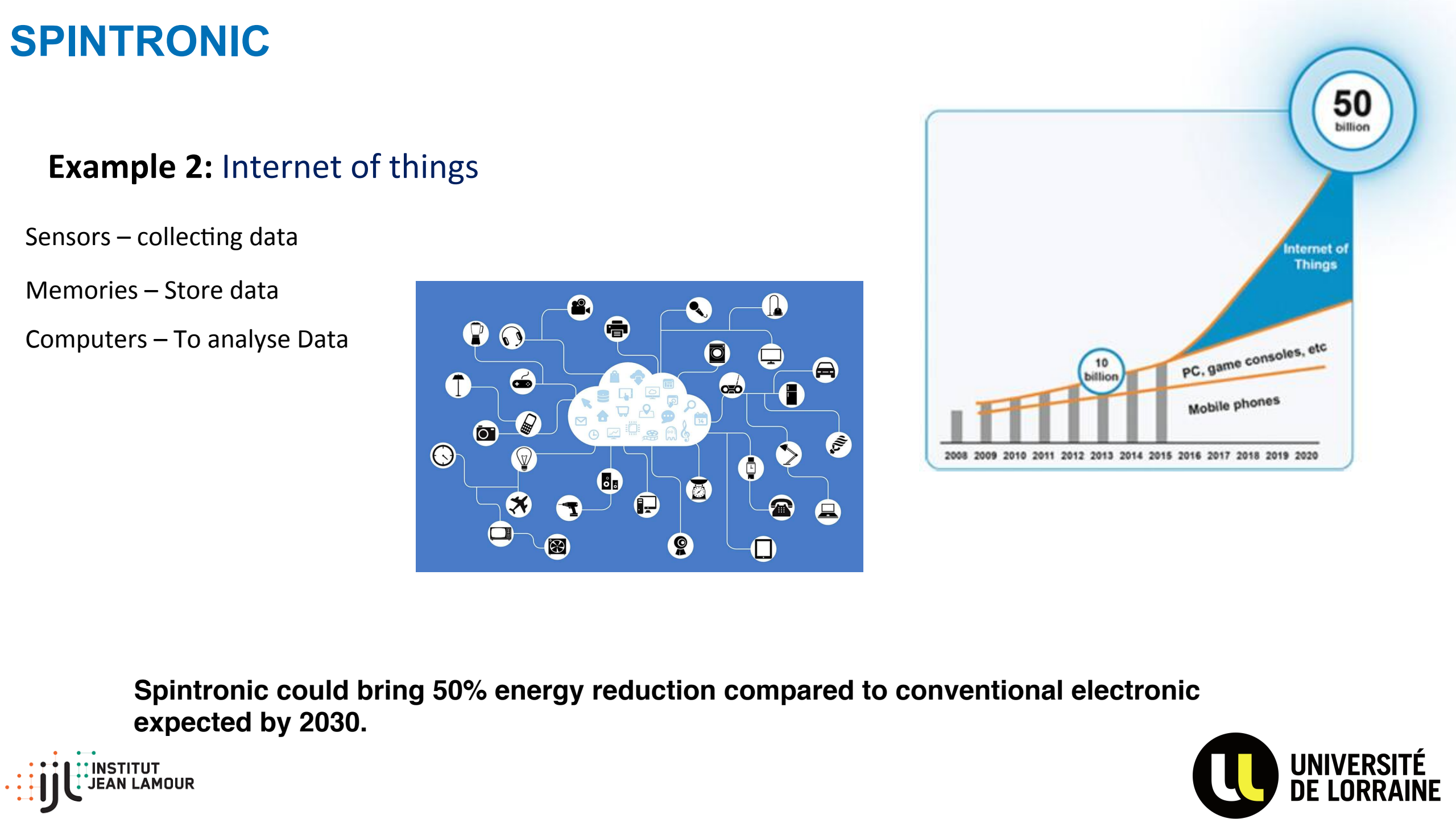
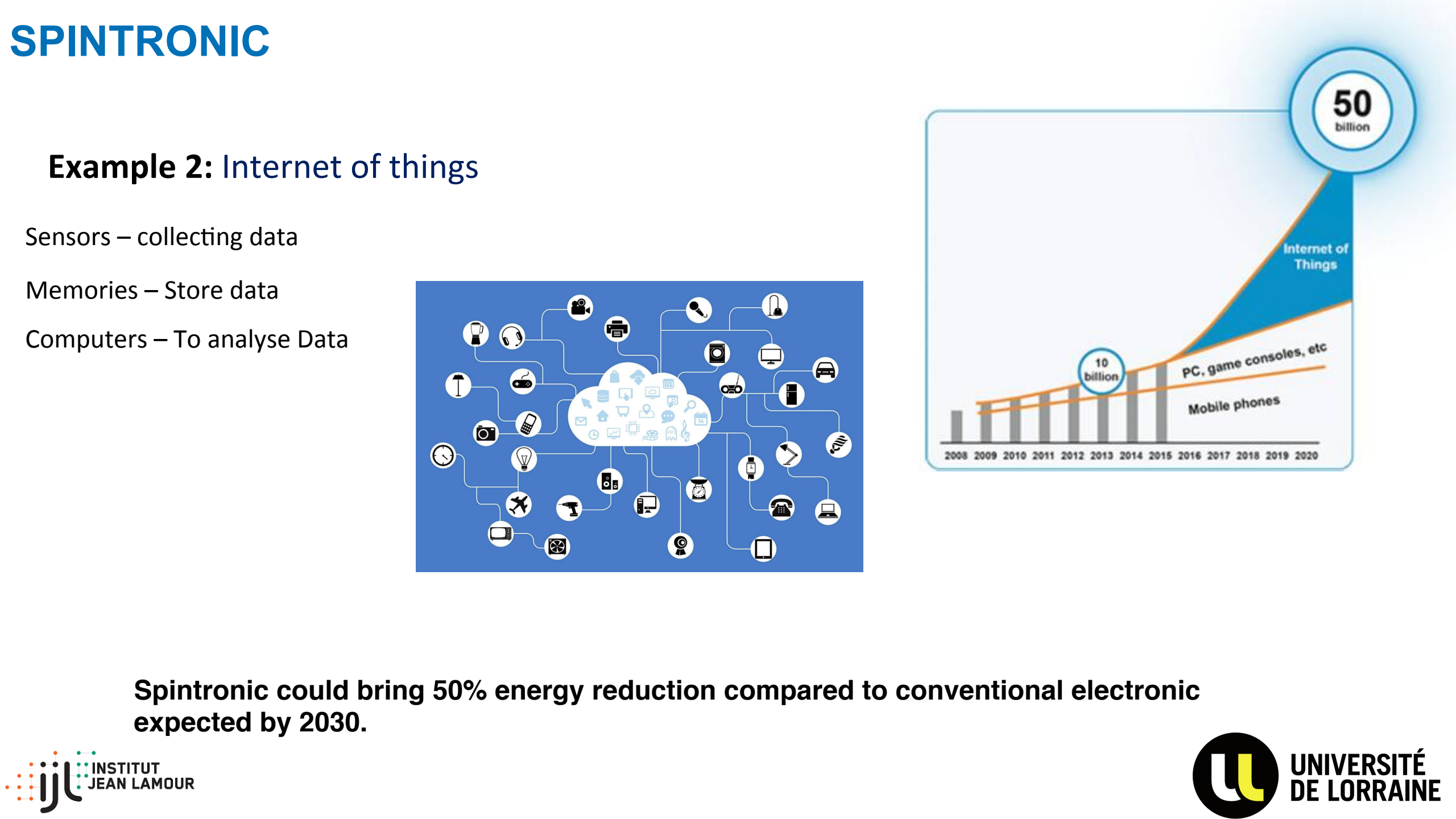


Year	Mobile phones (billion)	PC, game consoles, etc (billion)	Internet of Things (billion)
2008	1.5	1.0	0.5
2009	2.0	1.2	0.7
2010	2.5	1.4	1.0
2011	3.0	1.6	1.5
2012	3.5	1.8	2.5
2013	4.0	2.0	10.0
2014	4.5	2.2	15.0
2015	5.0	2.4	25.0
2016	5.5	2.6	40.0
2017	6.0	2.8	50.0
2018	6.5	3.0	50.0
2019	7.0	3.2	50.0
2020	7.5	3.4	50.0

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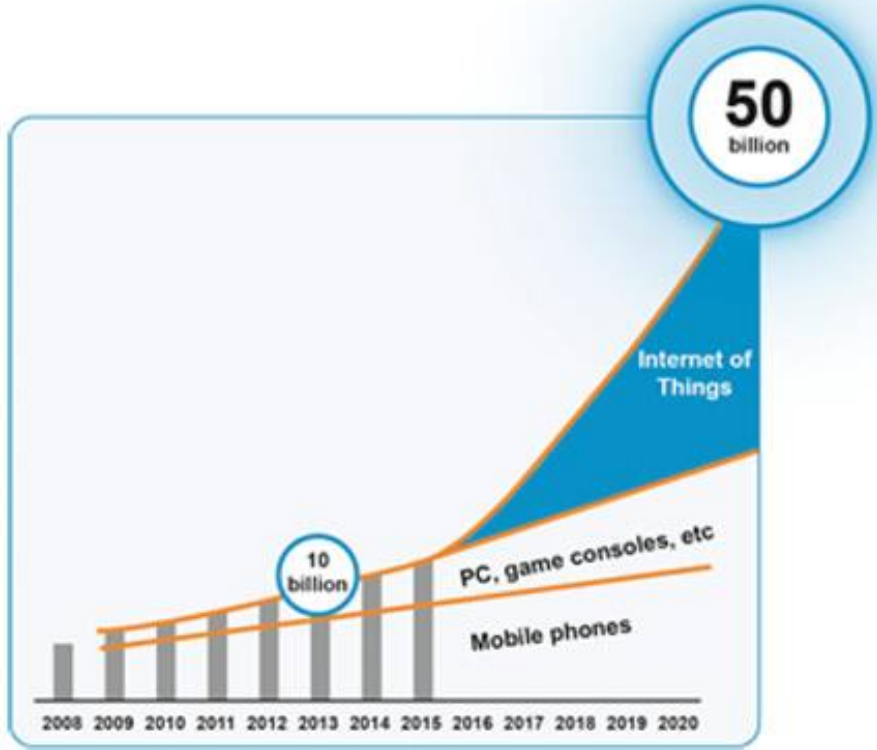
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2011	3.0	1.6	1.5
2012	3.5	1.8	2.5
2013	4.0	2.0	10.0
2014	4.5	2.2	15.0
2015	5.0	2.4	25.0
2016	5.5	2.6	40.0
2017	6.0	2.8	50.0
2018	6.5	3.0	50.0
2019	7.0	3.2	50.0
2020	7.5	3.4	50.0

Spintronic could bring 50% energy reduction compared to conventional electronic expected by 2030.

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SPINTRONIC

- Spintronic chips already on the market
- Investment and integration of talent needed for mass production
- Industry / Academic collaboration (pilot line)

Asia



USA



Europe



**THANK YOU
FOR YOUR ATTENTION**