

Can IoT Enable Smart Cities?

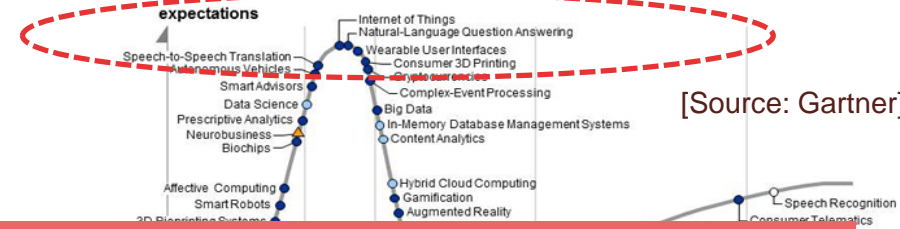
Prof. David Atienza

Embedded Systems Laboratory (ESL)

EPFL, Switzerland

david.atienza@epfl.ch

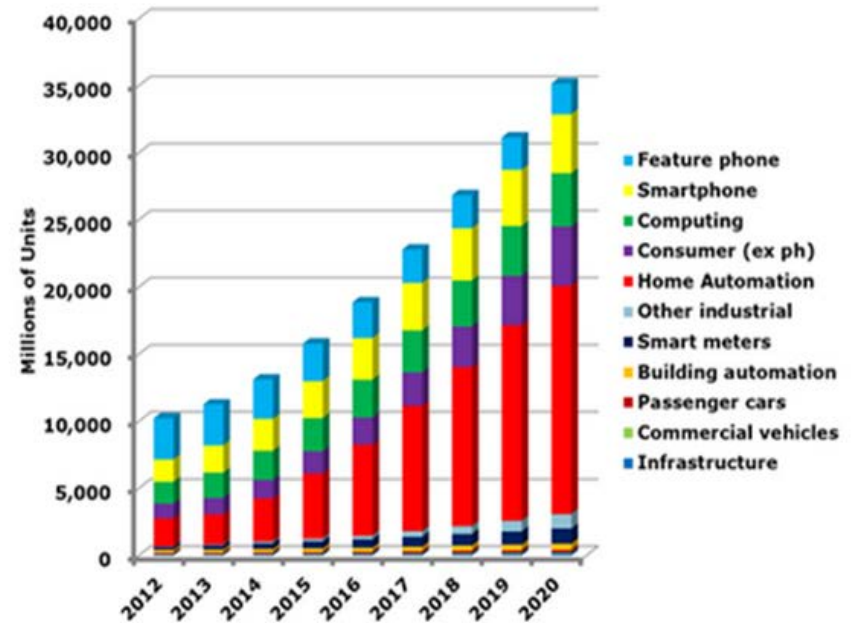
- Diffusion of innovations: very high expectations
 - Smart cities
 - Cheaper healthcare
 - Smart manufacturing



Dramatic growth! But are we technically ready?

- Economic benefits [McKinsey]
 - **\$11.1 Trillion/year savings** by remote healthcare
 - Business-to-Business (B2B) uses: **70% added value**
 - Efficient energy use in EU cities can **save 45TWh/year**

Total Internet of Things (or IoT) Connected Devices



Market Realist^Q

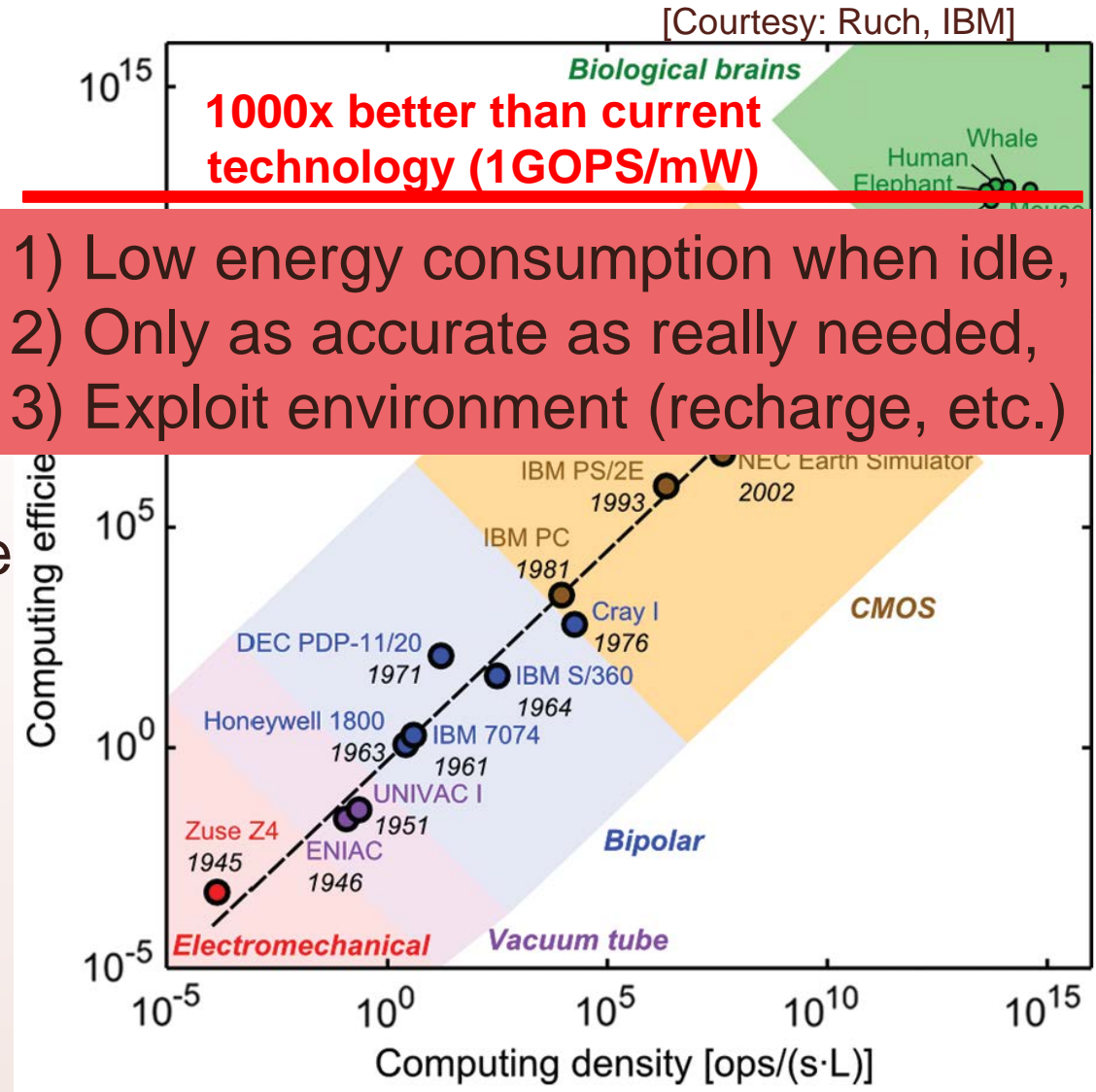
Source: Semico Research

■ Cheap hardware

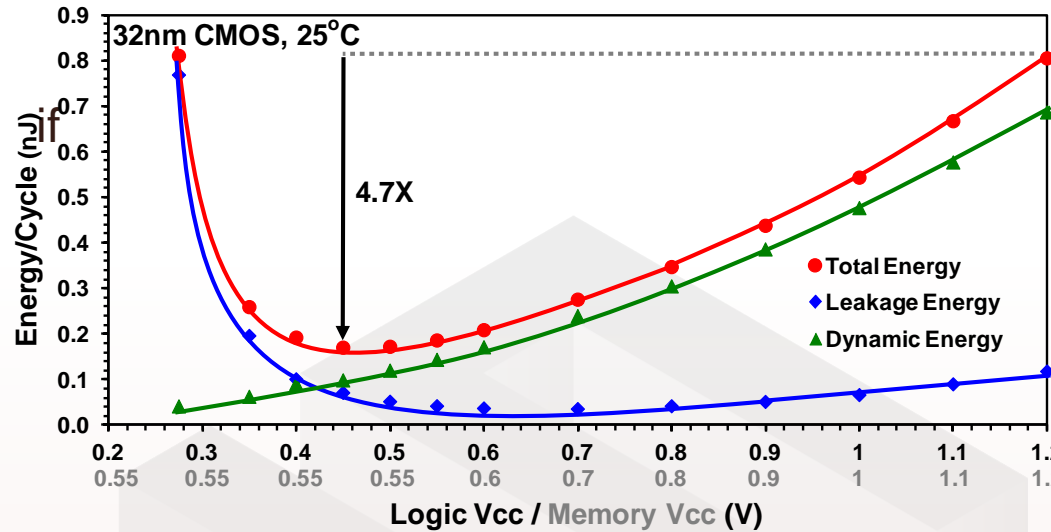
- Sensors: ~60 cents
- Bandwidth: 40x in 10Y
- Processing: 60x in 10Y
- Network: IPv6
(3.4×10^{38} Devices)

■ IoT trends can increase power needs by **2.5-5.5%/year**

[Goldman Sachs]

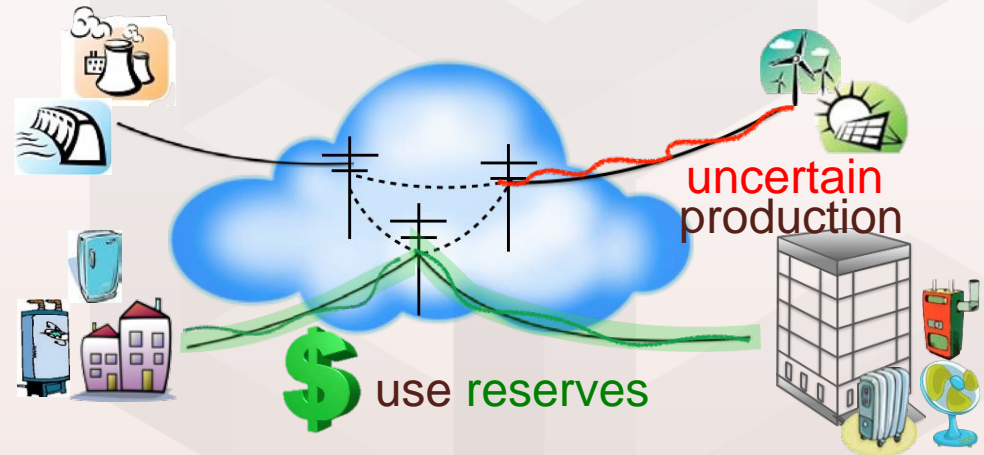


- Event-driven devices
 - “Zero-Power” (no leakage) not used
 - Hardware-software cooperation for optimization and energy use **forecasting**

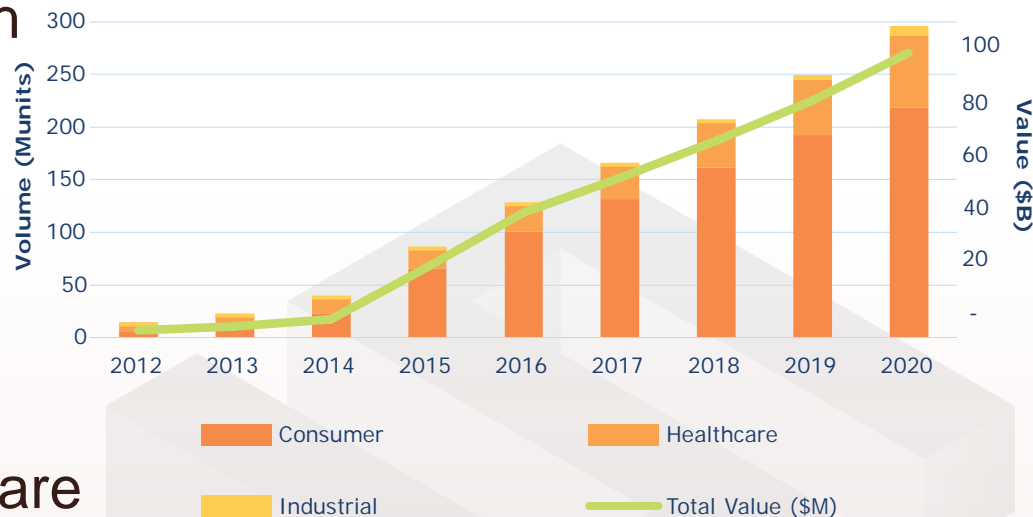


[Source: Vivek De, INTEL – Date 2013]

- Gather **only needed information**
 - Off if not required
 - Average power plant today: 20K sensors, only 4% used
- Collaboratively **sharing duties**: wireless wake-up and self-recharge technologies
 - Smart Power for IoT [ST]



Wearable Applications Breakdown - 2012/2020



(Yole Développement, July 2015)

A MUCH More Diversified Market Than Investors Realize



CREDIT SUISSE

- B2B models not defined, though market grows all the time...
 - Who pays: Insurance, user?
 - Who owns the data?

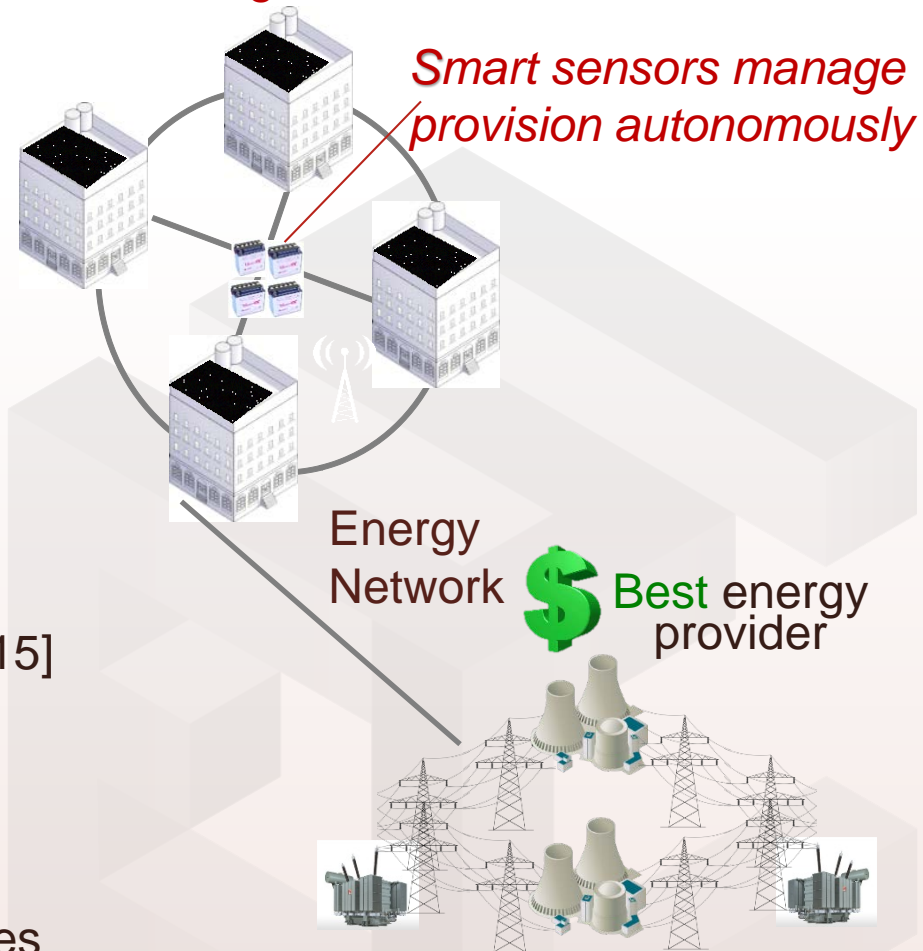
- IoT interconnectivity for healthcare devices not established
 - **Data sharing**: standard formats [IEEE P243 WG, DDS-PrismTech]
 - **Security**: ultra-low power IoT protocols [OWASP IoT Top 10]
 - **Big data**: new prediction and data mining techniques [IBM Analytics for Healthcare]

- Decentralize production control
 - New **distributed programming** frameworks: exploit IoT info to assign work to do [MQTT, IBM Bluemix]

- No (limited) human intervention, automated management of faults
 - IoT **network resilience** topologies [Smart OOB - OpenGear]
 - Big data analysis and **prediction** [1.6B € total volume in Germany, 2015]

- Smart Sensors: **self-awareness**
 - Machine learning: intelligent "human" management of manufacturing facilities
 - Self-distribution of roles and energy supplies with new sensors (add/remove)

Self-management of factories



- Definitely possible, but only starting to shine...
- Many questions to solve to have full Sun:
Academia and Industry together

