pervasive, ambient, ubiquitous:
the magic of radio

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Note: The views expressed in this presentation are those of the author and do not necessarily reflect the opinions of the ITU or its membership. Lara Srivastava can be contacted at lara.srivastava@itu.int

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trends toward ubiquity

- Trends in the ICT market point to the preponderance of radio technologies
- Tremendous growth of mobile cellular and wireless broadband networks
  - 2 billion mobile phone users today
- Importance of always-on access and availability of communications and information anywhere, anytime
- … making technology “ubiquitous”

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radio, radio everywhere

- The densest radio systems in the world are terrestrial radio and cellular
  - the ratio of radios to humans is nearing 1 to 1
- But we are soon entering a new era:
  - in which this ratio could exceed 1000 to 1
- Thus, radios would be all around us, becoming “ambient” in the environment
- … thereby radically transforming the role of technology

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radio in on the internet of things

- We have oft talked about anytime and anywhere connection by anyone
- But it can go further still through radio technology:
  - By **“anything”…**
- This is the vision underlying the concept of a “network of things or objects”
  - Giving each thing its own “identity” in cyberspace
- In other words: the internet now connects computers to one another, but imagine if it could also connect computers to things – a whole new dimension?
  - Is this the dawn of an **“Internet of things”**?

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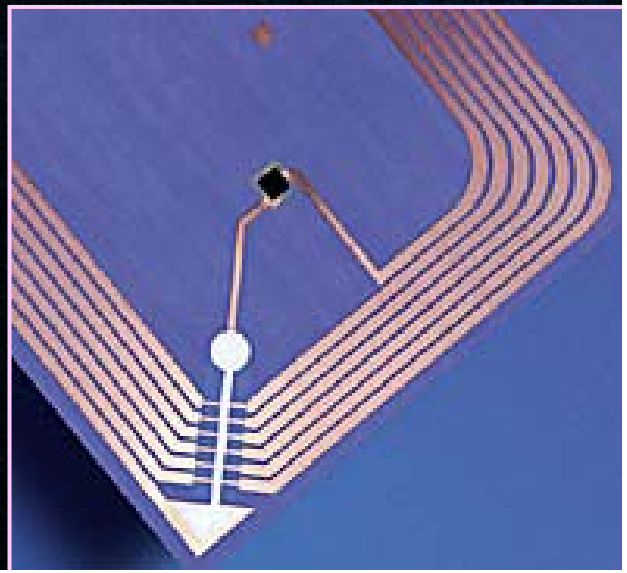
RFID: a key enabler

- The term RFID consists of two parts: *radio-frequency* (RF) and *identification* (ID)
- RFID systems allow us to identify individual "things" in the environment
  - **typical system made up of reader, tag & middleware**
- RFID systems provide a sort of "map" of the real world in the virtual world
- As such they can wirelessly monitor objects in real-time, without necessarily having line-of-sight



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a big idea but not a new one

- It's all about radio after all (19th century)
  - Combined with radar (discovered 1922 by Leo Young)
  - RFID said to be discovered ca. 1948, in a landmark paper by H. Stockman

History of RFID: Over the decades

Decade	Event
1940-1950	Radar defined and used. Major World War II development efforts. RFID invented in about 1948.
1950-1960	Early explorations of RFID technology. Laboratory experiments.
1960-1970	Development of the theory of RFID. Early field trials.
1970-1980	Explosion of RFID development. Tests of RFID accelerate. Early adopter implementation of RFID.
1980-1990	Commercial RFID applications enter the mainstream
1990-2000	Emergence of standards. RFID more widely deployed.
2000-2010	Innovative applications emerge. Combination of RFID with personal mobile services. Subcutaneous RFID emerges for animals, humans. RFID becomes part of daily life.

big idea in a small package

Tag/Transponder
located somewhere within this dark dot

Some Hi-tech
Orange Material
For Display

Interrogator
(…waiting back stage)

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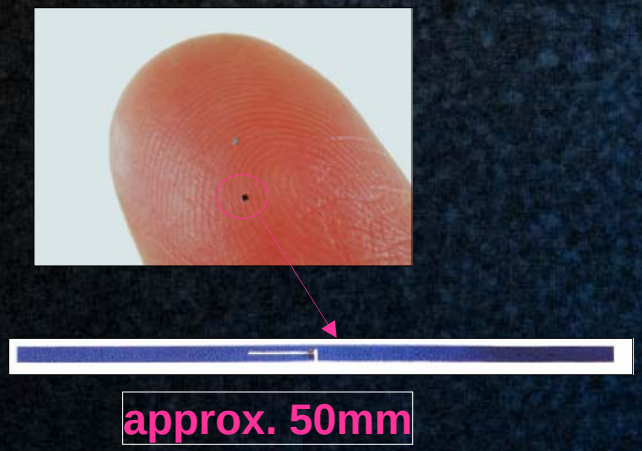
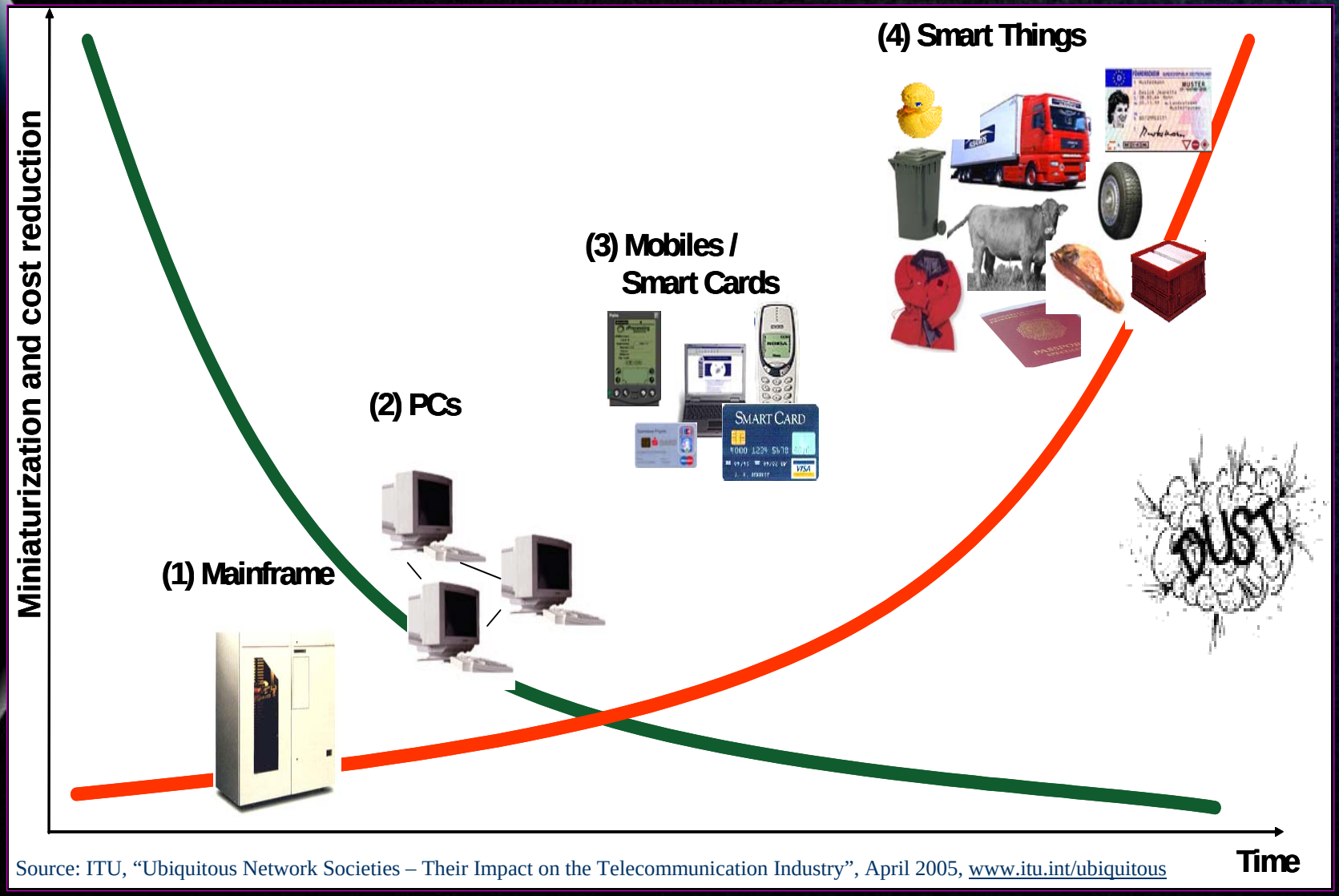
and shrinking all the time

- **µ-Chip** (Hitachi)
  - World's smallest at 0.4 mm x 0.4mm x 0.15mm
  - No power source (no battery)
  - Reading distance: approx 30 cm



- Scientists now working on developments to shrink computing power further
  - Nanotechnology and the disappearing processor
  - One day "**smart dust**"?
- Far from science fiction, it's bordering on science fact!
  - MIT, Berkeley etc… working on autonomous sensing and communications under a square millimetre
- The linking of tinier and tinier things will increase network communications at a staggering scale

network connections multiply, as size and cost shrink



Source: ITU, "Ubiquitous Network Societies – Their Impact on the Telecommunication Industry", April 2005, www.itu.int/ubiquitous

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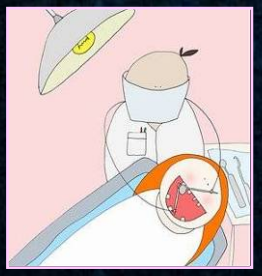
“the magic of things” yielding a plethora of new applications









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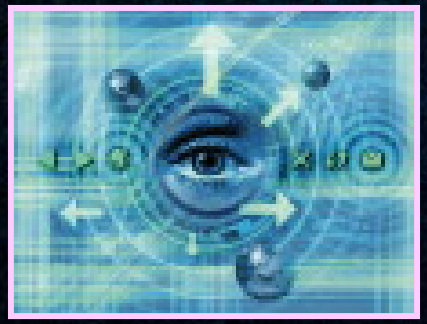
RFID and sensors: complementary technologies

- **Sensors:** *enable detection of environmental status and sensory information*
  - in combination with sensors, RFID can better track the status of things, e.g. their temperature, the presence of bacteria etc…
  - they can replace human senses to monitor the environment
  - as such, they act as a further bridge between the physical and virtual worlds



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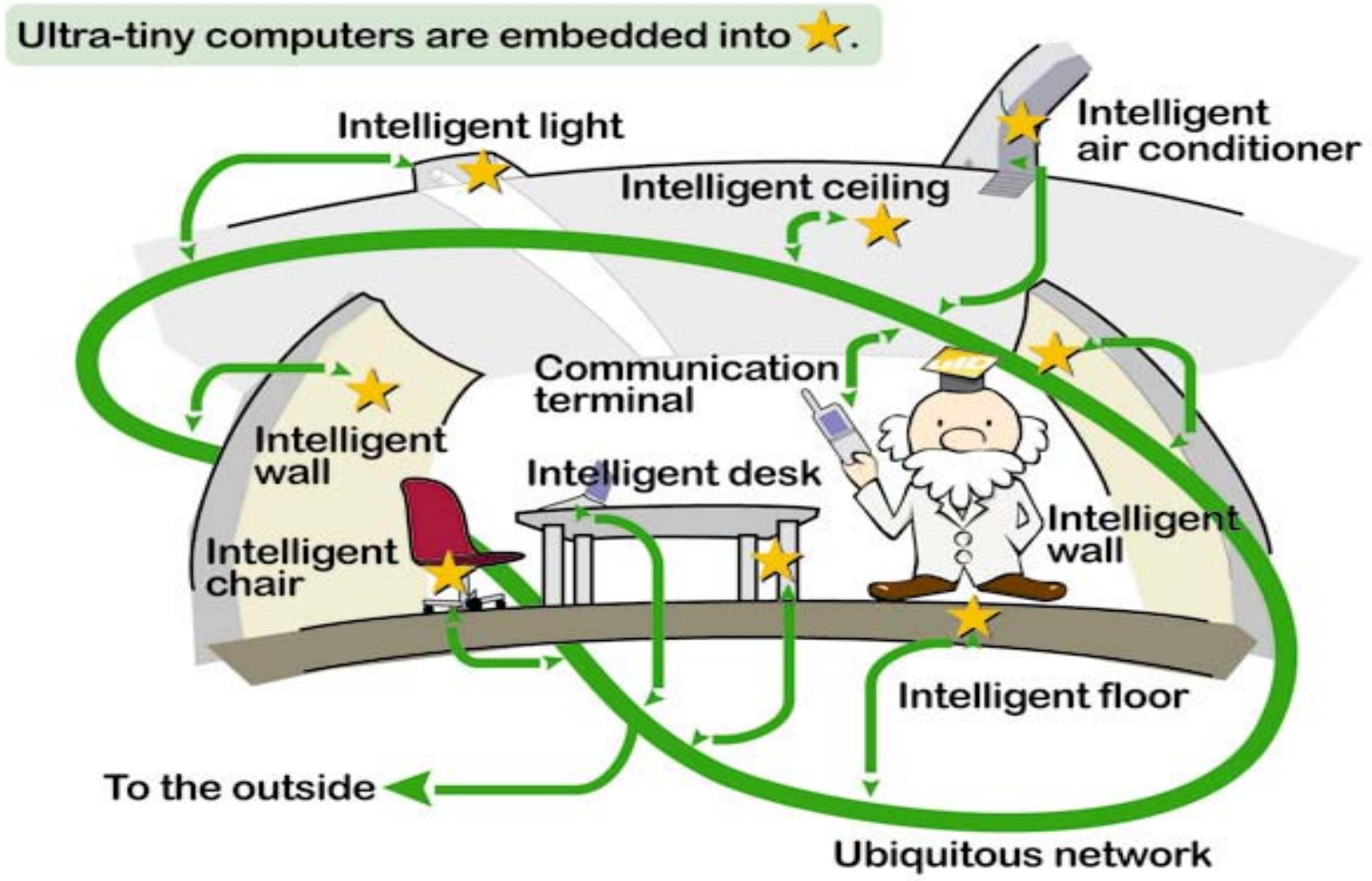
So what if things could think (ambient intelligence)?



Source: Ubiquitous ID Center

their thinking and talking would occur invisibly in the background

- Who controls information on the tags?
- Who has access to it and when?
- RFID has already been plagued by delays due to consumer concerns
  - e.g. Benetton
- Public sector has begun addressing the problem
  - EU Data Protection WP, Japan's RFID Guidelines
- How to avoid a privacy divide?
  - The phenomenon of the supermarket loyalty card
- There remains a lack of clarity
  - How to convince users to take up the technology amidst concerns over privacy

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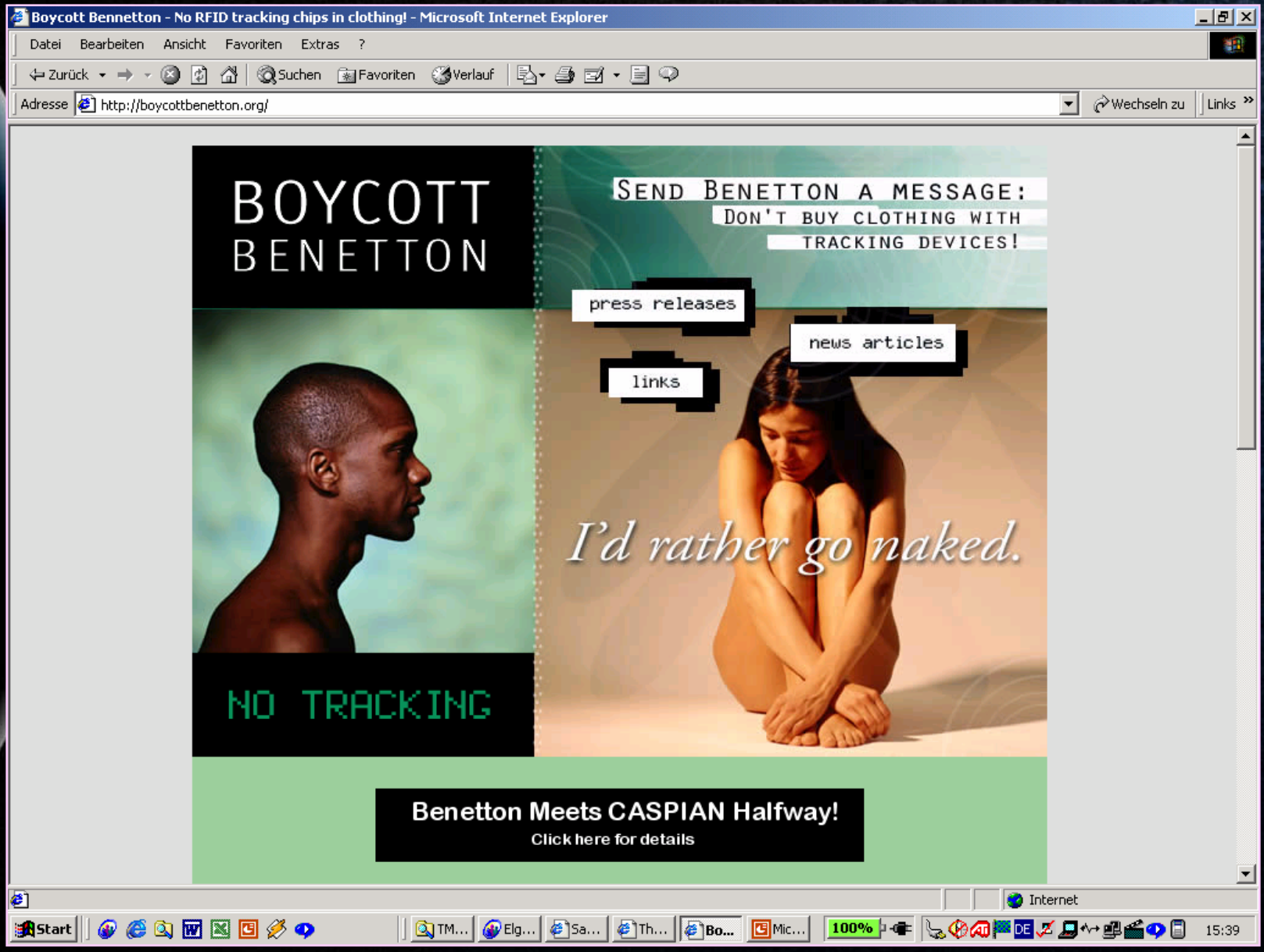
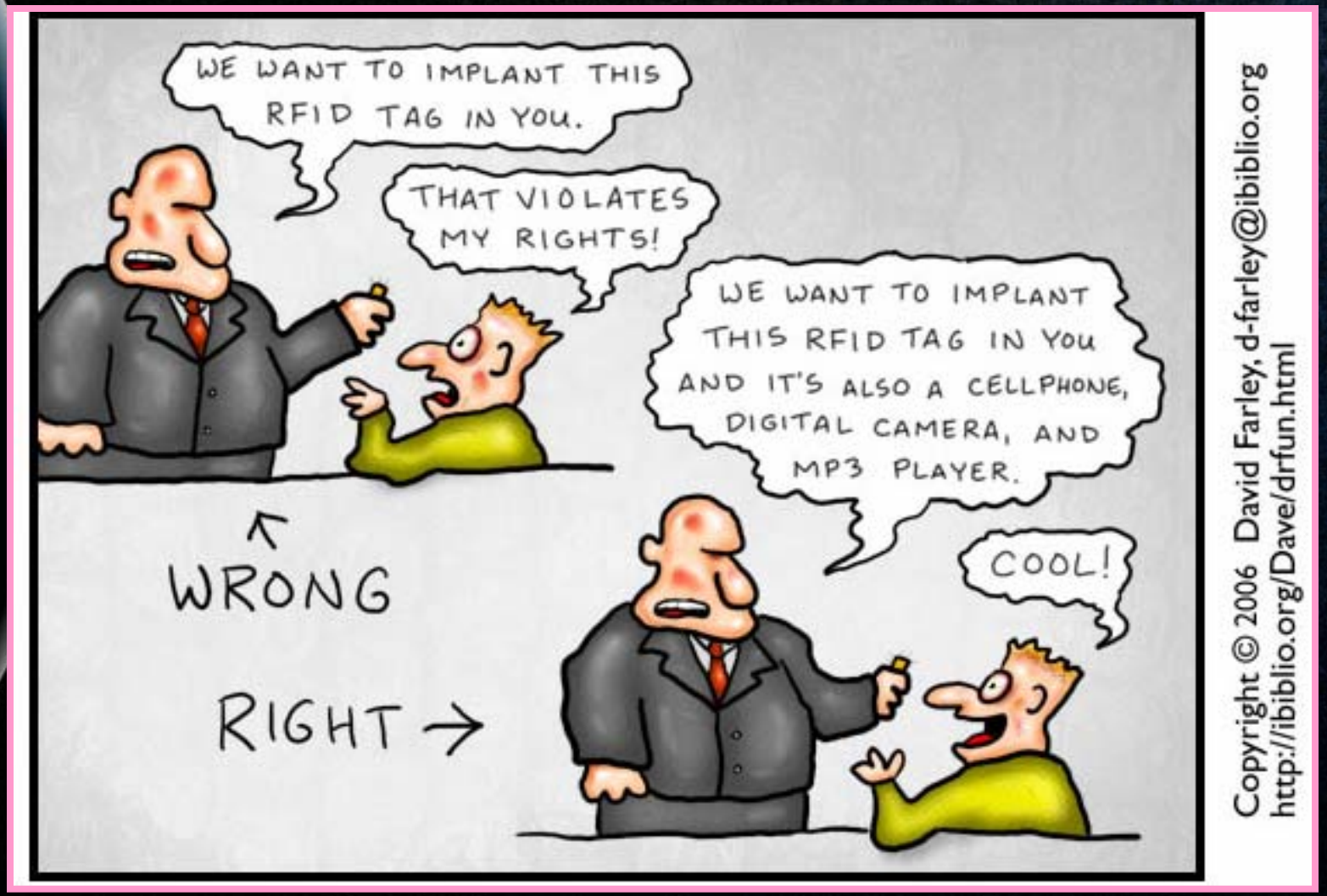
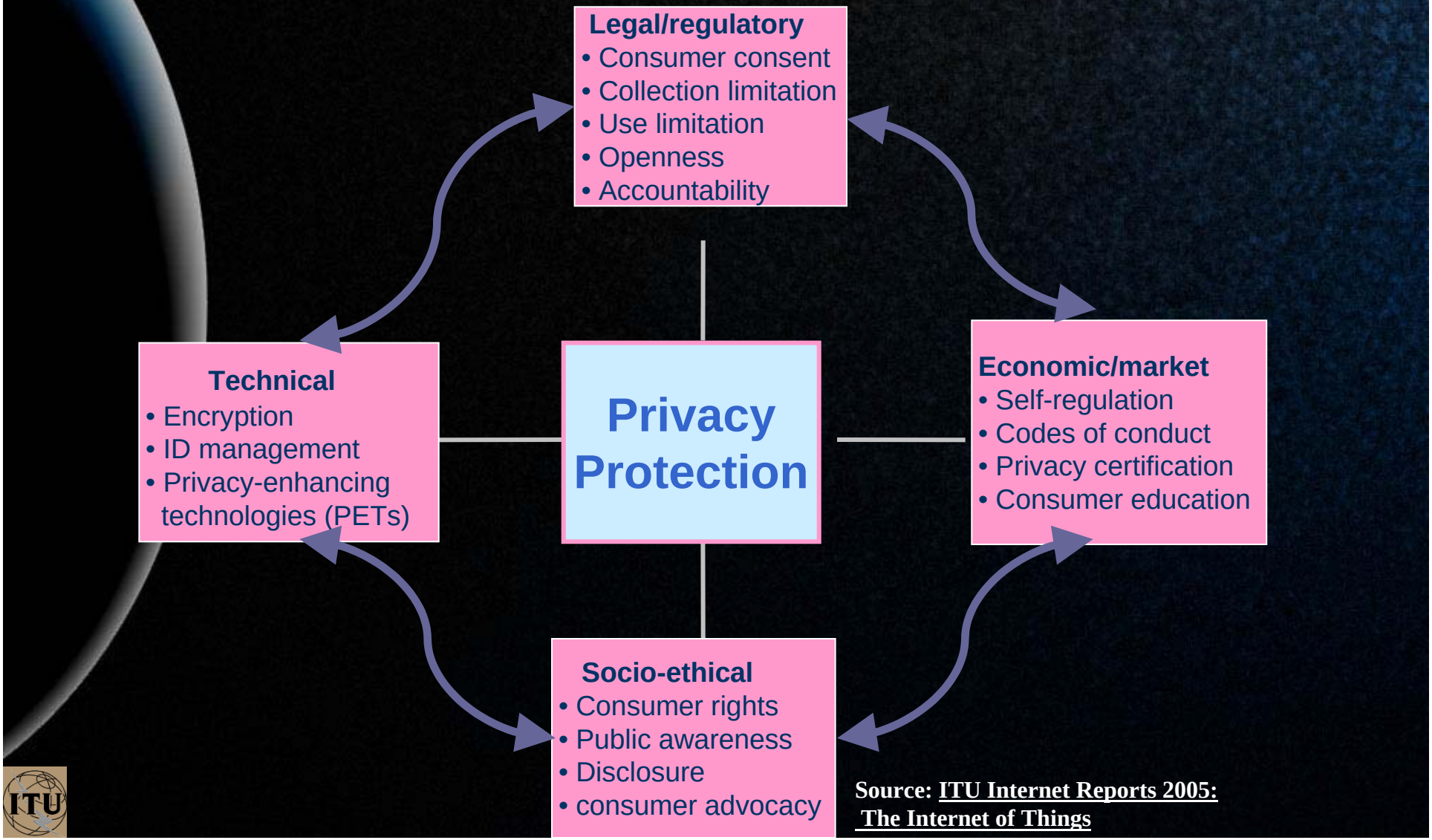
demand side: the benetton boycott



supply side:
is this the whole answer?



privacy in all its facets should be built into the design of technology



Source: ITU Internet Reports 2005: The Internet of Things

Important challenges

- Consumer protection
  - e.g data protection, privacy - also cybersecurity & spam
- Standardization at a global level
  - Standardization remains fragmented
    - not only in networking protocols, but also for tag formats (EPC, uCode…)
    - standardization for authentication and privacy also needed
  - Need for global standardization called for at ITU Workshop on RFID: Systems and Services (Feb 14-15th 2006)
- Governance of Resources
  - Who owns the identifiers?

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be not afraid of going slowly,

be afraid of standing still

Japanese proverb

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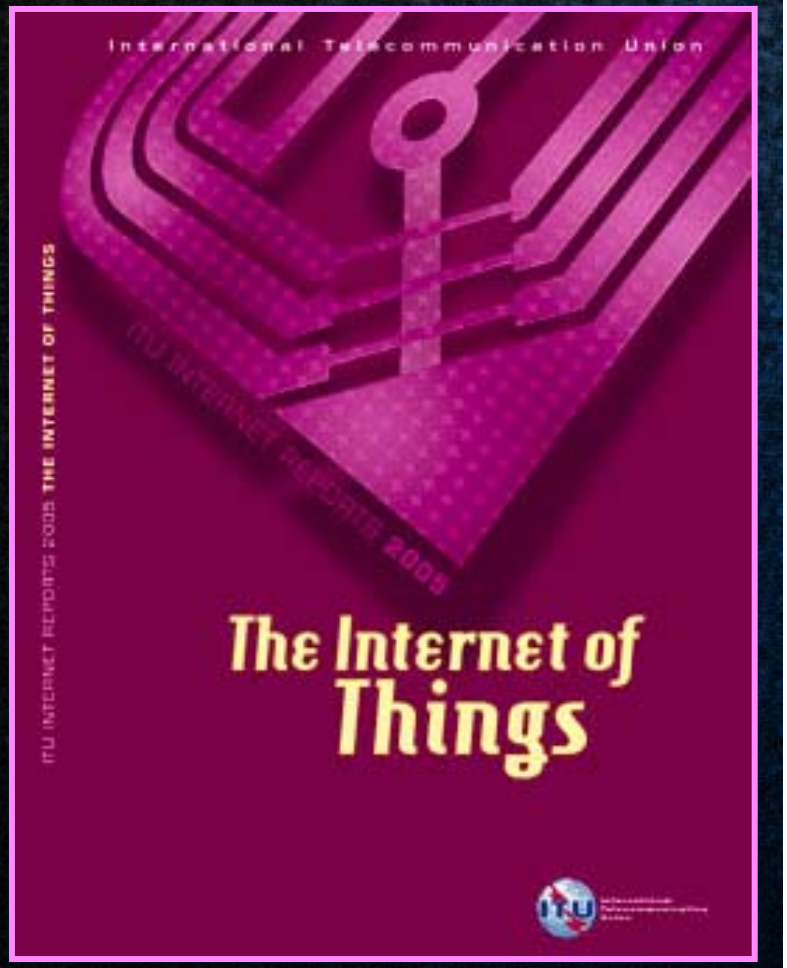
THANKS!

www.itu.int/internetofthings



ITU Internet Report 2005 on "The Internet of Things" launched at the *World Summit on the Information Society*, Tunis, November 2005

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