

# Internet Science Research – The Green Dimension

## Workshop on Green ICT

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Network of  
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Internet Science



# Internet phenomenon

- **Economic** transformation

- Productivity gains in standard businesses
- New businesses/SMEs, new advertisement paradigms, energy grids
- New economic models (skype, google, apple, cloud, ...)



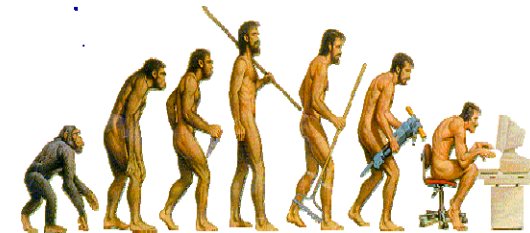
- **Social** expansion



- Ubiquitous access to information (copyrighted or free: wikipedias, googlemaps, ...)
- Online social networking (Linkedin, Facebook, Twitter, ...)
- Personal expression (Youtube, Flickr, ...)

- **Psychological** change

- Internet time (affecting workstyles and lifestyles)
- Globalisation, multilinguality, Augmented Reality
- Online Trust



- **Legal** Impact

- Redefinition of Privacy and Identity
- Copyrights in the digital era
- Cybercrime

# Internet: more than a technology

From a technical artefact



to a central element of our social fabric



Internet becomes closely interwoven with major societal movements and environmental challenges

## Internet-Human Interactions:

- Human Activity shapes the network
  - Network impacts on human behavior
- 
- *Which are the reciprocal influences linking the Internet and broader socioeconomic systems ?*
  - *Which are the prospects and limitations associated with our attempts to extend the current Internet and how we can influence its future development?*

→ **Network of Excellence in Internet Science (FP7-ICT-2011.1.6-288021 EINS)**

# EINS Consortium

EINS coordinator: CERTH (Prof. Leandros Tassioulas)

EINS unites a **wide team of 33 partners** from:

- ICT, with track record on interdisciplinary research & cooperation with non-ICT
- non-ICT, with track record on Internet research
  - The right mix of skills and adequate experience is key to the endeavour success



# Network of Excellence in Internet Science

- A. Coordinate the investigation, from a **multi-disciplinary perspective**, of specific internet-related topics **at the intersection between humanistic and technological sciences**, such as sustainability, privacy and identity, reputation, virtual communities, ...

**JRA4: Governance, Regulation & Standards**



**JRA5: Internet Privacy, Identity, Trust & Reputation Mechanisms**



**JRA6: Virtual Communities**



**JRA7: Internet as Critical Infrastructure; Security, Resilience and Dependability Aspects**

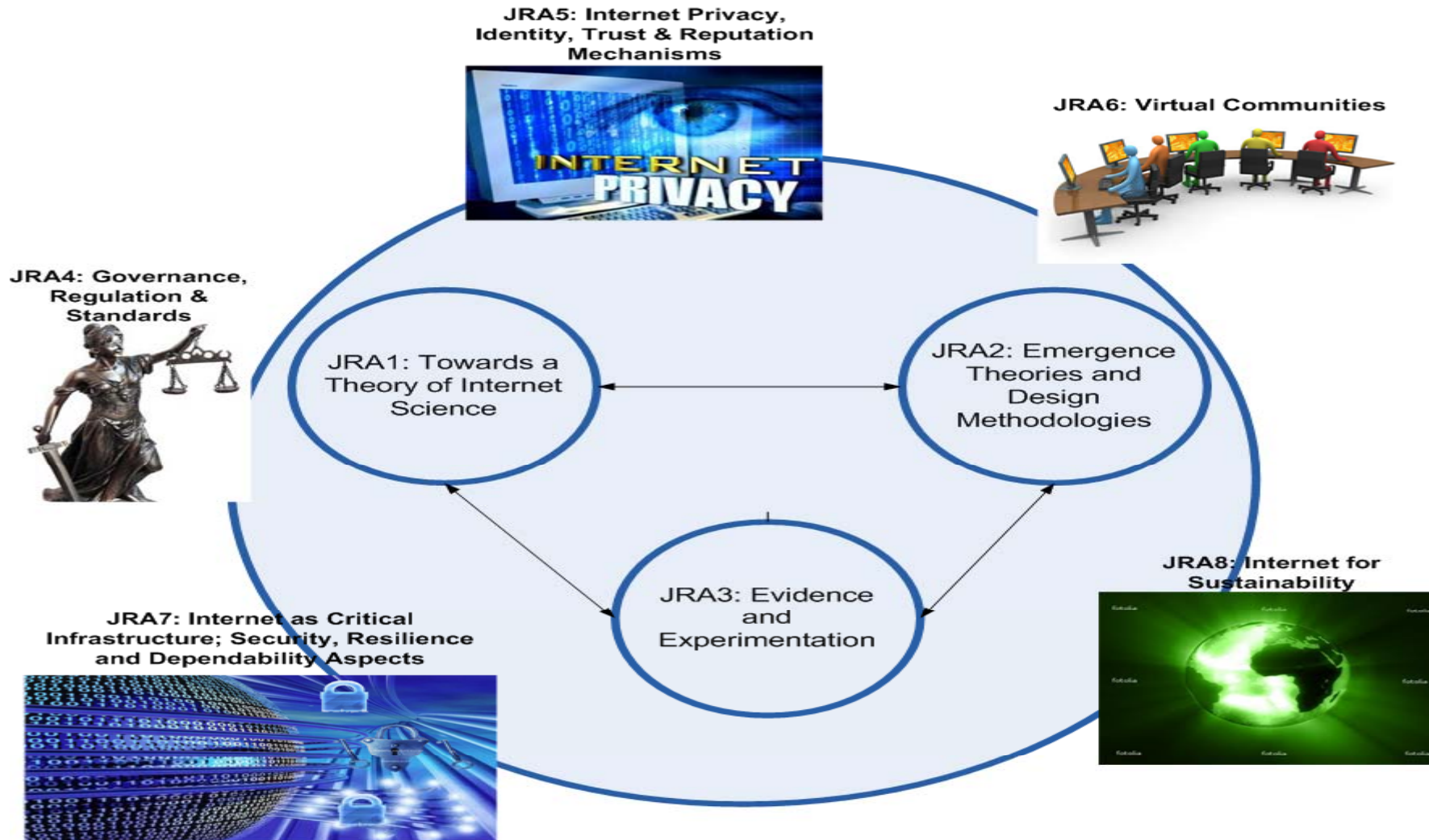


**JRA8: Internet for Sustainability**



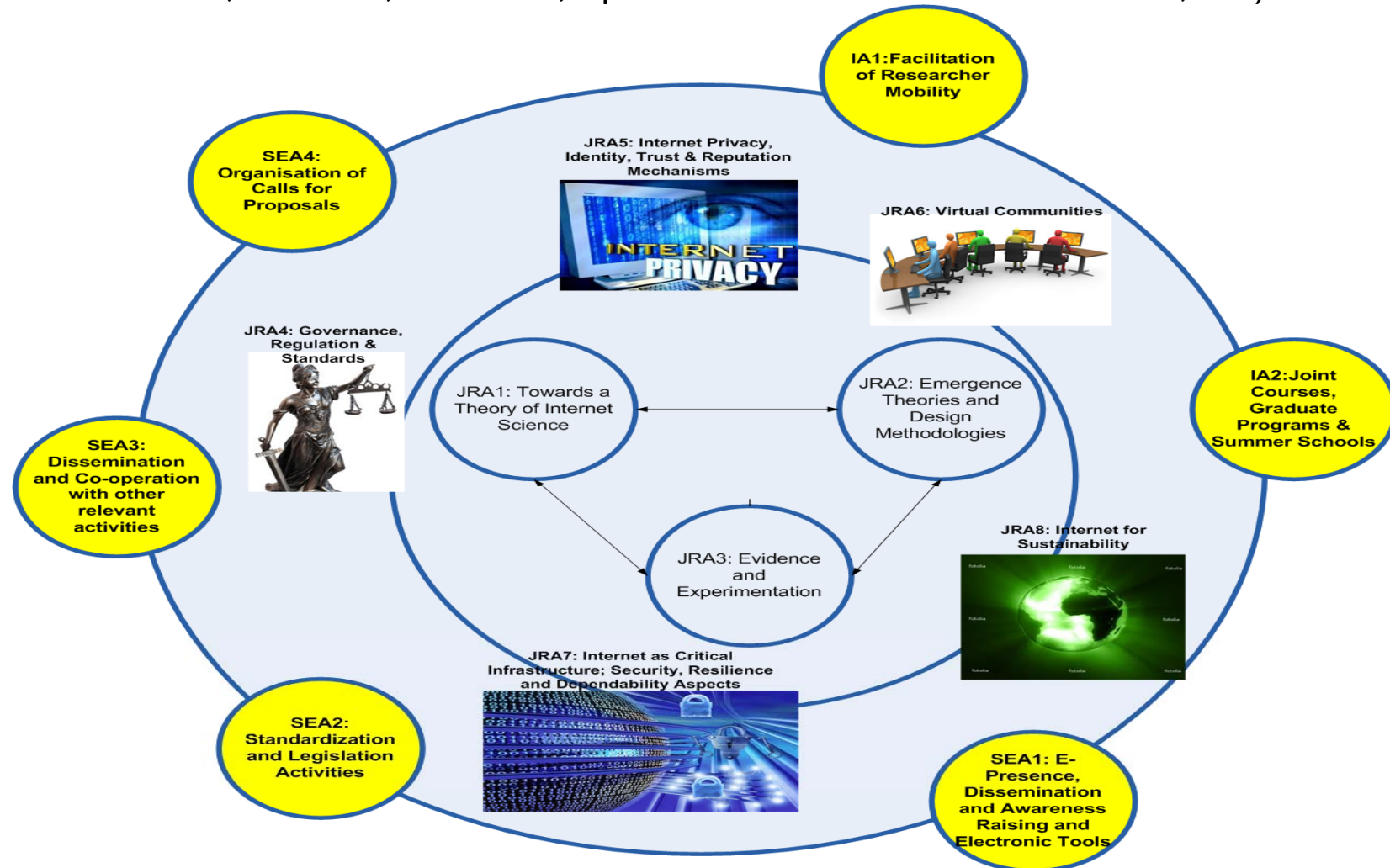
# Network of Excellence in Internet Science

- B. Lay the foundations for an Internet Science, for codification and integration of applicable bodies of theory and evidence, applying to aspects of the Internet



# Network of Excellence in Internet Science

- C. Provide concrete incentives for academic institutions and individual researchers to conduct studies across multiple disciplines (online journals, conferences, workshops, PhD courses, schools, contests, open calls for innovative activities, etc)



# Vision behind JRA8



- We are facing the convergence of multiple crises
  - **Financial, Environmental, Energy, Social**
- How can Internet help the transition towards a more sustainable future?
  - **Environmental-friendly way of living**
    - Product ranking, Life footprint, efficiency
  - **Sustainable economic development**
    - Empowering people, new market models, new IPR
  - **Participative global governance**
    - Based on cooperation, sharing, low-cost access



# Internet and Sustainability

- **Evolving toward sustainable civilization**

- **Can the Internet play a role in this?**

- Design an energy-efficient architecture for the internet



- Affect sustainability at planetary scale:

- Diminish Greenhouse gas emissions
- Energy production
- Sustainable lifestyle
- Climate change



- Smart Grid, environmental monitoring, natural resources management, green transportation, etc.

- Foster environmental awareness and actions



# Two key research tracks

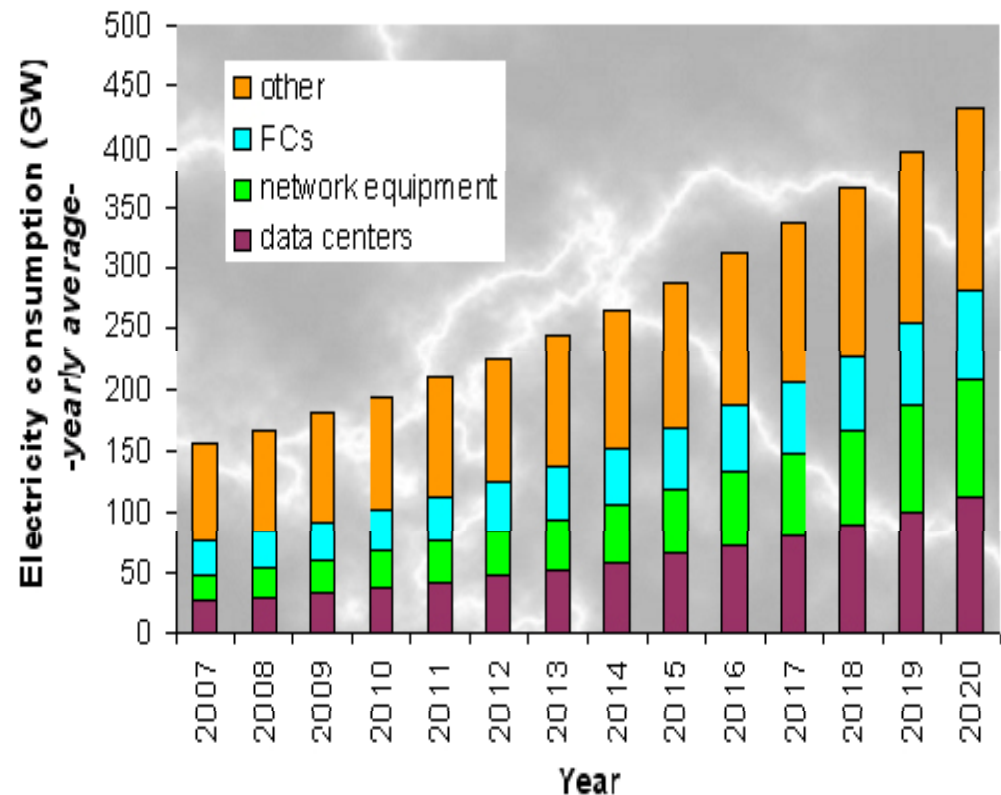
- European 20-20-20 objective: by 2020
  - 20% increase of energy efficiency
  - 20% increase of renewable energy sources
  - 20% reduction of greenhouse gases emissions
- **Green ICT:** Towards an energy-efficient Future Internet
  - Energy evaluation of different network paradigms
  - New energy-sparing network paradigms (Future Internet)
  - ❖ additional challenges: full life-cycle analysis (LCA), not only CO<sub>2</sub>, ...
- **ICT for Green:** Future Internet for energy-efficiency in other domains
  - Environmental monitoring & decision making through high-quality networks
  - Energy optimization in heating, transport, power grids, ...
  - ❖ additional challenge: estimating rebound effects

# Multi-disciplinary approach

- Interaction between different factors:
  - Technical potential
  - User behaviour
  - Economic drivers
  - Regulation
- User behaviour greatly affects potential vs. realistic energy savings
  - User adoption: are energy-efficient technologies used?
  - Rebound effects: cf. “using a less energy consuming product more frequently”

## R8.1: Assessment and reduction strategies for ICT energy consumption

- Frameworks and methodologies for measuring and reporting energy consumption of ICT
- Overview of the carbon footprint of the Internet
  - Data centres
  - Network equipment
  - PCs
  - Others (TVs, telephones, gaming consoles...)
- IBBT study from 2007
  - >8% of total electricity consumption consumed by ICT in 2007
  - 1/7th of electricity goes to ICT use phase in 2020



- Identifying directions to lower the environmental impact
  - Novel network architectures
  - Novel routing/protocol paradigms

# 'Green ICT' research

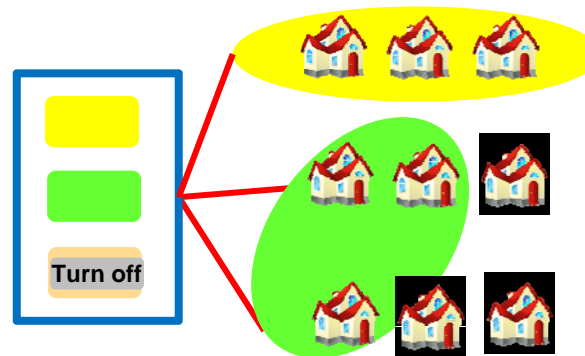
## ■ Functional consolidation/virtualization

- replacing desktop and laptop computers with lightweight thin clients and migrating the processing to a data center
- consolidation of multiple virtual machines onto the same host



## ■ Temporary switching-off components

- Sleep mode operation
- Traffic engineering

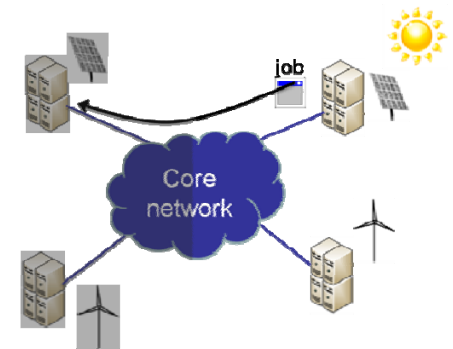


## ■ Load reduction

- Adaptive link rates

## ■ Optimal use of available energy sources

- Follow the wind/sun paradigm



## R8.2: Investigating “ICT for Sustainability” tracks

- Environmental monitoring
  - To assess consequences of e.g. pollutions
  - Using distributed sensor networks, by opening traditionally closed sensor systems
  - Technical & social [privacy] aspects
- Smart grid solutions
  - To reduce carbon footprint of energy supply
  - integrating renewable energy sources into the power grid
  - Introducing smart meters
  - Demand Response (DR), Demand Side Management (DSM), or Price-responsive demand: users' demand respond to the state of the grid → efficient share of available resources & alleviation of peak loads
  - Technical feasibility & steering user behaviour
- Energy consumption reduction in Other Smart Environments (Smart Home, Smart Buildings)

## R8.3: How to influence the user behaviour

- Estimating and judging user behaviour of new “ICT for Green” solutions
- Designing measures to drive user behaviour
  - Financial or social stimuli
  - Policies and regulations
  - Feedback to users themselves
- Investigating how user-centric monitoring and feedback solutions could help
- Interdisciplinary approach
  - ICT, social sciences

## R8.4: How to be influenced by the user behaviour: potential versus realistic benefit from 'ICT for Green' solutions

- Potential benefit and reality can be quite different
  - Influence of user behaviour on actual savings
  - Psychological and sociological factors
    - Adoption
    - Rebound effects
  
- Investigating and estimating the above factors for some “ICT for Green” solutions
  
- Helping to identify
  - Barriers responsible for this gap
  - Measures to overcome these barriers



# Conclusion

- Green ICT is an important research dimension of Internet Science and EU goals
- An interdisciplinary approach (eg. considering social factors and rebound effects) could help to further improvements

[www.internet-science.eu](http://www.internet-science.eu)

- *Become an EINS affiliate member and share your thoughts with us:*

➤ <http://www.internet-science.eu/affiliates>

- *Contribute to our Internet for Sustainability blog:*

➤ <http://www.internet-science.eu/blogs/group/57>



# Thank you!

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