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## Energy-efficient Networking at Institute IMDEA Networks

Antonio Fernández Anta  
Senior Researcher

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## Energy Efficiency

- Reducing energy consumption and carbon emission is becoming a priority:
  - Global warming
  - Pressure from society
  - Energy prices
  - Governments regulations

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## ICT and Energy Efficiency

- Energy-efficient ICT
  - ICT amounts for 2% of global consumption
  - Equipment and services are not energy efficient
  - Substantial room for power savings
- ICT for energy efficiency
  - ICT can help reduce power consumption in other areas
  - Smart grids, smart buildings, smart logistics, smart-\*

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## Outline

- Energy-efficient ICT
  - Sample results in wireless and wireline networks
  - Current and future projects
- ICT for energy efficiency
  - Sample results in smart buildings
  - Current and future projects
- Conclusions

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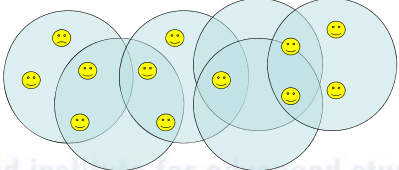
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## Power Saving at Wireless Base Stations

- Wireless network with variable user demand
- Base stations (BA) can be powered on/off
- Compute minimal BA density and power savings



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### Powerdown in Wireline Networks

- Links can be powered down/up
- Group packet into bursts
- Coordinate the bursts in the whole network

A link with 10% load can save ~80% power

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### Current and Future Projects

- Energy Efficient Ethernet (EEE, IEEE P802.3az) recently approved by the IEEE SASB.
- Same as powerdown model
- Lines of research:
  - Application of results to EEE networks
  - Efficient deployment of EEE
  - Impact of EEE in existing networks

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### Smart Buildings

- Collection of air conditioners
- Want to reduce peak power consumption
- Reference period; one duty cycle in the period

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### Smart Electric Vehicles Charging

- Electric vehicles charging station
- Want all vehicles leave with similar charge: **fairness**

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### Current and Future Projects

- Smart buildings
  - Efficient scheduling of power consumption, production, and storage under user restrictions
  - Mechanisms and pricing schemes to condition user behavior
- Electric vehicles charging stations
  - Smart charging scheduling
  - Batteries as energy storage
  - Incentives to vehicle owners

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### Conclusions

- Wide experience in energy related problems
- Interesting and challenging research problems
- Application of communication concepts and solutions to this new environment
- Open to face new challenges:
  - Smart grids
  - Smart logistics
  - Traffic control

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Nov 10th, 2010 Symposium IIN-AETIC-UC3M 13