Networks, Standards, and Energy

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This workshop

Measurement Standards

Stated focus:

"technical standards to **define** and **measure** energy efficiency performance … standardised methodologies … **support** the implementation of energy efficiency practices"

Observing or evaluating use and savings.

Network Standards

Networks **require** standards to work at all.

Network standards:

– strongly determine energy use and functionality.

– can **prohibit** or **require** energy-saving features

This presentation

In Scope
- Residential buildings
- Commercial buildings
- People

Not in Scope
- Industrial energy use
- Sensor networks
- The meter
- **Anything** on the grid side of the meter
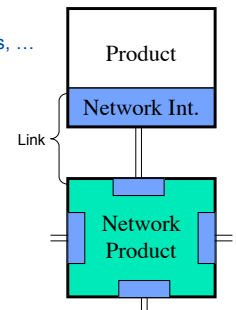
Networks and Energy

Network equipment ….
Routers, switches, modems, wireless APs, …

… vs **network**ed equipment
PCs, printers, set-top boxes, …

How networks drive energy use
- **Direct**
  – Network interfaces
  – Network products
- **Induced** in Network<u>ed</u> products
  – Increased power levels
  – Increased time in higher power modes (to maintain network presence)

Product

Network Int.

Link

Network Product

## Measurement Standards - *in progress*

- Test procedures
  – Network equipment (home, office, service provider)
  – Electronic products
  – Low-power modes w/network connectivity
  – Appliances
- Evaluation criteria
- Limits / Specifications

- Issues: configuration (hardware, software), interface issues, utilization, etc.

Measurement Standards - *attention needed*

- Resist temptation to evaluate electronics for "*efficiency*"
  – Instead focus on functions, capabilities

- Use existing networks for energy-related measurement
  – Critical for management

- Speed of technology changes
  – Existing standards mechanisms too slow

Network Standards
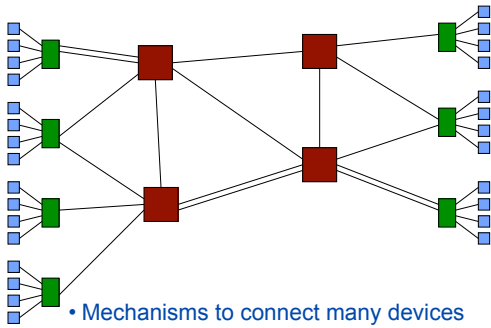
- Mechanisms to connect many devices
- Define links, discovery, messaging, data formats, management, etc.
- Communication, computation

OSI Network Model
(Open Systems Interconnection Reference Model)

Layer	Name	Function
7	Application	"I want a web page"
6	Presentation	.
5	Session	.
4	Transport	.
3	Network	.
2	Data link	.
1	Physical	"Bits on a wire" (or non-wire)

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("8th layer" — User Interface)

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Key Advantages
- Can replace individual layers without affecting higher and lower layers
- Facilitates interoperability
- All revolves around Internet Protocol

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("8th layer" — User Interface)

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*"Devices whose primary function is **Information** (obtain, store, manage, present)"*

- **Electronics** <u>are</u> an end use of electricity
  - Includes both Information Technology (IT) and Consumer Electronics (CE)
  - Much of this is digitally networked

- Electronics
  — based in <u>information</u>
- Conventional end uses (HVAC, lighting, appliances, …)
  — all based in <u>physics</u>

What <u>is</u> a building network?

- People
- Light Sources
- Light modifiers
- Thermal sources, ventilation
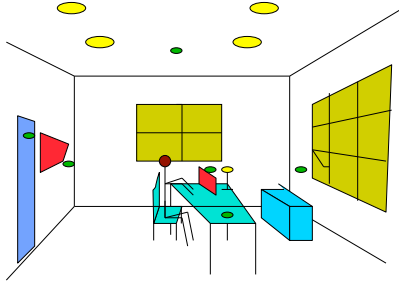- Displays
- Sensors
- Appliances
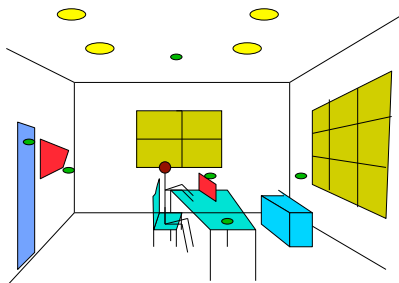
Building networks today

- At an early stage of development
- Not inevitable that building networks will save energy
- Much (most?) activity in building networks is driven by short-term business interests, <u>not</u> saving energy
- "Home Automation" to date rarely informed by energy

- Building networks best understood as a means to provide **functionality**, NOT as a means to save **energy**

What is a building network?

- People
- Light Sources
- Light modifiers
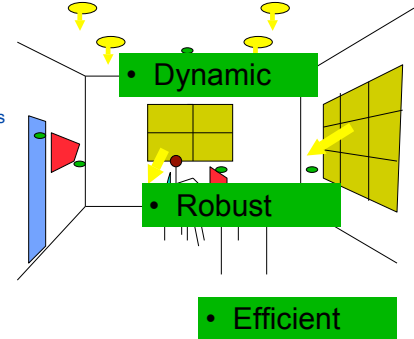- Thermal sources, ventilation
- Displays
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really good
What is a building network?

- People
- Light Sources
- Light modifiers
- Thermal sources
- Displays
- Sensors
- Appliances

- Dynamic
- Robust
- Efficient

Universal Interoperability

Any device should work with all other objects in any space

- Across **building types**
  - Residential, commercial, vehicles, …
- Across **geography**
  - Countries, language, …
- Across **time**
  - Worthy of durability
- Across **end uses**
  - Coordination, cooperation
- Across **people**
  - Age, disability, culture, activity, context, …
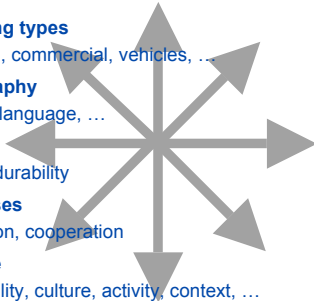
Represent the *physical* world in the *information* world

- Need a standard "dictionary": things, ideas, principles, actions, etc.
  - Standard "names" for common elements
    - Standard translations for all languages
  - Embody these in protocols, data dictionaries
  - Embody in user interfaces
  - Identify the meaning (semantics) of the information
    - not how it is encoded or represented …
    - … except as corresponds to the user interface

build·ing [bil-ding] net·work [nĕt'wûrk']

Physical World Concepts

- Building elements (energy using or not)
  - Lights, climate control devices, windows, displays, rooms, sensors, appliances, people, …
- Ideas
  - Presence, schedules, prices, events, preferences, …
- Characteristics
  - Physical location, power levels, light levels, …
- Actions
  - Dim, open, go to sleep, …
  - Announcing and requesting

"Affordances"; metaphors

Standard Concepts

- User Interfaces
  - Automobiles: controls, roads, …
  - Tape transport: Play, pause, stop, fast-forward, eject, …
- Document conventions
  - Fonts, margins, headings, columns, …
  - Web page conventions: forward, back, navigation, links, …
- Data and File formats
  - ASCII, PDF, HTML, …
- Email conventions
  - Structure, addressing, …

All present in device ⇔ device and
device ⇔ person communication

People

- … are often absent from design, presentation
- … best understood as nodes on the building network
  - Even more than portable electronics, they move
- … need standard interfaces, just like devices do
  - Nature of interface different, but principle same

- User interface design should be a starting point
  - to help create dictionary
  - before we design protocols
- Ensure that devices are adaptable to different people
 - Needs, desires, capabilities

User Interfaces

- **Standard Interface elements common throughout daily life**
- **Key to safety, ease of use, efficiency**
- **Many use graphics, color, location, etc. to improve functionality and reduce language-dependence**
- **Commonality limited to comprehension needs**
- **Can deviate from standards when there is a good reason**
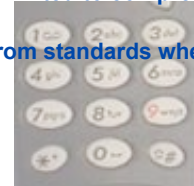
User Interfaces

- Consistent across:
  - Manufacturers
  - Products
  - Countries
- Simple
- Accessible
- Portable

Key Elements
- *Terms*
- *Symbols*
- *Colors*
- *Metaphors*
- *…*
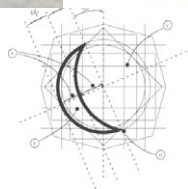
Non-Interoperability
w/ devices or w/ people

- Failure to accomplish interoperability:
  - Causes confusion
  - Is annoying
  - Costs product manufacturers
    - Design
    - Manufacture / Sales
  - Wastes energy
    - Difficult or impossible to match wanted service to delivered
  - Impedes addressing climate change

Relation to Existing Technology

- Adopt standard network technology up through TCP/IP for building networks
  - No reason to duplicate
  - Need to share infrastructure and interoperate with electronic devices
  - Want connectivity to Internet
- Be prepared to jettison any / all existing technology
  - For product, standards design only
  - Need gateways to legacy systems for extended period
- Adopt "Guiding Principles" for efficient networks
  - See: *IEA Digital Networks workshop, May 2007*

Recommendations for Standards Orgs.

- Adopt goal of "**Universal Interoperability**" as organizing principle for building network standards
- Organize all relevant standards orgs. to play proper role; divide up work, responsibility; avoid duplication
- Create Building Network Task Force (BNTF) as sibling to Internet Engineering Task Force (IETF)
- --IETF is part of Internet Society (isoc.org)
- Consider standard "energy implications" section for all standards (IETF does this for security)
- Develop faster process for electronics / network standards
- Get started as soon as possible

Conclusions

Network standards
– strongly determine energy use and functionality.
– can **prohibit** or **require** energy-saving features

Building Networks
– Inevitable
– Will greatly influence energy
– Essential for many savings opportunities

Standards organizations
– Must lead on building networks topic for good outcome
– Time to act is **today**

Thank you

Decisions made "today" will be with us for generations
Our obligation: design best building networks we can

Building Networks and the "Smart Grid"

• If the "Smart Grid" stops at the meter:
– I have nothing to say

• If the "Smart Grid" extends through the meter:
– (I assume real-time pricing; don't care how transmitted)
– Suggests one architecture that extends from power plant to each end-use device
– Will impede improvements in grid
– Will impede improvements in buildings
– No barrier to occasional "opt-in" agreements / exchanges between devices and outside entities
• Demand response, local generation and storage, ..
– The meter is our friend

Building Networks

• **Electronics**
– Products whose primary function is information (acquire, process, store, transmit, display)
• **Lighting** - sources, controls, shades
• **Climate Control** - sources, distribution, openings
• **Security**
• **Sensors**
• **Other** (Appliances, Misc.)
• **Human beings** (future: each human has IP address?)

• **Future: All one network**
– separation for illustration only

Relation to Existing Technology

• Fund academic research on key topics
– Network architecture
– Presence, authority, security, user interfaces, protocol design, …

• Path to future requires some "leaps" in technology and standards
– Incrementalism alone is the path to mediocrity
• If devices interoperable with people, much easier to be interoperable with each other

Fundamentals

Electronic networks (IT, CE)
– Information Technology, Consumer Electronics
• Basis: Information
• Functionality: Well-developed
• Energy: Mixed results

Building networks
– Lighting, climate, appliances, misc., security*, …
• Basis: Physics
• Functionality: Not well developed
• Energy: Too early to say

Complexity

While some integrators are skeptical about the prewired, preprogrammed NHS rack from Sony, others embrace the solution for its simplicity.

- Complexity is easy
  - Ordinary outcome

- Simplicity (and power) is hard
  - Doable
  - Well worth effort