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Deploying the "Internet of Things"
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Echelon Corporation

An Internet of things….

From a report by the International Telecommunications Union, released at a UN summit in November 2005:

"It would seem that science fiction is slowly turning into science fact in an 'Internet of Things' based on ubiquitous network connectivity," said the report.

"Today, in the 2000s, we are heading into a new era of ubiquity, where the 'users' of the internet will be counted in billions and where humans may become the minority as generators and receivers of traffic."

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Agenda

- What does Echelon do?
- Coupling Echelon's technology with the Internet to save significant amounts of energy
  - Building automation
  - Utility automation
  - Outdoor lighting
- Issues with deploying large numbers of autonomous devices
- Conclusion & Questions

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Echelon Overview

Echelon's Founding Technology Premises

- Distributed control systems are inevitable, just as distributed computing was 20 years ago...
  - distributed control is a harder problem that distributed computing
    - distributed control is multiple computers working together on a problem
      - Can involve the synchronization of a single state machine across a network
- There is a general solution to the problem of distributed control
  - there is enough in common to build a platform across all vertical markets
    - thus there is a large market for control infrastructure built around a universal, world-wide, standard control technology
- Distributed control, built on top of an open, standard communications infrastructure will create a market of multiple component vendors
  - the combined product investment of these companies will create a compelling offering to end users and system integrators
  - because distributed control is a difficult problem to solve, the barriers to entry are high and there is a chance for a single standard to emerge

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Echelon's Product Goals

- Fulfill the technology premises by:
  - Developing a comprehensive set of development and installation tools for distributed control
    - Enable the creation of an environment of multi-vendor, interoperable, distributed control systems
  - Create a components market for distributed control devices
    - Offer end users the choice of multiple vendors
  - Develop infrastructure products that lower the cost of control system deployment so that it becomes practical to put everyday devices into a control network
    - Attack the problems of installation cost and network management

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Echelon Has a Broad Line of Control Networking Infrastructure Products

- Power Line and Twisted Pair transceivers for the LonTalk® protocol
  - Making networks much easier to install
  - 3rd parties also provide transceivers
- Development tools for distributed control
  - Making distributed applications easy to create
- Routers for LonTalk to LonTalk and LonTalk to IP channels
  - Enable the integration of multiple communication technologies
- Embedded web services and web server devices
  - Connect to enterprise systems and to end users via standard browsers
- Network management, network diagnosis, and installation tools
 - Make the management of thousands of nodes a part time job

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Echelon Timeline

- Started in November 1988
  - Founders: Ken Oshman (ROLM) and Mike Markkula (Apple)
- Launched LONWORKS® Platform in December 1991
- Created the LONMARK® Interoperability Association in 1994
- Became a public company in July 1998: NASDAQ:ELON
- Launched the *i*.LON® – 1000 internet server in September 1998
- In 1998-1999 the LonTalk protocol, Echelon's flexible topology twisted pair transceiver, and Echelon's power line carrier transceiver all received ANSI standardization
- In June of 2000, entered into a joint R&D agreement with ENEL to replace every one of ENEL's 27,000,000 electricity meters with LONWORKS enabled meters (completed in 2005)
- In November 2002 released the *i*.LON web services enabled internet server
- In December 2003 launched the Networked Energy Services System – the next generation after the system deployed with ENEL
- In December 2005, received the first large deployment order for NES with Swedish utility Vattenfall

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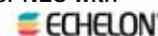
Market Adoption of the LONWORKS Platform Promotes Worldwide Standardization

- The LONWORKS protocol has recently become a European Building Standard
  - EN14908
  - Impacts all EU building construction
- Expanded role of the LONWORKS protocol in semiconductor manufacturing equipment
  - SEMI E54 for Sensor-Actuator Networks
  - Specifies a complete solution for equipment manufacturers to deploy the LONWORKS protocol as the technology of choice for sensor-actuator network communications
- Existing standards
  - NA buildings, train control, freight car braking, control networking
  - European gasoline stations

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Energy Conservation through Control

Some Echelon Customer Case Studies

- It is possible to dramatically reduce energy consumption and the pollution it causes with LonWorks based control systems
  - Conservation doesn't mean lack of comfort or capability
  - Controls coupled with energy savings can actually increase user satisfaction
- Three examples are presented to demonstrate the power and capability of distributed, autonomous intelligence
  - Echelon's corporate headquarters in San Jose, CA
  - ENEL's Utility Metering System (27,000,000 meters in Italy)
  - Outdoor Municipal Lighting in Oslo, Norway

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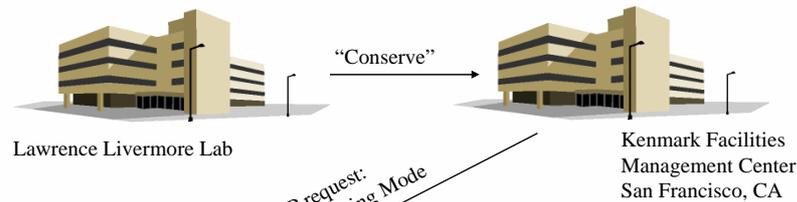
Echelon's Corporate Headquarters

- An ordinary Silicon Valley building constructed in 1999
  - Single paned windows
  - Poor insulation
  - 80% of energy consumption is Air Conditioning, Ventilation and Heating
- Made energy efficient with LonWorks
  - Energy conservation capability qualifies for lower electricity rates
- Made more comfortable with LonWorks
  - Every employee has control over their immediate environment

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LLL's Energy Conservation Study

"Conserve"

Lawrence Livermore Lab

Kenmark Facilities
Management Center
San Francisco, CA

SOAP request:
Energy Saving Mode

- Within 3 minutes of the Soap request, building energy consumption is reduced by 30%
  - The building can maintain this savings for at least 4 hours without occupant discomfort
- No human intervention required to initiate the conservation
- No special construction techniques needed for the building

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Lessons from the LLL Study

- Ordinary buildings, not constructed to save energy, can become significant energy savers with controls
  - Significant because over 90% of the buildings in the developed world that will be standing 20 years from now have already been built
- Rather than constructing new power plants to cover peak loads we could improve building controls and save energy while reducing pollution
  - Web services equipped buildings could monitor the price of energy and reduce demand accordingly
- Modern controls allow every occupant individual control over their temperature, lighting, work schedule and energy star settings
  - User satisfaction can *increase* while total annual energy consumption is dramatically reduced

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ENEL – The Largest Electric Utility In Italy

- Italian government retains majority ownership
- ENEL serves ~95% of the Italian electricity market
- Researched intelligent metering systems and their benefits for over a decade
- Decided in June of 2000 to use Echelon's power line communication transceivers to network a new generation of meters
  - ENEL designed and manufactured their own meter with Echelon's power line transceiver embedded within them
  - Echelon designed and manufactured data concentrators to connect the meters to the PSTN (GSM and Land Line)
  - ENEL designed their own data center
  - ENEL contracted with 4500 installers, nationwide, to replace every meter in their service area
- Installed over a period of 4 ½ years, the system cost ~2,200,000,000 Euros
- Now that the project is complete, ENEL is publicaly reporting savings of ~500,000,000 Euros per year
  - Well under a 5 year payback on a system with a 20+ year life

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ENEL System Overview

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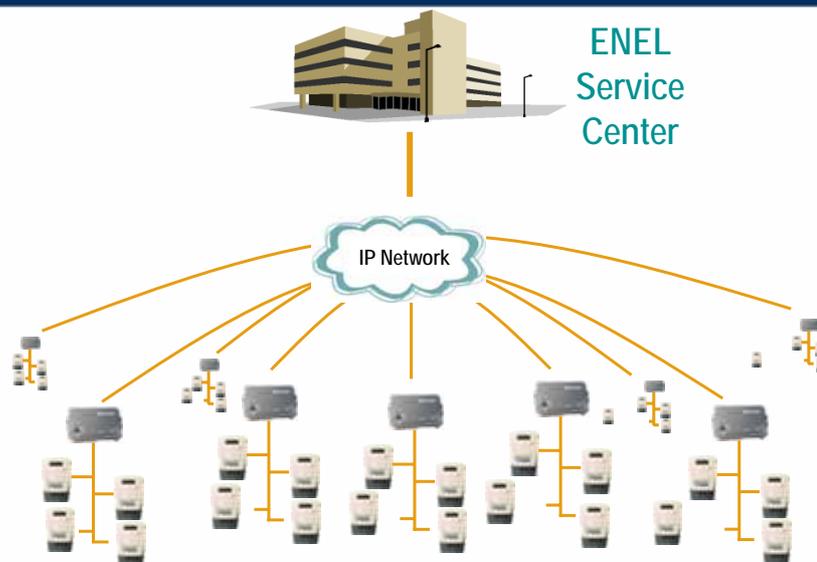
The Value in Networking Meters

- NOT from automatically reading meters!
  - In Europe, the meter is typically inside the house (not accessible to a meter reader) and is read once every 3 years or so!
- Savings comes from many areas such as:
  - Peak load management
    - Meters have an integrated disconnect that can be set remotely to a threshold
  - Phase balancing to reduce transmission losses
    - Can cut energy generation dramatically
  - Energy efficiency of the meters themselves
  - Higher accuracy in billing
  - Theft prevention
    - Disconnect with threshold can provide life-line service to non-payers
  - Theft detection
  - Outage duration measurement

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Outdoor Lighting – Networking Light Bulbs!

- **In Oslo, Norway what started out as a project to replace street lights that contained PCBs turned into a project to conserve energy, provide better service, and to serve as a model for environmental responsibility**
  - In Norway, between 6 and 8% of ALL electricity usage is for outdoor lighting according to the Oslo utility
- **The pilot project uses only 30% of the energy of the lights that were replaced – a 70% savings in energy!**
  - Again, as measured by the city and utility
- **The system is projected to save 50% of the maintenance costs over its life**
- **The system provides street lighting that is safer**
- **The system has been providing a 15% return on investment to the city since it was installed**
  - The Oslo utility, Hafslund, has stated this publicly

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What Networked Lights Can Do

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Main Lighting Features

- Light levels ramp up at dusk and down at dawn according the the sunrise and sunset times for that particular day
  - Saves energy, extends lamp life and thus reduces maintenance costs
- Sensors in the road detect times at night when there is no traffic, and the lights dim
  - If a car turns onto the road, the lights go on
- If bad weather reduces the light on the roadway, sensors detect the light level and the street lights are automatically turned on
- The city found that people drive slower at night with the light levels down, so to reduce accidents at night, they dim the lights
  - In the case of an emergency, the lights can be raised to full on via the internet

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Deploying the *Internet of Things*

Issues and Challenges

The Main Needs of an *Internet of Things*

- Ubiquitous, peer to peer, internet connectivity
- Standards
- Network security
- Interoperability
- Broader understanding of the economic and societal benefits
  - Without this, the will to change the status quo does not exist

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Device Internet Connectivity

- Devices don't have full internet access today – they are clients, not servers or peers
  - Devices need routable IP addresses
  - Devices need either a static IP address or a DDNS resolvable IP address

- ISPs don't want to give devices full internet access
  - Scalability fears
  - Denial of service attack fears
  - Network security fears

- Business models for devices do not exist
  - Devices use very little bandwidth, but get charged like a typical internet user

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Standards

- Large energy consumers need choice of suppliers
  - Single suppliers add risk to a risk-adverse utility
  - Standards promote choice in the market
    - Published standards allow competition within a framework of compatibility between products

- Standards add legitimacy to solutions
  - A technology that is field proven, and that goes through the standards process shows supplier and consumer support
    - Members must vote for a proposed standard

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Network Security

- System operators need confidence that their energy savings will not be compromised by network security breeches

- ISPs need confidence that attaching so many devices to their networks will not cause scalability problems or network integrity problems

- End users need confidence that billing results produced from automated systems are accurate and fair

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Interoperability

- An *internet of things* can produce a LOT of data and is made up of a LOT of devices
  - How will it be interpreted and used?
  - How can information from systems of different vendors be unified to provide decision support?
  - How can end users be sure that a compatible replacement device is available years from now?

- Communication standards must also include standard ways of encoding and rendering data
  - Current efforts are underway with XML as the technology for providing this interoperability
  - See OASIS Open Building Information Exchange (oBIX) TC

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The Will to Change

- The price of energy continues to rise
- Concerns about pollution and human induced global warming continue to grow
- There is confusion about what to do
  - Search for more energy to get the price down?
  - Curtail our energy usage to curb pollution and cut greenhouse gas emissions?
- The technology exists today to dramatically curb energy consumption and payback the systems that do it in very reasonable timeframes
  - With the knowledge of these systems, the better alternative is obvious!
  - See www.echelon.com for more of our customer's energy savings success stories

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Thank You Very Much!

Questions?

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