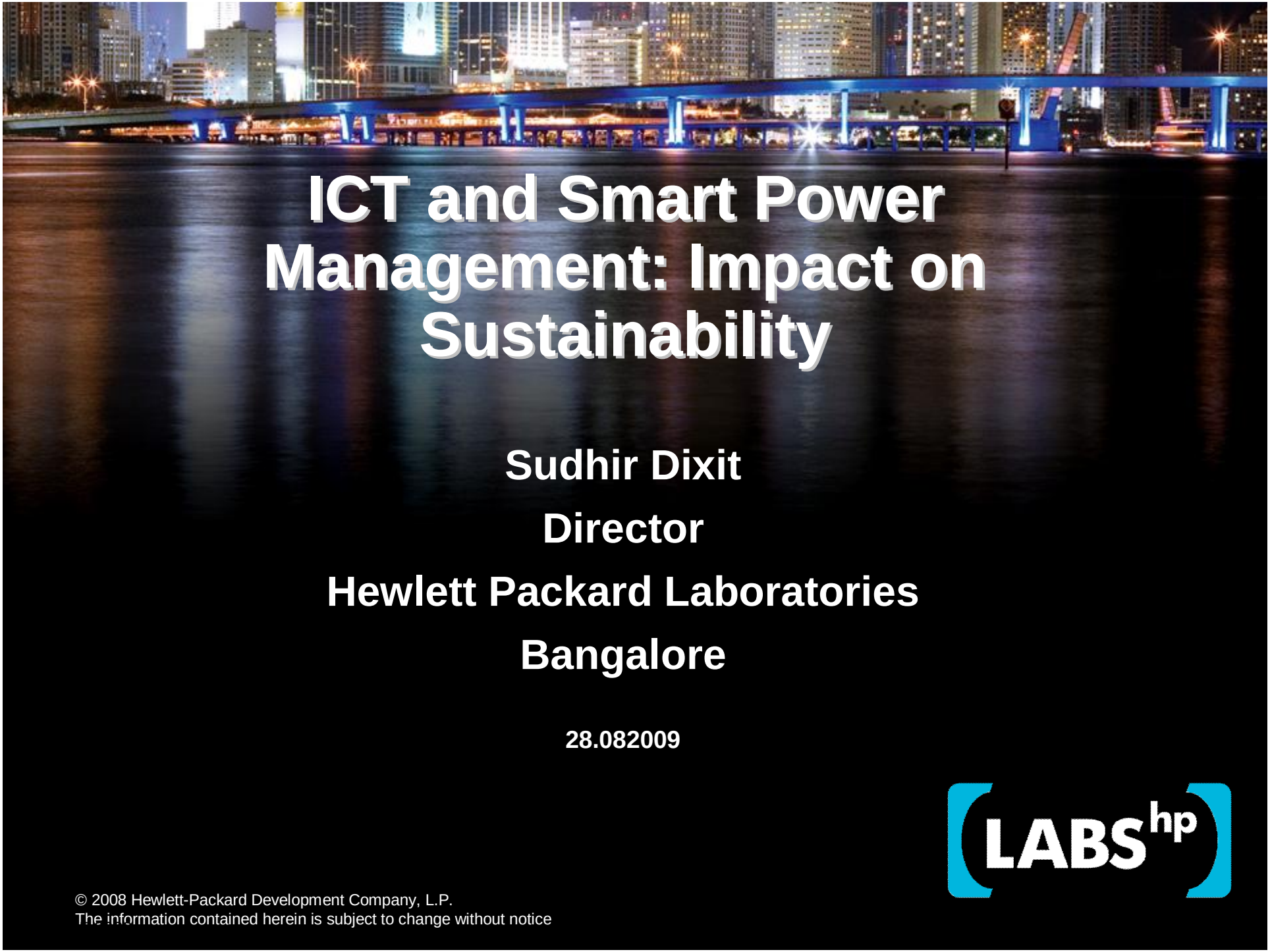


ICT and Smart Power Management: Impact on Sustainability

Sudhir Dixit

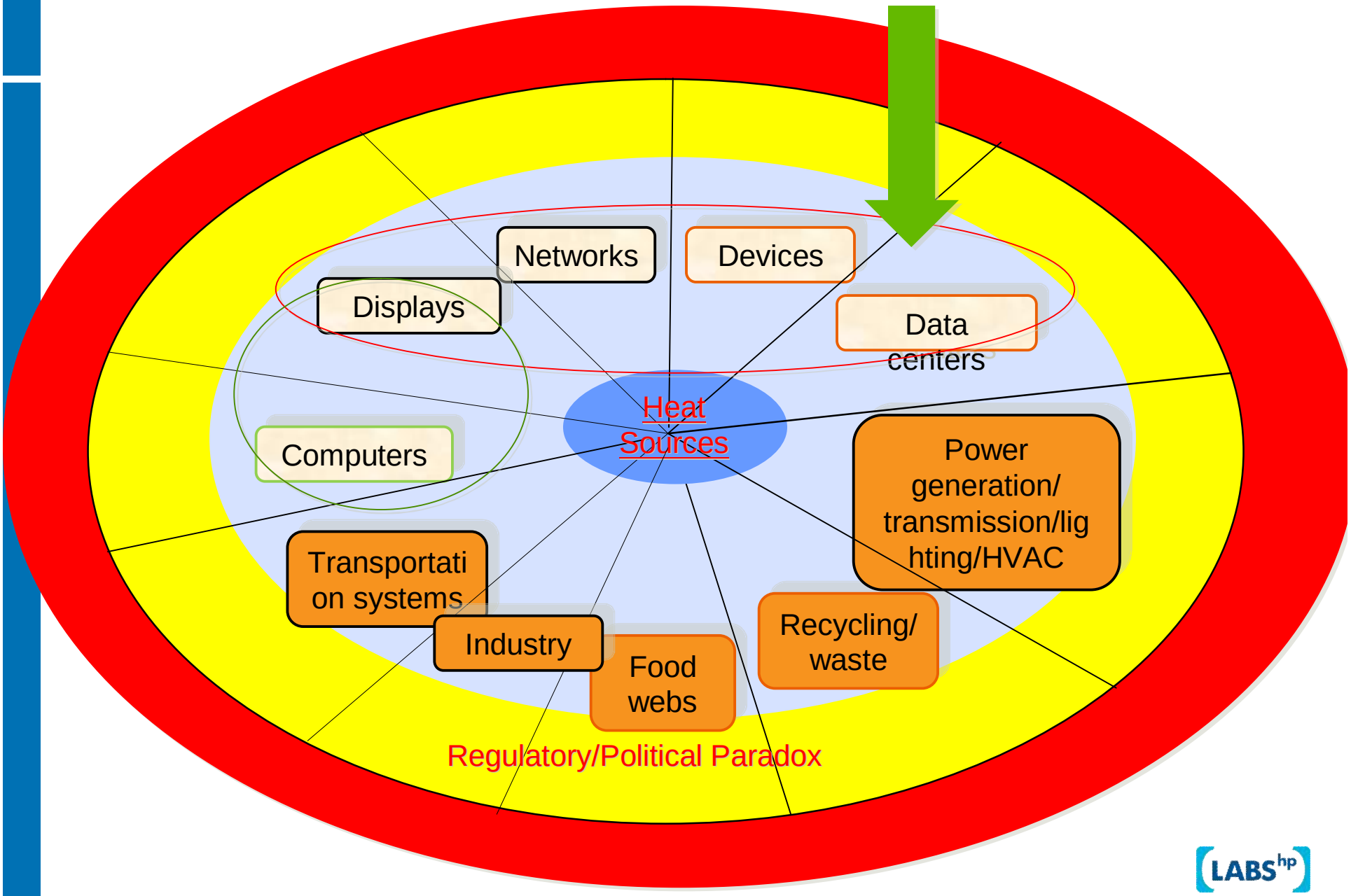
Director

Hewlett Packard Laboratories

Bangalore

28.082009

ICT contributes 2-2.5%
of global GHG emissions



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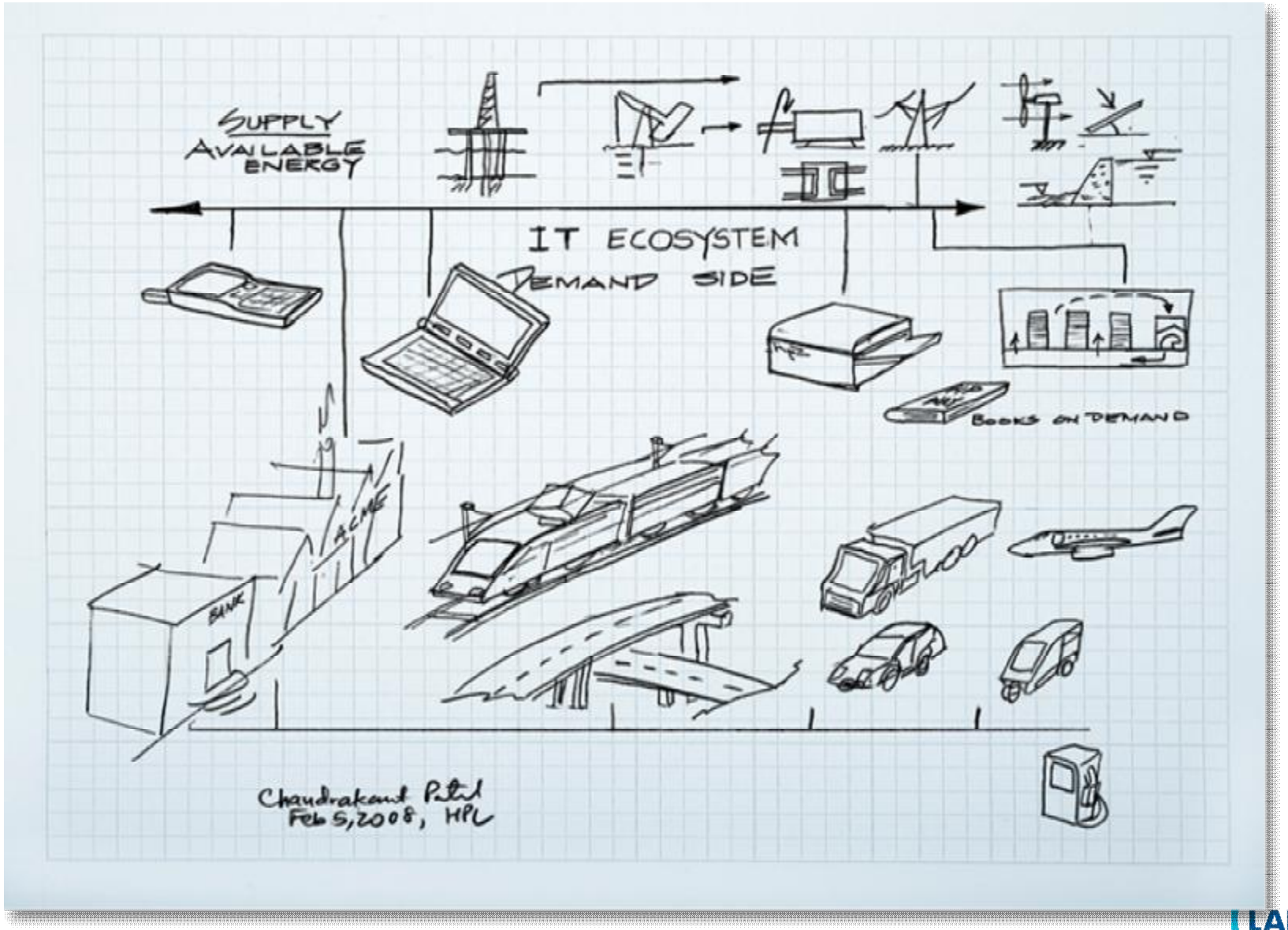
Sustainable IT Ecosystem

billions of service oriented client devices and thousands of data centers….to deliver net positive impact



Courtsey: Chandrakant Patel, HP Labs, Palo Alto, California

Holistic View

European Commission states:

"Information and Communication Technologies (ICTs) have an important role to play in reducing the energy intensity and increasing the energy efficiency of the economy. In other words, in reducing emissions and contributing to sustainable growth. In ored to achieve the ambitious targets set and meet the challenges ahead, Europe needs to ensure that ICT-enabled solutions are available and fully deployed….but efforts should be made so that ICT leads by example and reduces the energy it uses"

From Addressing the challenge of energy efficiency through ICTs, 13.05.2008. COM (208) 241.

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Drivers

Economic, Environmental & Social

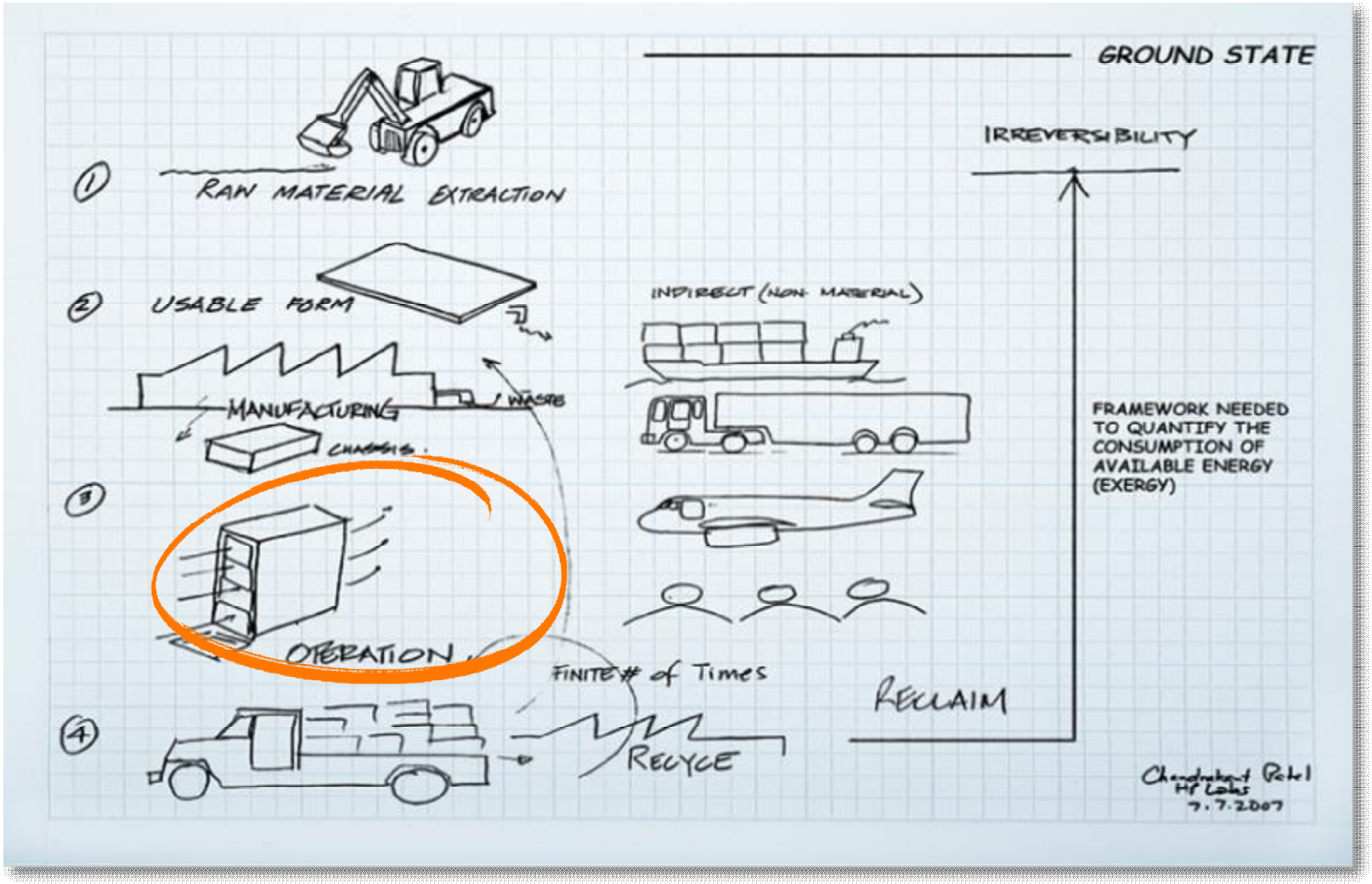
- Deconstruct conventional business models and replace with IT services
- *Advantage of scale when billions utilize IT to address their fundamental needs and improve quality of life*
  - **Transformation necessitates**
- Reducing the cost of IT for universal accessibility
  - Reducing TCO necessitates addressing sustainability with an **end to end perspective**
- Use the IT ecosystem to enable need based provisioning of resources across all ecosystems
- **Transformation necessitates**
  - Pervasive sensing, knowledge discovery, and control
  - Return to fundamentals of Physical Engineering in combination with Computer Science
- Human capital trained in the fundamentals – multidisciplinary curriculum

Courtsey: Chandrakant Patel,
HP Labs, Palo Alto, California

End to End Perspective

life cycle engineering and management

extraction	manufacturing	operation	End of Life



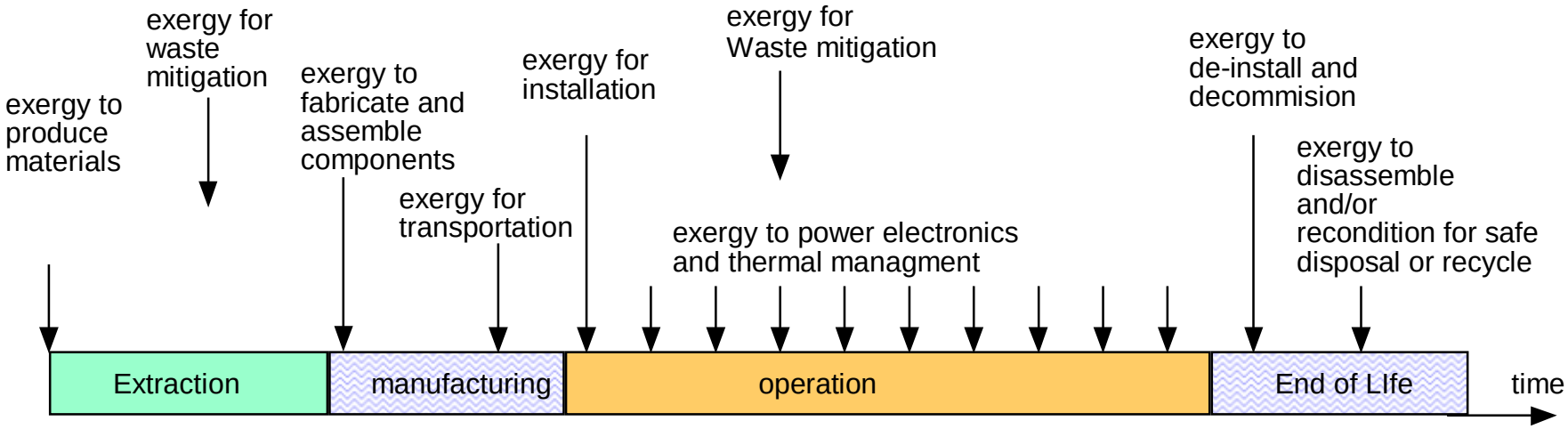
Courtsey: Chandrakant Patel, HP Labs, Palo Alto, California

End to End Perspective

Technical Approach

- Can a measure of the total exergy or available energy destroyed across a product's lifetime ("lifetime exergy") be a measure of the environmental sustainability?
- Can we build a "hub" of exergy data to enable lifetime exergy analysis for a given product?

Joules of Exergy consumed becomes the currency of the Sustainability Age



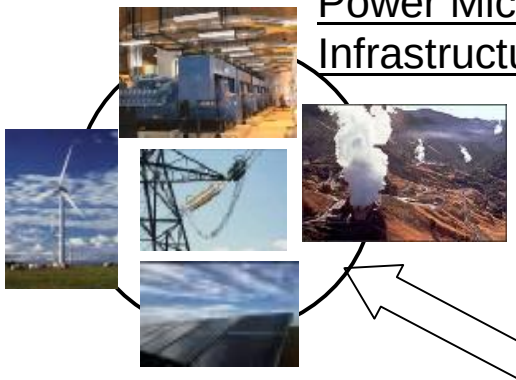
Hannemann CR, Carey VP, Shah AJ, Patel C., "Lifetime exergy consumption as a sustainability metric for enterprise servers. Proceedings of the ASME Energy Sustainability Conference (ES)", Jacksonville, FL, 2008.

Shah, A.J., Patel, C.D., Carey, V.P., "Exergy Based Metrics for Sustainable Design", 4th International Energy, Exergy and Environment Symposium, Sharjah, UAE, 2009

Courtesy: Chandrakant Patel, HP Labs, Palo Alto, California

Role of the IT Ecosystem

IT enabled management of resources at city scale



Power Micro-Grid Infrastructure

- Least Lifecycle Exergy Destruction

=>

- Least Total Cost of Ownership

Sustainable Datacenter

Ecosystem of Clients

Medical & Health Infrastructure

Education Infrastructure

Water Micro-Grid Infrastructure

Transport Micro-Grid Infrastructure

Courtsey: Chandrakant Patel, HP Labs, Palo Alto, California

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Computers/Computing Platforms

- Architectures, load distribution, miniaturization, multicore, materials, smart cooling; example Intel's newest server chip Nehalem (Xeon 5500) designed with 3 key features – energy efficiency, virtualization, fast access to memory
- Energy-aware software architectures and coding
- Energy-aware statistical profiling of applications
- Desktop uses 60-250W, laptop uses 15-45W
  (screen savers saves no power!), sleep, standby, hibernate mode : 0-5W,
  Sleep/standby 1-5W, hibernate 0W
- Computer power supplies are only 60-80% efficient!
- Smart cooling with sensors
- Up to 50% reduction in energy consumption possible
- Use power strips to turn everything off!
- Over 1B computers today and forecasted 2B by 2015
  (100W x 1B x 12)/1000 = 1200 GWh x .0005883 metric tons CO_2 per kWh
  = 705,960 metric tons of CO_2

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Devices

- Handsets: cell phones – 2 to 5Wh, idle mode ~50 mW, heat dissipation limited to ~3W
- Worldwide number of mobile subscribers crossed 4B at the end of 2008
- How to minimize power consumption?: better designs, displays, adaptive power modes, energy-optimized software architectrures

Displays

- 17” CRT uses 80W Vs 17” LCD uses 30W
- 42” LCD TV uses 210W and 42” plasma 270W, DLP about 30-50% less
- Research in energy-aware interfaces
- Smart intensity/brightness management

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Networks

- Network nodes, transmission links (amplifiers/repeaters, power loss etc), network terminations
- BS and backhaul networks of mobile networks consume about 60B KWh per year, equivalent to 0.33% of the global electricity consumption and 15-20% of the entire ICT energy footprint
- Example: 3G networks – node B (6KW), 98% network share; RNC (2.5KW), 1.5% network share; UMSC (4KW), 0.5% network share

Solutions:

(1) Cognitive radio and cognitive networks,

(2) Multiple power modes

(3) Energy-aware routing

(4) Power information sharing protocols

(5) Auto discovery, PnP, zero configuration self-organization

(6) Use solar and wind power for energy source

(7) Design with power efficiency as an objective – think of Joules as currency!

Data Centers (IT Eco-System)

- Storage and servers stacked in data centers: ~70% of servers purchased by Google, Yahoo, e-Bay, Amazon, and similar internet service providers
- Cooling is a huge cost
- Smart data center design and smart dynamic cooling
- Distributed data centers around the globe, their locations, load distribution, and peak operational times optimized for local temperatures = Virtualized and distributed storage
- Example: HP taking a huge lead by committing to reduce carbon foot print by 75% through projects like " The Sustainable Data Center project" : use lasers, fibers, targeted cooling in data center equipment, printers, computers and servers equipped with sensors. Home is more advanced than data center.

application at scale ……

Project Nilgiris, Vindhyas

Vindhyas - HP R&D Laboratory Data Center

Facility Building Blocks

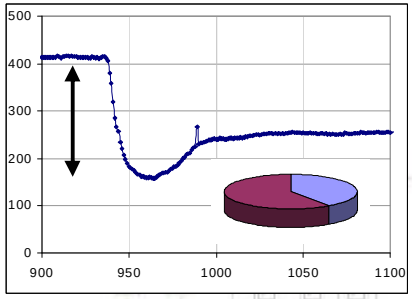
- **Chillers**
  - §3 air-cooled
  - §2 water-cooled
- **Pumps**
  - §7 Primary
  - §5 Secondary
- **CRAC units**
  - §55 units
- **Diesel Generators**
  - §5 3MW units

- Software Operations, Bangalore
- Consolidation of 14 lab data centers

IT Building Blocks

- Servers
  - §Non-Stop servers
  - §Proliant servers
  - §Blade servers
  - §Custom Enclosures
- Storage (XP/EVA)
- Multiple Network topologies
- Sensor Network
  - •7500 sensors

5 floors @14k sq. ft.
900kW cooling per floor



- Need based provisioning of compute, power and cooling resources based on available energy consumed (supply side)
  - o Dynamic cooling control implemented
- Data Analysis, Visualization and Knowledge Discovery to detect anomalies, improve reliability and minimize redundancy

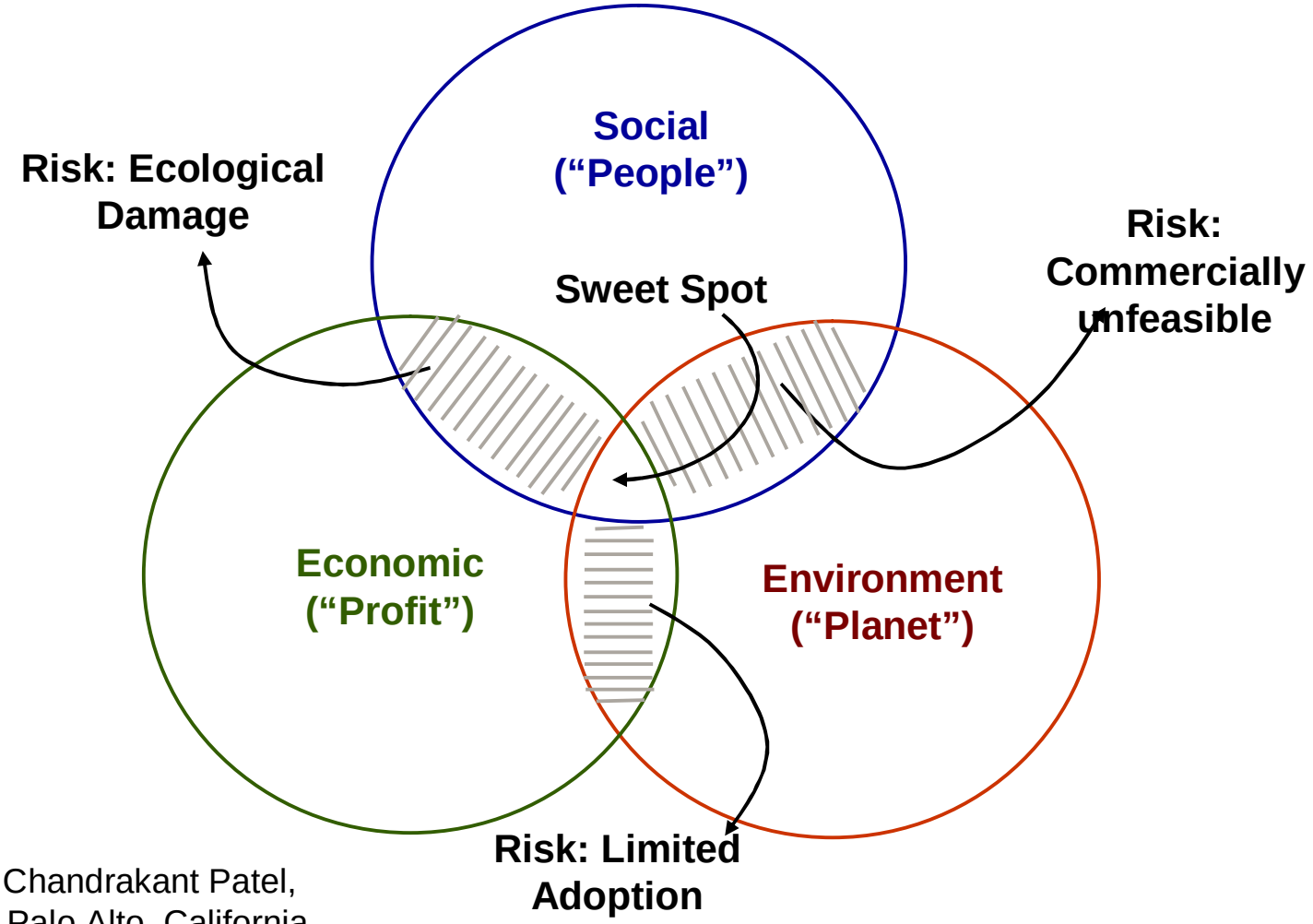
40% reduction in AHU power
20% reduction in Infrastructure Power
7,500 tons of CO_2 prevented annually

Courtsey: Chandrakant Patel, HP Labs, Palo Alto, California

Regulatory, Fiscal, and Management

Non-Technology Paradoxes	Need for new business models and social and cultural change
Regulatory	• Local, national and global agreements. Those not adhereing take competive advantage • Cheaper products mean more waste and recycling. • Policing and enforcement
Fiscal	• Taxes on energy being a major source of revenue for the governments make it difficult to match rhetoric with real action • How to shift jobs from one industry to the other? It is a long-term process
Management	• Companies need to embrace new organizational structures • Need for employee training, information sharing, rewards • Real management commmitment

Science & Engineered Technologies to meet the needs of society (P3)



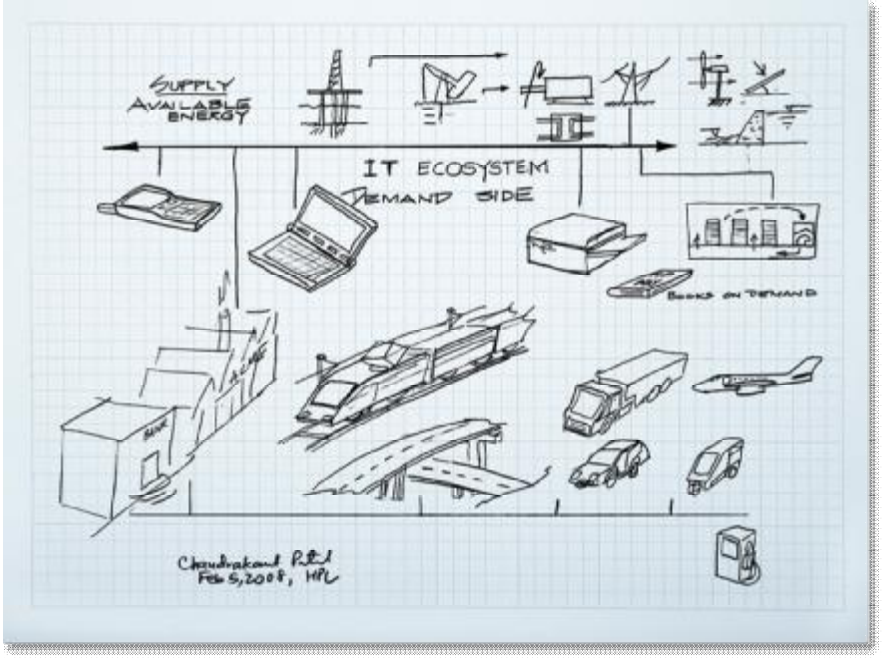
Courtsey: Chandrakant Patel,
HP Labs, Palo Alto, California

Figure Credit: A. Agogino, UC Berkeley

Curriculum for the Sustainability Age (Challenge for the IEEE and the academic community)

=> building the human capital

Track e.g. IT Infrastructure



Fundamentals:
Need for inter-disciplinary education and training from schooling to college.

Courtsey: Chandrakant Patel, HP Labs, Palo Alto, California

THANK YOU!

From "Always On" to "Always Available"

Contributor & Credit: Chandrakant Patel, HP Labs, Sustainable IT Ecosystem Laboratory, who provided a number of slides.