

Mobility: Economic & Policy Challenges

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MIT Communications Futures Program

*"Defining the roadmap for communications
and its impact on adjacent industries."*

Mobility: Economic & Policy Challenges

- ❑ Future vision of mobile Internet & its implications
- ❑ Econ/policy in Network Architecture Design
- ❑ Some mobility related research challenges

Internet Future: broadband & mobile (wireless)

User experience: pervasive computing

- Ubiquitous, always on, 24/7
- Mobile/portable
- Multimedia
- Interactive
- Embedded, Unaware
- Personalized

Implications: intelligent edges (and networks)

- Broadband
- Wireless (and wired, integrated)
- Context aware & dynamic
- Intelligent networks and devices

Essential socio-economic infrastructure

- Ever present in our lives, businesses (so will be regulated! Q: how?)
- Heterogeneous (technology, users, uses, *business models, markets*)
- Dynamic (context adaptive, varying time scales...)
- Distributed control/ownership (multi-stakeholder coordination)

Transition to *Liquid Value Chains*

SOLID PHASE

- vertical value/production chains
- hierarchical
- standardization
- rigid organizational structure
- well-defined industry boundaries
- public utility regulation

e.g.,
Traditional telecoms
Retail trade
Broadcasting/media content
Product design/marketing
Utility regulation

LIQUID PHASE

- flexible/dynamic organizations
- distributed, peering, outsourcing
- interfaces
- interactive
- industry convergence
- market competition

e.g.,
Internet
eCommerce, eBay
Blogs, Wikipedia, YouTube
Viral marketing
Markets & standards

Mobility: Economic & Policy Challenges

What moves? Potentially everything...

- Users: follow the user, not the device (personalization, experience)
- Devices: follow device separately (privacy & RF regulation)
- Networks: groups of nodes move
- Content/apps: digital rights management
- Control

How moving?

- Geo-spatially (location awareness)
- Time (dynamically)
- Topologically
- Context

New opportunities & challenges

- New markets: mCommerce, mHealth, mEntertainment, mGovt, Smart grids
- Industry/business restructuring
- Regulatory reform: Command & Control => Markets
- Trustworthy => Reliable, Secure, Privacy-preserving

Internet Design for the Mobile Future

Commercializability: is the architecture economically viable?

- “Market-based” resource allocation
 - ** Open system: substitution/complementarity, externalities, ...
 - ** Strategic behavior
 - ** Evolvability/deployability
- Cost/Benefit Analysis: Technical Performance not the most important!
- Challenge optimization or coordination (search)?

Regulability: is the architecture consistent with public policy?

- Collective decision-making: no unique answers. Efficiency & Fairness matter
- Some general themes...
 - * Pro-competitive : does architecture threaten monopoly? “Access” regs?
 - * Enforceability & Market rules : what institutions with what info needed?
 - * Trustworthy : Reliable, Secure, but also Privacy-preserving

What “economic/policy” functionality to embed in core?

e.g., Micropayment support? DRM? Regulatory enforcement?

Micropayments: dynamic resource markets, flexible/efficient contracts

- Incentives for efficient dynamic resource sharing/management
- Facilitate dynamic QoS & End-to-end coordination
- But how granular? *A market design* question
 - * granularity must be consistent with anticipated contracts
 - * goal to incentivize good behavior: whose behavior over what time period?

Key elements:

- Communication/info: can buyers/sellers observe what they need to?
- Control: how fine grained is resource control? Property rights?
- Value v. Transaction costs: assignment efficiency v. overhead?

Preliminary thoughts: do *not* embed micropayments as core function

- Transaction costs, evolvability, institutional bias
- Need (a) Separate control plane, (b) separation of naming/addressing for flexible transacting/partitioning of mobile resources

Mobility Challenges & the Internet

Spectrum Mobility

- Scarcity: need to share more intensively
- Frequency agility: CR/SDR, LTE, etc.
- Dynamic Spectrum Access

Internet

- sensing
- layering
- transaction mgmt

Network Mobility

- Ad hoc/mesh networking support
- Public safety: situation awareness/force mgmt
- Evolving the *status quo*...User acceptance...

Internet

- Distributed coordination
- Interoperability
- Security/reliability

Content Mobility

- DRM
- Efficient content delivery
- Privacy (access), e.g. health data....

Internet

- Rights mgmt/expression
- First Amendment platform

Business models for spectrum sharing

Spectrum access regime \Leftrightarrow *Technical Design & Use*

* quality: predictability availability, interference protection

* OPEX/CAPEX

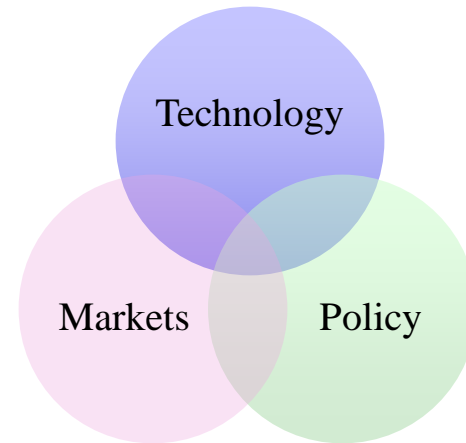
	Non-Cooperative	Cooperative
	Permission of primary user not needed. No explicit coordination. Other signals look like noise.	Permission of primary user needed. Explicit coordination. Other signals recognizable.
Primary Sharing	Unlicensed, e.g., WiFi, Bluetooth	Secondary markets, e.g., leasing <i>Bandwidth Manager (real-time)</i> <i>Closed commons</i>
Secondary Sharing	Easements: -- underlay, e.g. UWB -- overlay, e.g., TV White space (LBT)	<i>Bilateral contracting</i>

How will spectrum sharing evolve with LTE, WiMAX, TVWS, etc.?

Mobility: Economic & Policy Challenges

Future Internet is part of Socio-Economic System that must co-evolve...

- Changing environment
- Embedded policy
- Markets, not C&C



Research tools:

- Public Policy Audit: is arch consistent with *Commercializability & Regulability* goals?
- Roadmap for deployment
- At scale operational testing (early adopter communities)

Thanks! Bill Lehr wlehr@mit.edu

Backup slides not used

Selected References

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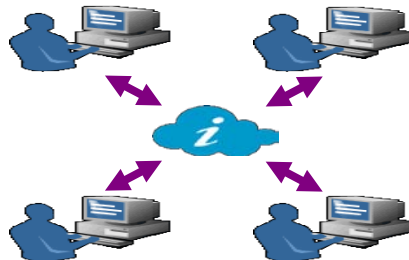
faster *Clockspeed*

Data Processing



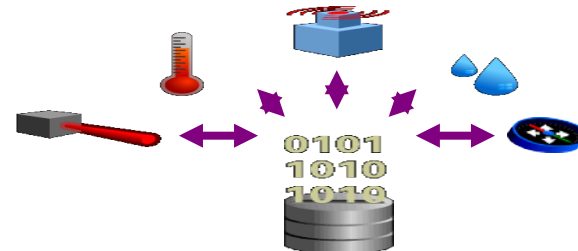
Weeks
Batch
Megabytes
Punch Cards
Few People

Internet (Still Happening)



Days
Request/Reply
Terabytes
Human
Many People

Real Time



Minutes
Automated
Exabytes
Event Driven
Beyond People

- more competition (faster entry/exit, geographic mobility)
- shorter product (firm/industry) lifecycles
- more systemic uncertainty (volatility, complexity)
- competitive advantage more ephemeral

e.g., Just-in-time organization, outsourcing, plan for unexpected, IT-intensive

End-user *Empowerment*

(aka, distributed control/ownership...)

End-users have the options...

- ICT saavy generation
- Rising discretionary income
- Communication intensive

Collectively, they control the info

- Wikis, Blogs, Social networks
- Viral networking
- Flash mobs

They control the platform

- Cell phone, iPod, PC
- Application (and OS)
- Lease or buy?

What do businesses need to do?

- proactive customer engagement
- interactive, open, truthful
- churn accelerates (fast and fickle)

They control the time/place

- Stream or Store/forward
- Internet is everywhere

Opportunities:

- self-service economy
- partners in risk/capital management
- continuous innovation