Future of the Internet

Open Research Topics

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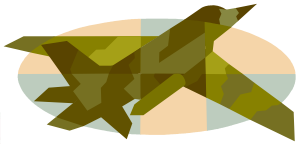
Evolution of Importance of the Internet

The Internet is No Longer a Toy









Research → Entertainment → B2C → B2B → Critical Infrastructure

Infrastructure Reliability & Security and Support of Complex Applications

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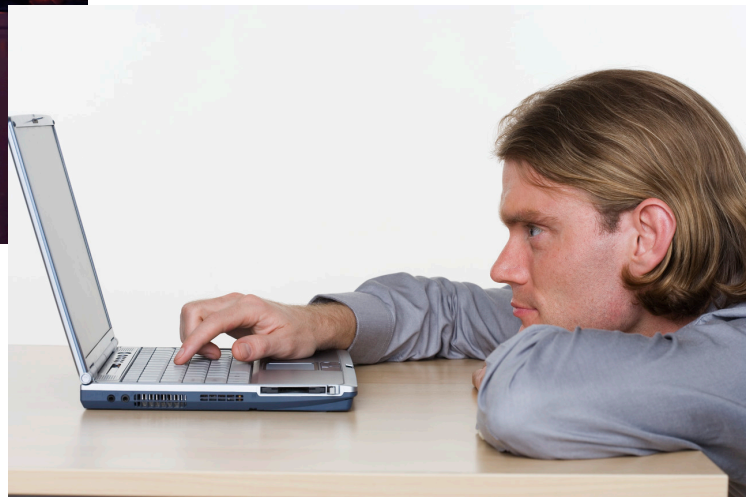
Where Do Applications Come From?



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What is a Good Internet Application?

- Sometimes you need complexity
- Sometimes you sell complexity
- Usually, simplicity rules

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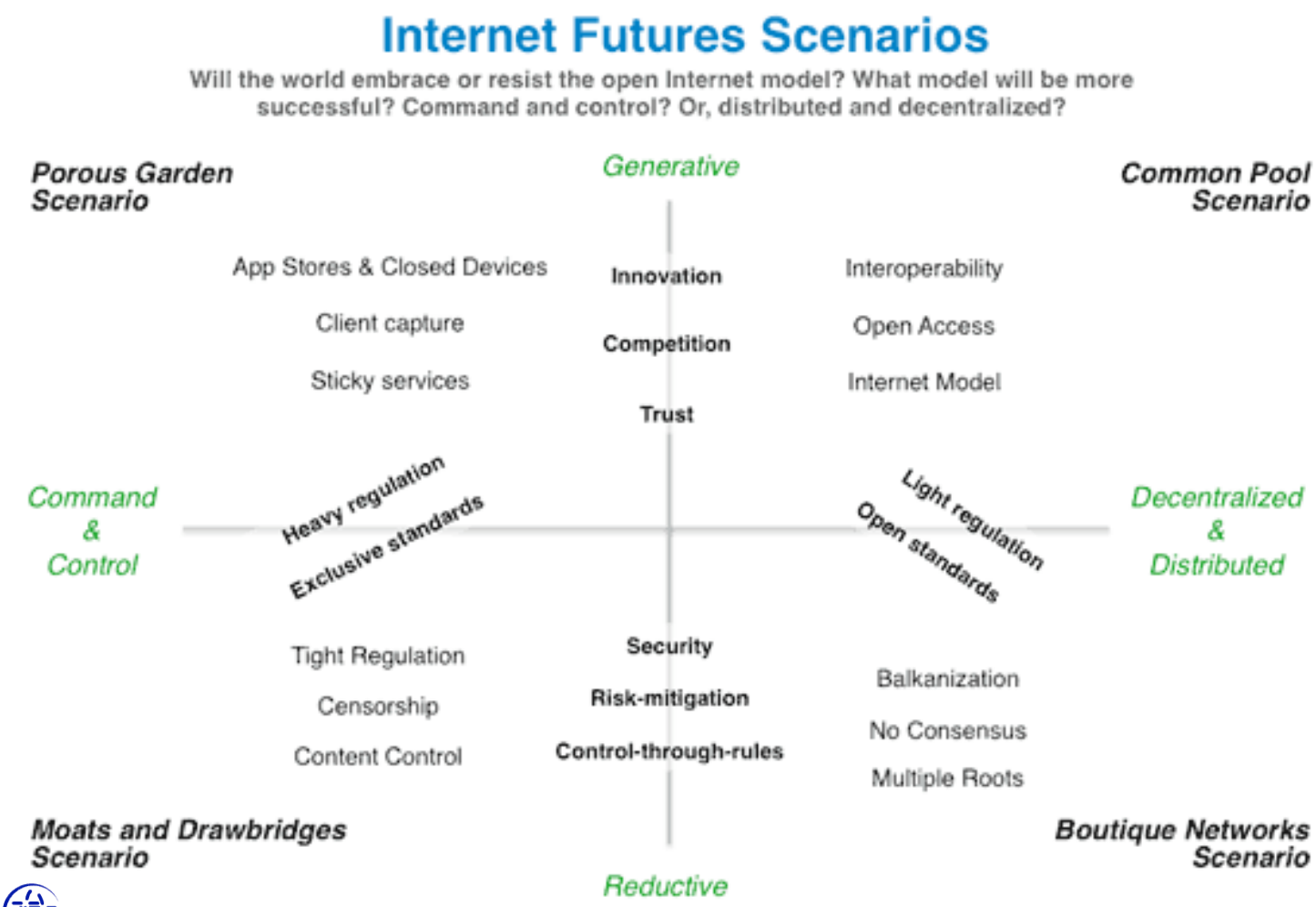
Future Internet Scenarios



Research at Neustar

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What is the Internet?

The Internet is Mobile

Implications

- Device is mobile
- Device is first a phone
- Phone identifies owner
- Content adaptation and low-power consumption factors in design

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Identity

- Cryptographic identity management
  - » Classic Computer Science problems
- Human factors and identity
  - » How do **people** want to refer to each other?
  - » Usernames
  - » National identity strings
  - » Telephone number (mobile)
- Separating identity and location from IP Address
  - » IETF HIP, LISP

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Peer-to-Peer

- Optimizing user experience and operator expenses
- P2P applications need to know network topology
- Operators know network topology
- P2P applications and operators do not trust each other
- How to share information?
  - » IETF ALTO work group

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Network as Critical Infrastructure

- Securing the DNS
  - » DNSSEC, others
- Securing BGP
  - » RPKI, others
- Identifying new architectures for Internet infrastructure
  - » Meet critical infrastructure requirements
  - » Keep end-to-end, innovation-driving aspects of Internet

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Internet of Things

- Movement to connect everything
  - Homes and content
  - Enterprises and content
  - People
- Sophistication of node
  - High performance computer
  - RFID tag on commodity
- Connection to network
  - Direct – wired
  - Direct – wireless
  - Gateway

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Internet of Things: Scale

- Millions (today) to thousand millions (near future)
- Impacts
  - » Addressing infrastructure
  - » Naming infrastructure
  - » Routing infrastructure
- Capability of nodes far less than current nodes
  - » Power – impacts CPU and networking
  - » Size – impacts interconnect and circuit complexity
  - » Intermittent activity – may not always be on
- Research Questions

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Internet of Things: Privacy and Control

- Exposing in-home usage can expose user's habits
- Safety and security impacts: stalking via location exposure
- Need to collect, use, process data; at same time need to protect, hide, control data
  - » Policy enforcement
- I want to remotely turn on my light
- I do not want you to remotely turn off my light
- Electric car catastrophe in the making
- Research Questions

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Internet of Things: Critical Infrastructure

- Smart Grid initiatives in Northern Europe, Middle East, South America, Asia, North America
- Network becomes national security domain
- Only true security is physical security
- But, most of the ultimate value of Smart Grid is interconnection to the Internet
  - » User self-monitoring
  - » User control
  - » Future, end-to-end applications not envisioned
- Impossible to keep separate: large enterprises will connect explicitly or implicitly
- Research Questions

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Internet of Things: Signaling

- Need ubiquitous protocol for messaging, session establishment, control
  - » Works across all network media
  - » Interoperates across different networks
  - » Has policy, security, privacy capabilities
  - » Small enough profile to run in embedded devices
- A leading option is SIP

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SIP for Smart Grid

- Has all of the interoperability properties
  - » Remote control of devices
    - Stahl, 2001 – demonstration of SIP light bulb
    - Burger, 2006 – demonstration and theory for any network interoperability
- Policy, security, and privacy
  - » Extant in protocol
  - » Not well adopted in today's applications
- But, SIP is considered a very heavy protocol

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SIP for PSTN versus SIP

- SIP envisioned as a small protocol to establish sessions using the Internet model
  - » End-to-end principal
  - » Recognizing need for policy enforcement, location services, and impaired (NAT) networks: Proxy Element
- SIP "lost its way" when adopted as the protocol for next generation telephony signaling
  - » Specification of 200 pages in 1999 is now well over 5,000
  - » Almost all of that is extensions
  - » Base protocol relevant for many uses other than telephony

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Summary

- Evolution of Internet: we depend on it
- Neustar Internet research: how to make Internet dependable
- Internet of things: ripe area for research
- SIP and the Internet of things
- Future delivery of the Internet and governance
  - » You will be a user of the Internet
  - » You may be creating the new Internet
  - » You may be creating new uses for the Internet
  - » You may govern the Internet
- Keeping the Internet safe, secure, and available and at the same time keeping what made it the most important 20th century technology: the end-to-end principal

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