

# Making the World of Communications a Different Place

Presented by:

Noorien Halari, Slava Bukhtiyarov, Sarvinderjit Singh,  
Farnaz Vahab, Ben Tagger

# Outline

- **Main focus on future technology**
- Technology at the Edge
- Universal System for Location
- New Design for Secure, Robust Operation
- Operation in Times of Crisis
- Small Networks
- Quantum Computers
- Control/Data Plane Dichotomy
- A Presence in Cyberspace
- Reduced Energy for Communication
- Software Radio
- Research & Experiments
- Missed Opportunities

# Technology at the Edge

## Summary:

- *"How the computing and communications world may be different in 10-15 years and how we could define a research agenda that would get us to that world!"*
- Better future, importance behind the vision and its goals and challenges arising for the coming years.
- Edge of network - the bulk is carried out "future expectation" everything to be embedded in one.

# Technology at the Edge

## Conclusion:

- No shared vision today.
- Lack of long-term motivation in understanding concepts of communication.
- Technical objectives to be accomplished.
- Important focus on infrastructure for the next generation devices.
- Research will play a pivotal role in the future.

# Technology at the Edge

## Critical appraisal:

- Limited examples of research areas.
- Little motivation/information on current work conducted.
- Future expectations stated, but no mention of what is lacking and what needs improving.
- No references to refer to with regards to current research that had been / is being carried out.

# Technology at the Edge

## Similar research conducted:

- NSF- focus on a new architecture for the Internet of the future
- Research on Network Communications by Andrew Odlyzko
  - Growth of the internet and its implications
- Inst. of Communication Studies in Leeds
  - Changing patterns of communication, its impact on technological change and its social implications; issues on new forms of communication
- Intel's Networking and Communications Centre
  - Focuses on “getting closer to wireless freedom” as a future goal

# Universal System for Location

- GPS is very popular nowadays
  - Effective and cheap.
  - But can be used only in open space.
- A system providing location information everywhere can bring many new benefits
  - Tracking objects, location-aware services, information tailored for particular context.
- *"In 10 years there should be a ubiquitous infrastructure that allows devices to determine their location, both inside and outside, with suitable level of precision".*
- Many risks / privacy concerns with location information.
- Important component of future networks.

# New Design for Secure, Robust Operation

- Internet was designed many years ago
  - Great concern with security and trust.
- Improvements were introduced, but they are partial.
- *"In 10 years our communications infrastructure should be based on an architecture that provides framework for security, robust operation in the face of attack, and a trustworthy environment for applications".*
- Enhanced security provides
  - resistance to different attacks
  - prevention of disruption of services
- Support of emergency services over the Internet for users.

# Conclusions and Importance

- Current technologies are not suitable for future
  - Provide limited functionality.
  - Design problems.
  - Currents improvements are just patches.
- Strong desire for new infrastructure to provide new quality services.
- Internet - a major “communication infrastructure of future”
  - Importance of bringing many improvements together.
- Changing the networks today when extensive research is already held in this area.
- No assessment of feasibility of changes. Lack of examples.

# Relevant Work in the Area

- Universal location system
  - No single technology for location information in different “environments”.
  - Can be achieved by combination of current technologies.
    - GPS + WLAN/RFID (Intel Research).
- New architecture for security
  - Tremendous research on the new infrastructure for the Internet
    - Internet 2, NSF "GENI" project, Intel Research etc.
    - Additional reasons for new architecture.
  - Many significant obstacles
    - Feasibility or economically inefficiency of replacing current technologies.
- Operation in times of crisis
  - I-911 - Internet based emergency call architecture by NTIA.

# Small Networks

Local communications architecture for interconnection of small devices.

- Bluetooth
  - proves there is demand to interconnect devices
  - limited number of peers
  - low bandwidth
- Demise of blackplane
  - it is better to treat the components of a system as individual devices.
- Optical or Wireless devices on CMOS. Into the chip networking

# Quantum Computers

- A new mode of information processing.
- The fundamental unit of information (called a quantum bit or *qubit*), is not binary but quaternary.
- A qubit can exist as a zero, a one, or simultaneously as both 0 and 1, with a numerical coefficient representing the probability for each state.
- Communication require qubit routers and dedicated optical fiber.

# Effect on Security

- Most current cryptography relies on Integer factorisation of two large prime numbers.
- Quantum computers require Quantum Cryptography.
- Unlike traditional cryptography which relies on mathematical techniques, Quantum cryptography is based on certain phenomena of quantum physics.
- Man-in-the-middle attacks are impossible.
- "...If, without in any way disturbing a system, we can predict with certainty ... the value of a physical quantity, then there exists an element of physical reality corresponding to this physical quantity." \*definition of perfect eavesdropping!

# Prospects of Quantum Cryptography

- Quantum states in the real world, rarely usefully stable.
- One of the major obstacles of quantum computing is the problem of decoherence.
- Errors that arise due to decoherence or decay from a given quantum state into an incoherent state need to be corrected.
- The first commercial applications of quantum cryptography have thus a limited reach.
- The cost of the needed equipment and dedicated fiber optic line are weighing against its wide application.

# Control/Data Plane Dichotomy

- Data plane / Control plane
- Drawbacks:
  - It can not reliably detect when the user is having the problem
  - Certain limits in control plane architecture
- *“In 10 years, the Internet should be augmented with a new set of mechanisms for diagnosis and configuration, which can improve the usability of the Internet, reduce the need for manual intervention, and provide a linkage between application intentions and network behavior.”*

# A Presence in Cyberspace

- Any physical object has an appearance
- A person cannot only “look at” an object in the real world, but “look at” its manifestation in the cyberworld.
- *“In 10 years, any physical object should be able to tag itself in a way that links it to relevant information and functions in cyberspace.”*

# Reduced Energy for Communications

- It seems likely that in 10 to 20 years, the wireless interface will be primary consumer of energy in any device that combines computation and radios.
- The main goal of community in three orders of magnitude:
  - It gives a crisp metric for measuring efficiency.
  - It can further drive the creative development of new radio technologies.
  - The advent of software radios makes it far easier to perform the wide range of experiments required to meet this goal.
- *“In 10 years, in a wireless network, the energy cost per bit of data transferred should be 1/1000th the cost it is today.”*

# Software Radio

- “A software radio is a radio whose channel modulation waveforms are defined in software.” - Joe Mitola
- Get the software as close to the antennae as possible.
  - 10 year aim: *“To have working software radio systems that demonstrate that spectrum can be used and managed in revolutionary ways. We should demonstrate highly efficient use (and reuse) of spectrum, and establish a regulatory regime that permits these modes of operation.”*

# Research & Experiments

- Limitations of the publication.

## TODO:

- Set some long-term visions to achieve.
- Establish infrastructure for experimental testbed.
  - Create new infrastructure.
  - Supply existing infrastructure.
  - Agree

# Missed Opportunities

- Benefits of the 10-year plan.
- Commercially-driven advancement.
  - Poor long-term vision (profit-oriented).
- Missed Opportunities:
  - Home-networking
  - Automobile-networking

# Further/Related Work

## Software Radio:

- Centre for Communication Systems Research: [www.ee.surrey.ac.uk/CCSR/](http://www.ee.surrey.ac.uk/CCSR/)
- Advanced Telecommunication Laboratory (Japan):  
[www.csl.sony.co.jp/ATL/](http://www.csl.sony.co.jp/ATL/)
- 4<sup>th</sup> Karlsruhe Workshop on Software Radios (March 2006):  
[www.int.uni-karlsruhe.de/conferences/wsr06/](http://www.int.uni-karlsruhe.de/conferences/wsr06/)
- Defense Advanced Research Projects Agency (DARPA): [www.darpa.mil/](http://www.darpa.mil/)

## Related Work:

- BT Reveals Insight into the Future:  
[www.btplc.com/Innovation/News/timeline.htm](http://www.btplc.com/Innovation/News/timeline.htm)
- Vodafone Future Vision:  
[www.vodafone.com](http://www.vodafone.com)
- Architectural Innovation: Future Vision 2015:  
[www.intel.com/technology/architecture/vision2015/](http://www.intel.com/technology/architecture/vision2015/)

**Questions?**