# Emerging IT Platforms
# Mobile Phones; Mobile Computers

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NOKIA Connecting People

## Nokia Research Center

- ~1000 employees
- Globally distributed
  - Helsinki, Finland
  - Bochum, Germany
  - Cambridge, UK
  - Palo Alto, California
  - Tokyo, Japan
  - Beijing, China
  - Cambridge, Massachusetts
- NRC Cambridge
  - Charter: renew Nokia by open innovation
  - 16 researchers working on joint projects with MIT CSAIL
  - 15 faculty and about 20 students working with us



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## Evolution of the IT Platform

~200 countries
~50 languages
~800 networks
~1 B sold in 2006
2.6B subscribers



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## How is Mobile Phone Different from Tiny PC?

- Mobile Phone Experience
  - One phone, one user
  - Always on, always connected, always with user
  - Enables context/location based services
- Limitations
  - Relatively slow (up to 600MHz, up to 4 application CPUs in next few years)
  - Less memory (128MB now, up to ~1GB next few years)
  - Less non-volatile storage (1GB now, ~10GB next few years)
- Fixed constraints
  - Small devices so they can always be carried
  - Physically small screens
  - No room for full keyboard



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## Mobile Phones and Mobile Computers

- 2006:
  - 900 million mobile phones sold worldwide
  - 120 million smart phones
- Computing capacity
  - 100MHz – 600 MHz
  - 1 to 5 general purpose processors (ARM)
  - 1 or more DSPs
  - Sometimes graphics and imaging accelerators
- Communication capacity
  - Voice
  - 9600 bps to 100Kbps (2.5G) to 5 Mbps (3G) to 100Mbps (4G)
  - Also Bluetooth, WiFi
  - WiMAX, UMTS LTE, UMB all 4G technologies based on OFDM



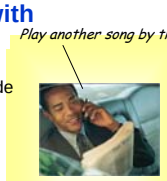
## Open Technical Research Issues

- Small device user interface
  - New metaphors needed
  - Speech interaction
- Context and user modeling and adaptation
  - Location based services
  - Reacting appropriately to user's surroundings and context
  - Anticipating user's needs and desires
- End-user customization and programming
  - More mobile phone users have even less exposure to technology than PC users
- Faster creation of more kinds of special purpose chips
  - Special purpose hardware uses 100x-1000x less energy than software
  - But current standard practice for hardware takes too long
  - Move to better tools (e.g., Bluespec) and network-on-chip

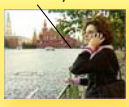


## Speech interaction with applications

- Language is the primary mode of communication among humans
- Devices need to incorporate spoken language technology
  - Especially as they shrink in size
- Language can become a major mode of interaction for communication, control, and information management







## Evolution of the Mobile Phone Platform

- Originally, closed devices with fixed “firmware” – telco style
- Then added extensibility via Java Micro Edition
- Symbian allowed 3rd party native applications
- Linux and open source increasingly of interest
  - Starting in Asian markets
- Full featured browsers becoming commonplace
  - No more WAP or other phone-specific web protocols
  - AJAX now possible
- Constraints
  - Latency, bandwidth, screensize, memory lack of keyboard all still issues
  - Latency decreasing, bandwidth and memory increasing
  - Display sizes fixed by ergonomic constraints but number of pixels increasing



## Business and Technology Drivers



## Staying Competitive

- To keep jobs in the US
  - Move up technology curve
  - Deliver hardware and software with greater scalability
  - Manage greater degrees of complexity



## Open Business/Economic Issues

- Commoditization of 2G phone hardware and software
  - Lower margins -> less R+D investment
- Open source vs proprietary software
  - Open source enables greater differentiation!
  - Less investment needed to match status quo
  - More investment available for innovation
  - Less time lost to contract negotiation
- Community vs centralized software development
  - Open source led community development processes
  - Nokia engineering and product teams have similar needs
- Open source vs proprietary hardware?
  - Fragmented ASIC IP market causes difficulties integrating and shipping hardware and software

## US Platform Technology Strengths and Weaknesses

- Software engineering strong



## Policy Recommendations

- Research funding
  - US government funding of long-term research has decreased
  - Corporate research funding has taken up some slack
  - Corporate research funding has more strings
  - To maintain competitiveness, increase US government funding of long-term research



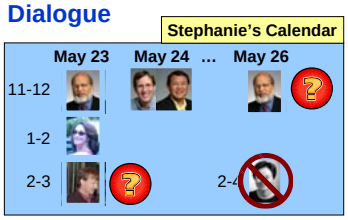
## Project Summary

- Enable spoken interaction to simplify the mobile interface to phone features


- Develop methods for annotating audio-visual content and subsequently retrieving it
- Demonstrate technology in several application domains
- Transfer spoken language technology and systems to Nokia
- Collaborate with related research projects



## Example Dialogue





Spoken language technology capabilities:

- Speaker-independent speech understanding
- Speech generation to support display
- Dialogue support for complex queries
- Confirmation sub-dialogues
- Negotiation for conflict resolution
- Support for anaphoric references (e.g., this meeting)