“Innovations in Mobility”
Nokia Research Center
North America Lab (NAL)

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July 30, 2012
**NRC NAL Research Teams**

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**Nokia Research Center**

[http://research.nokia.com/page/12381](http://research.nokia.com/page/12381)
Team: **Mobile Computer Systems (MCS)**

Federated system architectures supporting seamless experience across diverse devices and platforms; future personal computing and communication devices.

**Quinn Jacobson;** PhD, Director, Disruptive Innovations

- **Deepti Chafekar;** PhD, Senior Researcher
- **Rachel Hinman;** Senior Researcher, User Experience
- **Shani Jayant;** PhD, Senior Researcher
- **Annie Luo;** PhD, Senior Research Engineer
- **Sri Nair;** Principal Member of Research
- **Hawk Pang;** Principal Engineer, Architecture and Systems Design
- **Mohammad Rahimi;** PhD, Senior Researcher
- **Vivek Shrivastava;** PhD, Member of Research

**MCS Project:** Create a highly mobile device suitable for content consumption and content creation enabling cross-device seamless interoperability user experience.
Develop innovative features for the post-tablet mobile computing device:

- Content creation (cover-keyboard and stylus);
- Device awareness and interoperability (flick content to another device or tile two devices);
- Deep sense: 3D sensing and new kinetic user interface; and
- Enterprise security and manageability.

Do the research, prototyping, advanced development, and rapid product concept development to provide a number of key differentiating features for family of high-end next-generation mobile computers.
Team: **Innovate, Design, Experience, Animate (IDEA)**

Novel ideas in group communication and social interaction supported by emerging devices, tangible UI, and rich immersive and interactive contents.

**Mirjana Spasojevic;** PhD, Director, Exploratory Research

- **Tico Ballagas,** PhD, Principal Researcher
- **Dave Dearman,** PhD, Senior Researcher
- **Hiroshi Horii,** MFA, Senior Researcher
- **Jofish Kaye,** PhD, Senior Researcher
- **Koichi Mori,** PhD, Senior Researcher, Architecture & Systems Engineering
- **Dan Odell,** PhD, Principal Researcher
- **Vidya Setlur,** PhD, Principal Researcher

**IDEA Project:** How to adapt educational content to be both interactive and adaptive to support children’s learning and family communication?

“This is Elmo’s classroom. What things do you see in Elmo’s classroom?”
Offer novel ways to interact with top-tier content and deliver differentiated experiences on Nokia Platforms. Distant families are connected through learning and play.

Collaborate with premier content partners (Disney, Sesame, Pearson) to deliver signature apps for Windows Phone and Windows 8.

Key objectives:

- Release Interactive Rich Reading titles with Sesame Workshop on Symbian and WP.
- Connected Reading with Sesame for AARP.
- Read for the Record with Pearson.
- Augmented Reality Paper Books with Disney.
- New connected curriculum modules around Executive Function and STEM with Sesame.

www.connectedreading.com
Sesame on Nokia Lumia

Through Interactive Rich Reading (IRR), we embarked on a mission to bring world-class educational content to the Nokia Ecosystem. Our objective was to build novel learning experiences that actively involve adults in children's literacy development. The philosophy behind our novel interactive book implementation is to encourage children to talk more during the reading experience.

Research on "dialogic reading" shows that the more kids talk about a book during the reading experience, the better their vocabulary development. In our implementation, Elmo from Sesame Street brings the book to life as a live, story-time participant. Elmo asks questions about each page to encourage children to talk about the contents of the book with their parents.

NRC's research collaboration with Sesame Workshop, the creators of Sesame Street, led to the creation of multiple literacy prototypes and, ultimately, the IRR mobile application. IRR apps are the cornerstone of a broad global distribution agreement with Sesame Workshop spearheaded by DXM to bring a library of exclusive Sesame content to Nokia Ecosystems.

Now we have launched four Sesame Street titles to the Windows Phone Marketplace:
- 100th Day of School,
- Abby in Wonderland,
- Big Block Party, and
- Color Carnival.

“100th Day of School” is part of the Nokia Collection offered to the user. Now you can download it to your phone for free and enjoy with your family and friends!
Team: Spatial Technologies (SPATE)

Create a 3D maps based platform that facilitates applications and services in an augmented and mixed reality 3D spatial environment

**Radek Grzeszczuk;** PhD, Research Leader

- **Carmen Au,** PhD, Senior Researcher
- **Jerome Berclaz,** PhD, Senior Researcher
- **Varsha Hedau,** PhD, Senior Researcher
- **Thommen Korah,** PhD, Senior Researcher
- **Vasu Parameswaran,** PhD, Senior Researcher
- **Timo Pylvänäinen,** PhD, Senior Researcher
- **Ray Rischpater,** Senior Research Engineer
- **Gabriel Takacs,** PhD, Senior Researcher
- **Ramakrishna Vedantham,** Senior Researcher
- **Jason Wither,** PhD, Senior Researcher, User Interface

**SPATE Project:** Creation of 3D maps on a global scale is a big challenge requiring processing of massive amounts of data.

Our objective is to create a next generation street-level map experience that would be unmatched by competition in terms of user experience and quality.
Creating 3D maps from visual data

Semantic 3D City Model: model divided into meaningful parts, information connected to the model and accurately placed in 3D, both abstract and photorealistic representation of the world

Next Generation 3D Maps: Abstract, Photorealistic, 3D-Localized Content
Create next generation 3D maps. Use visually rich street-level data to create a photorealistic and immersive user experience.

Analyze the visual data to create simple, abstract 3D city models that can be used for augmentation, intuitive UIs and automatic 3D content placement.

Key objectives:

- Develop text sign recognition, visual navigation and indirect AR.
- Create 3D city modeling from street-level data.
- Integrate City Scene 2.0 into Nokia products.
Team: **Mobile Internet Services Systems (MISS)**

End-to-end large-scale platforms for mobile LBS and experiments with technologies for supporting and enabling HTML5 based web applications

- **Ken Tracton**, PhD, Principal Researcher
- **Baik Hoh**, PhD, Senior Scientist, System Software Engineering
- **Toch Iwuchukwu**, PhD, Senior Researcher
- **Amol Khadilkar**, Senior Engineer, Application Software Engineering
- **Peter Mikelsons**, PhD, Senior Researcher, Application Software Engineering
- **Luis Sarmenta**, PhD, Principal Researcher
- **Olli-Pekka Tossavainen**, PhD, Member of Research Staff
- **Ji-Dong Yim**, PhD, Member of Research Staff

**MISS Project:** Social network routing and voice guidance mapping with HTML5. 3D version of indoor mapping.

**MM2 Project:** Caltrans integrated corridor management study with UC Berkeley.
Next generation automotive data probes:
- **Client-side**: Based on Mirror-Link collected data. Collection points include ML generated, connected device collection and OBD2 information.
- **Server-side traffic generation**: Including a queryable spatially organized database supplying ETA, congestion, pollution and other details.

Key objectives:
- Social network routing and voice guidance mapping with HTML5.
- 3D version of indoor mapping.
- Standalone mapping application with traffic and routing for Odysseus. Enable Odysseus to be a standalone heads-up display.
Caltrans sponsored Integrated Corridor Management (ICM) study with UC Berkeley:

- Conduct real-time dynamic traffic modeling and provide incentives (e.g. lottery tickets) to selected drivers for them to change route in order to prevent traffic congestion.

Scientific/technology challenge:

- New methods to collect and represent spatial real-time automotive data, including automotive, air pollution, weather, environmental and traffic.

Key objectives:

- Local pilot study that uses a version of OMAP running on the Odysseus device.
- Front end client and backend server software stacks and optimizations for HTML5.
Team: Ubiquitous Mobile Interoperability (UMI)

Interoperability across mobile usage modes and device form factors, as exemplified by MirrorLink™ for supporting automotive interoperability

Jörg Brakensiek; D Eng, Research Leader

- Raja Bose, PhD, Senior Engineer
- Jonathan Lester, PhD, Senior Researcher

UMI Project: Establish a new automotive product category, eliminating special purpose mountable devices and phone docks.

Prototype a MirrorLink enabled smart navigation in-car tablet. Provide a set of signature consumer and enterprise experiences.
MirrorLink™
Smartphone Connectivity to In-Vehicle Units

- Smartphone controlled with Vehicle Controls / HMI
- Car sensor data used (e.g. car GPS)
- Optimized UI for in car use presented on the car display
- USB, BT, WLAN connection
- Audio routed to car audio system
- Driver distraction controlled through technical protocol and certification
Prototype a MirrorLink™ enabled smart navigation tablet that provides a native Nokia Drive Auto experience. Extend the user experience with MirrorLink enabled mobile device applications and HTML5 based Web Applications.

Bring embedded high-end infotainment system functionality to the masses, while providing smartphone connectivity. Provide end-to-end, fluid user experience.

Key objectives:
- PCB design, system software, and industrial design.
- MirrorLink 1.1 compliant client.
- OBD-II connectivity and steering wheel control via BT dongle.
- Overall UI & UX for in-car & out-of-car use
Team: Mobile, Social, & Interactive Computing (MOSAIC)

Disruptive mobile applications & mobile experiences for automotive; opportunities enabled by HTML5, mobile moments, and access to car, device & cloud resources

**Alison Lee;** PhD, Principal Scientist
- **Ville Karaila,** Senior Specialist
- **Hae-Jin Lee,** Senior Researcher
- **Juong-Sik Lee,** PhD, Senior Researcher
- **Oleg Romashin,** Senior Architect and Software Engineer

**MOSAIC Project:**
Create elements for the CAMP app ecosystem:
- HTML5 app execution environment,
- Signature mobile automotive apps built in HTML5, and
- OBD II JavaScript API to access car data.

WebGL version of 3D maps client running on the OMAP3 hardware
Car As a Mobile Platform – Auto Apps

Lead: Alison Lee

Create an app ecosystem around CAMP that is built using HTML5 technologies. Key deliverables:

- HTML5 app execution environment based on Mozilla backend.
- Signature apps in entertainment, infotainment, productivity, and car fitness space.
- JavaScript API to car data via OBD II; Web server on device for data/capabilities.

Scientific/technology challenge:

- User interface paradigm requiring minimal distraction for automotive environment.
- JS or web service APIs to variety of sensors (e.g., OBD, GPS, accelerometer, phone data).
- Browser performance on mass market mobile devices supported by cloud based resources.

Signature Apps:
- At the Reds
- Car TimeSAGE
- Car Trek
- Music Jukebox
Team: **Performance Efficient Mobile Platforms (PEMP)**

Achieving one to two orders of magnitude improvement on performance/energy efficiency for future mobile devices, including wearables, smartphones, & tablets

**Per Ljung**: PhD, Research Leader
- **Allen Cheng**, PhD, Senior Researcher, Architecture & Systems
- **Yoshiya Hirase**, Senior Researcher, Architecture & Systems

**PEMP Project**: A small, glanceable always-on accessory supporting voice & notifications. A Mirasol display lets user see notifications, which are updated every 60s using ultra low power radio. Voice is supported using BT classic.

Average power is only 3mW enabling 14+ day battery life with small 300mAh battery.

**PEMP Project**: Prototype 100-day phone/tablet by adding ULP subsystems for display, data, and apps. Device uses always-on ULP display, ULP CPU, and ULP radio, and connects wirelessly to access points.

Investigate ULP operation in home/office. Several user studies indicate that user spends 80% of time in home or office.
Ultra Low Power Always-On Device

Lead: Per Ljung

Amulet is designed to demonstrate ultra-low power (ULP) using available components. We have demonstrated 3mW average power consumption with display always-on, data radio receiving 1kB of notifications every minute (1.5MB/day), and BT hands-free-profile in connected sleep mode. With a 1Wh battery this corresponds to a 14 day battery life for an always-on device.

Amulet is tethered to an access point (e.g. larger smart phone, tablet or laptop) using low power radio to receive notifications.

We have integrated the prototype with 1.5", 4.3", and 5.7" Qualcomm Mirasol displays.

Moreover, we have created a browser-based UI mockup using jQuery mobile to explore UX of different feeds. The dynamic mockup contains live data (Facebook, Wtwitter).

Amulet prototype: msp430 CPU, cc2500 ULP radio, Bluegiga WT32 Bluetooth module, Qualcomm Mirasol 1.5" ULP display, joystick, accelerometer, microphone and speaker.
Increase battery life to 100 days when only 3mW ULP subsystems are active. The traditional hardware is normally off, and OS is hibernating. ULP subsystem supports fresh feeds and UI, and uses fast resume (3s) to wake the OS if needed.

Key objectives:
- Submit DARPA proposal for ULP computation for embedded systems teaming with Boeing, GreenArrays (*), and UC Berkeley.
- Identify suitable platform and ULP computation fabric.
- Augment target with ULP display and ULP radio.
- Prototype access point.
- Prototype hibernation with wake-on-event.
- Investigate cloud-based ”wake-on-event” to initiate resume from hibernation.

(*) GreenArrays GA144 is an ultra low power computational fabric, which is 100x more energy efficient than RISC, but with a difficult programming model.
Team: **Personal Ranking, Relevance, Recommendation (PR3)**

Leveraging unique sensors and behavioral data from mobile devices to dramatically improve relevancy of context recognition, search, ads, & recommendation systems

**David Racz;** Research Leader, Principal Scientist

- **Brett Clippingdale,** Senior Researcher
- **Evan Welbourne,** PhD, Senior Researcher

**PR3 Project:** Provide next-generation services for large-scale behavioral data collection, modeling, validation, and visualization.

Enable the rapid development, testing, and validation of predictive behavioral models and hypotheses.
Human Behavioral Research, Infrastructure, and Services

Lead: David Racz

Create well-defined use cases for context recognition and prediction. Develop infrastructure and services that support the rapid research and development required for productizing context recognition systems.

High-level goals:

- Provide fundamental services for large-scale behavioral data collection, labeling, modeling, validation, and visualization.
- Enable the rapid development, testing, and validation of predictive models and hypotheses.
- Deliver high-quality training/test corpora for specific context recognition tasks.
- Develop reliable predictive models for visit detection and activity recognition.
- Promote disruptive privacy principles and policies for exploiting data, without exploiting users.