Ubiquitous Sensing, Computing, and Communication

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Your personalized life interface

Local

Sensors

Computing

Memory

Sensor to environment

My device

My personal, trusted user interface

My applications

Gateway to cellular/IP networks

Global

Services

Communities

Content

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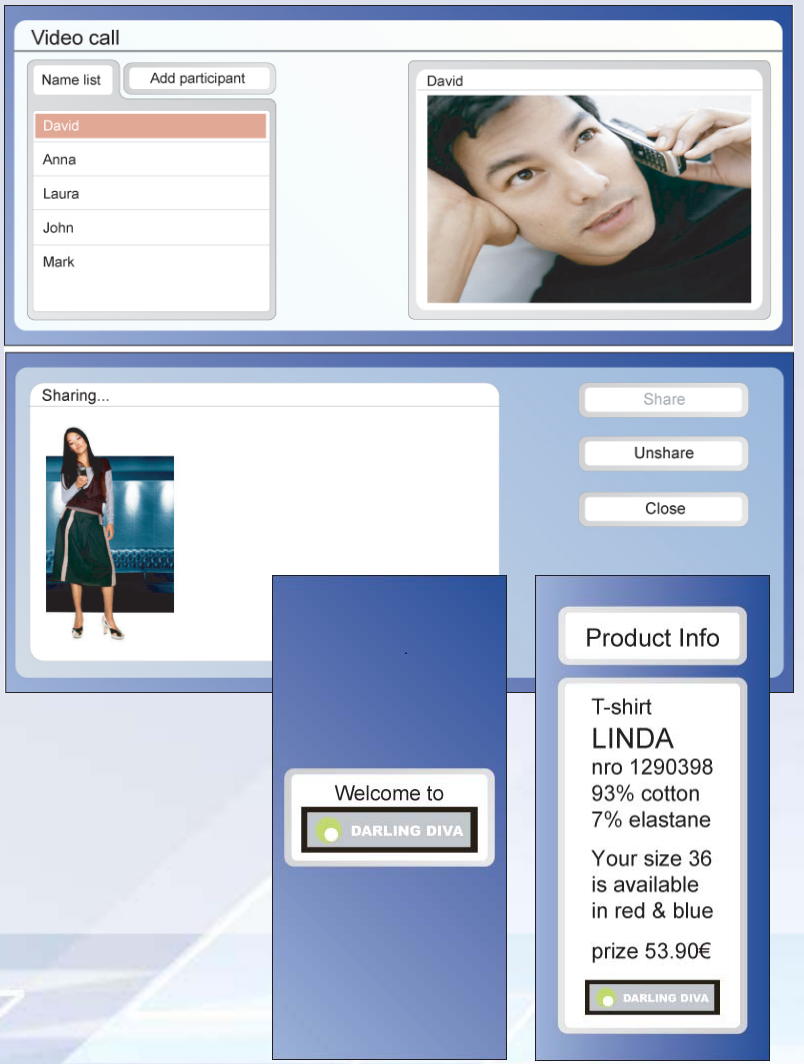
World in front of you, World behind you

The world is in front of you

- Intelligence within your reach
- Filtered by your personal profile
- Services ready to assist you
- Your own virtual self

The world is behind you

- Support from connected communities
- Multimodal communication (voice, images, video, haptic effects, gestures, ...)
- See-what-I-see, Hear-what-I-hear, Feel-what-I-feel
- Contextual virtual presence



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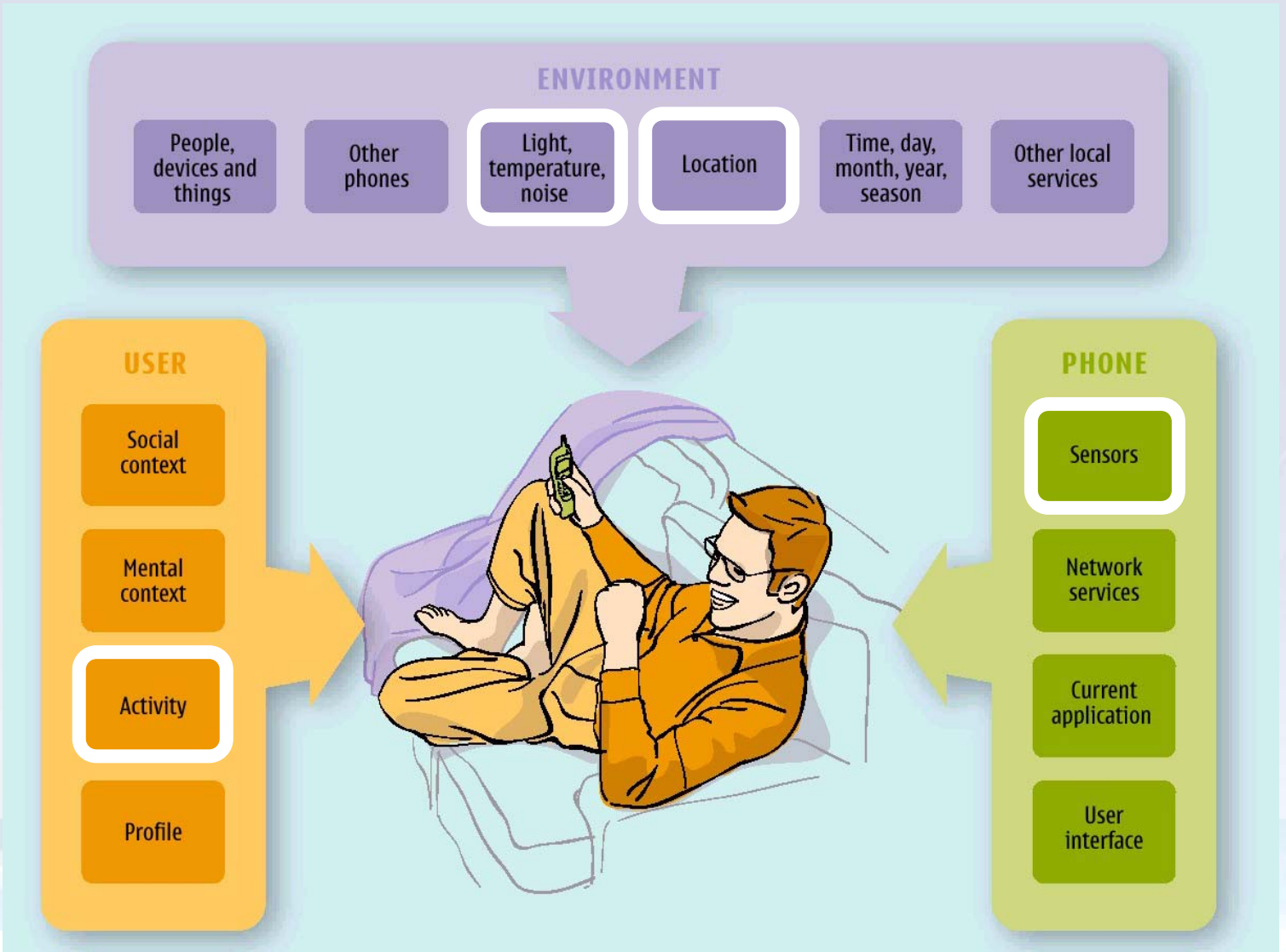
Context aware mobile device

WSN



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Mobile device as a wireless sensor network gateway

Home automation

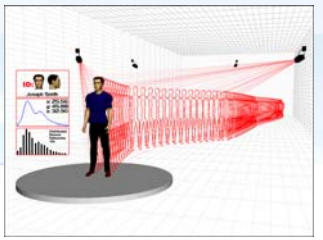
Mobile device as a user interface and a gateway to wireless sensor networks

Environmental monitoring

Logistics

Healthcare

Security



Entertainment environments

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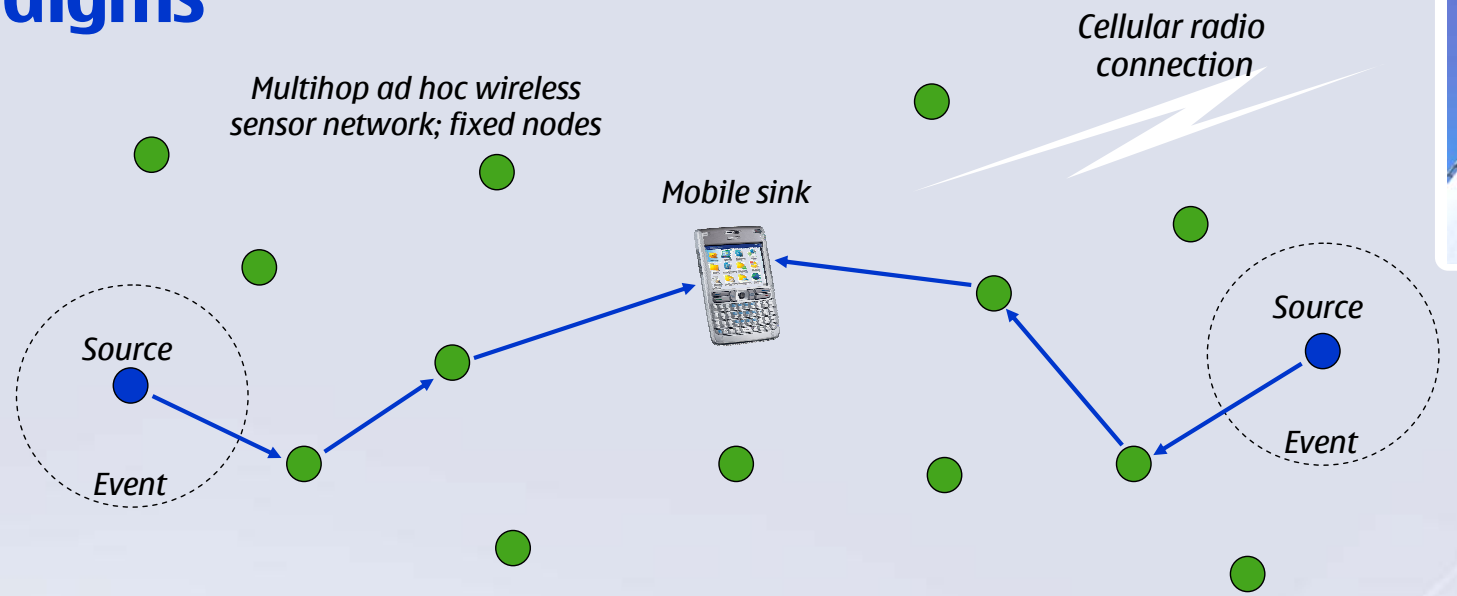
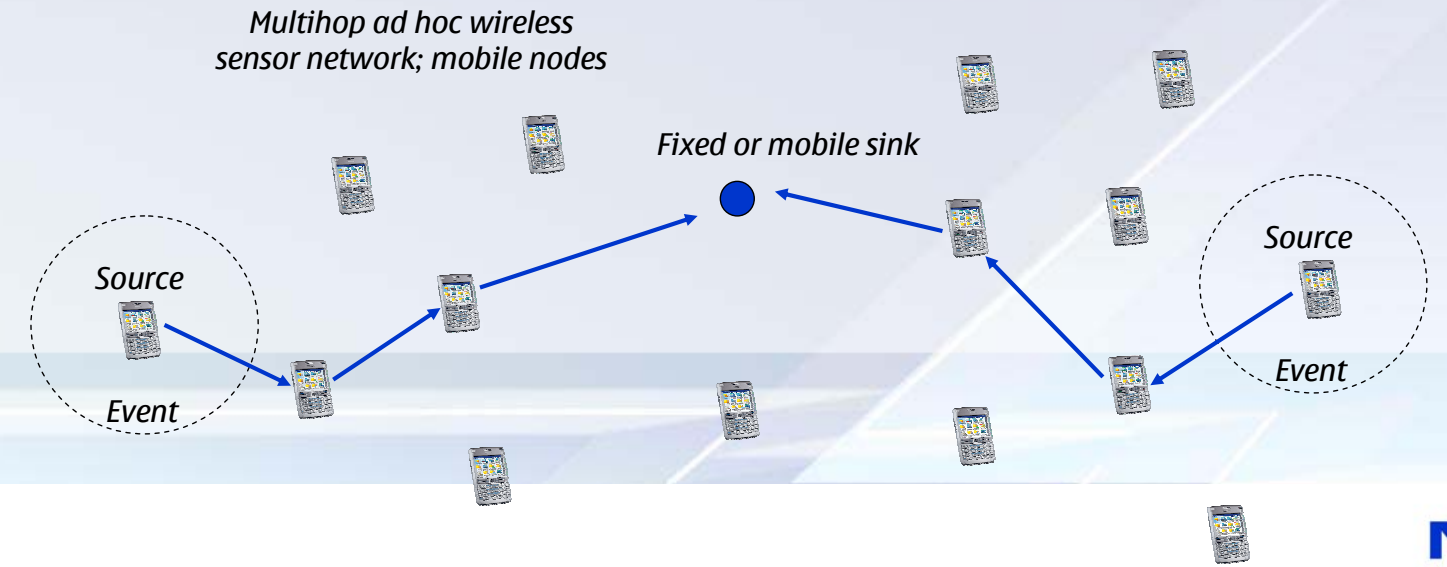
WSN Paradigms





Base Station

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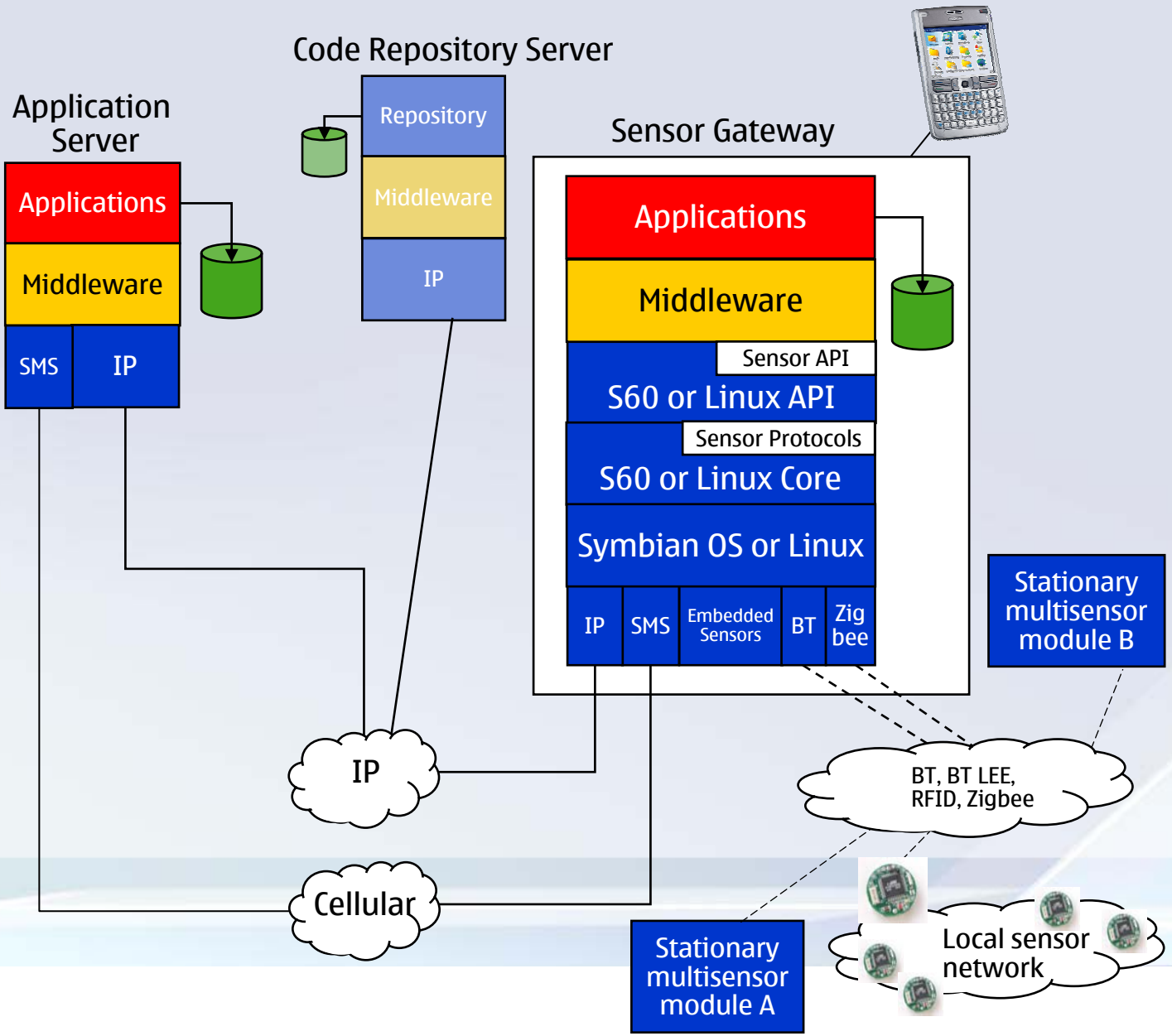
Nokia Remote Sensing Architecture



Technical Highlights

- Event-based architecture
  - Allows for collecting & aggregating local sensor data
  - Allows for local & remote sensing
  - Transfers only relevant data
- Moves intelligence close to sensors
  - Acquisition and aggregation done in gateways (e.g., ,mobile)
- Services on top of middleware
  - Re-usage of common functions
  - Abstracts from hardware details
  - Enables sharing of resources
- Support for access control implemented in future versions
- Allows for integrating local sensor networks
- Specific query & information model under development

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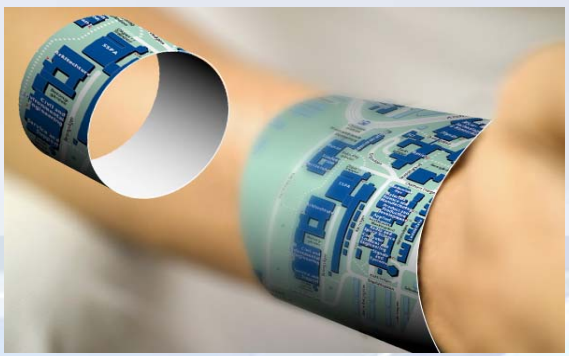
Some key technological challenges

- **”Sensor data challenge”:** how to make the high-volume sensor data useful
  - query/search problem
  - data management problem
- **”Mobile adaptation challenge”:** self-configuration and adaptation
- **”Integration challenge”:** how to integrate (two-way) WSN to Internet based services (create the “gateways”)
- **“Power challenge”:** even high-power mobile nodes are not enough



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Market moving from innovator phase to early adopter phase

2000 2001 2002 2003 2004 2005 **2006** 2007 2008 2009 2010 2011 2012

Innovator phase

- ~10 university spin-offs developing technology
- R&D activities hardware focused
- Proprietary technologies
- First attempts to standardize
- Narrow verticals: Environmental and military

Early adopter phase

- Proof of technology
- Wireline replacement
- Traditional applications
- Emphasis on customer needs and applications
- Large technology companies more active

Commercialization phase

- Wide-scale deployment
- Many application areas,
- New consumer apps
- Technology standards
- Timing of market take-off depending on large companies' activities

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Some research questions

What are the leading business models?

Where will the consumer-centric test laboratory be?

What about software and applications research?

How to store and scavenge energy?

?

How to make sense of high-volume sensor data?

Where are the standards for radio, messaging, and service discovery?

How to integrate WSN to other IT systems? What are the ”gateways”?

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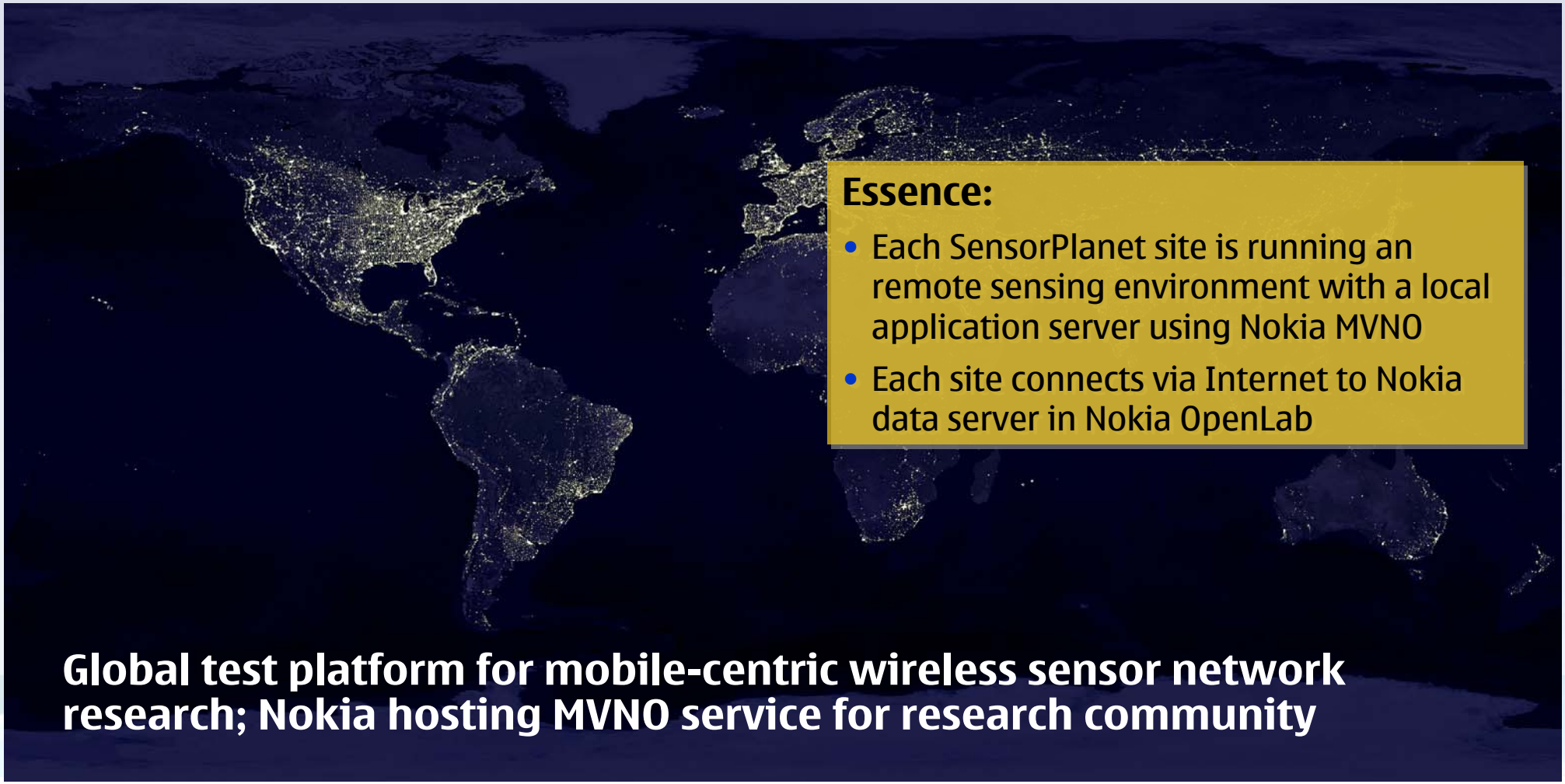
Nokia Sensor Planet



Essence:

- Each SensorPlanet site is running an remote sensing environment with a local application server using Nokia MVNO
- Each site connects via Internet to Nokia data server in Nokia OpenLab

Global test platform for mobile-centric wireless sensor network research; Nokia hosting MVNO service for research community

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