16th FFV Workshop

Mobile Web Services in Health Care and Sensor Networks

Fahad Aijaz
Department of Communication Networks
RWTH Aachen University, Germany

FFV Workshop, March 13, 2009
Outline

• Wireless Sensor Networks
  – A General Introduction
  – Problem Statement
  – Scientific Framework

• Service-Oriented Wireless Sensor Networks
  – Use Cases and Requirements

• Mobile Web Services
  – Types and Interactions

• Advanced Mobile Web Service Architecture

• Service-Oriented WSN Environments
  – A Collector Node Scenario
  – Healthcare Scenario and Requirements – MEDICARE
  – Measurement of Power Consumption

• Mobile Web Services Research at ComNets
Wireless Sensor Networks (WSN)  
(A General Introduction)

- A WSN is a wireless network consists of **spatially distributed devices using sensors**.
- Sensors **monitor the physical or environmental conditions** at different locations, e.g.
  - Temperature
  - Sound
  - Vibration
  - Pressure
  - Motion etc.
- Such networks are the key for gathering information in **smart environments**.
- Some application areas are;
  - Monitoring and Control Systems
  - Health care
  - Traffic control
  - Security
  - Home automation etc.

Typically, a WSN performs **distributed network computations** to meet its specific needs.

Data received by sensors is processed with **limited processing capabilities** of a sensor node.

Complex network computations demand **high processing power** within a sensor node.

This results in **high power consumption** and affects network performance.

**Issues:** Low processing power, Battery consumption, Network performance
'Collector nodes introduced in [1] are better equipped in terms of processing power and battery consumption than ordinary sensors.

- High-valued distributed in-network computations can be achieved by collector nodes' collaboration.
- Collector nodes represent local neighborhood of sensors to higher hierarchy of WSN.

- Collector nodes equipped with Mobile Web Services to perform local computations.
- Cooperation among the collector nodes would initiate higher-valued Mobile Web Services for complex distributed in-network computations.
- Study new fields in the area of Mobile Web Services to identify realistic business and application scenarios.

**Scientific Challenges**

- Network computations in wireless networks.
- Organization of cooperative collector nodes owning Mobile Web Services.
- Gain a high-valued network based on Mobile Web Services.

---

Service-Oriented Wireless Sensor Networks (Use Cases and Requirements)

Wireless Sensor Networks

Mobile Web Services Framework

Service Oriented Computing

Service Oriented Wireless Sensor Networks

Long-Lived Processes

Service Management

Interaction Patterns

Event Notifications

Data Representation

Short-ranged Comm.

Long-ranged Comm.

Healthcare | Traffic control | Security | Home automation ...

Domain Specific Applications

Mobile Web Services Framework

Enough?
P2P Mobile Web Services

**Execution Model**
- Synchronous (Short-lived)
- Asynchronous (Long-lived)

**Mobile Synchronous Interaction (MSI)**
- Mobile Asynchronous Interaction (MAI)

**WS Consumer**
- Mobile Web Server
- Mobile Web Services

**Consume**
- (SOAP)

**WS Provider**
- Mobile Web Server
- Mobile Web Services

**Search**
- (WSDL)

**Publish**
- (UDDI)

**Web Service Broker**
- WSDL Operations (Transmission Primitives)

**WS Consumer**
- Mobile Web Server
- Mobile Web Services

1. Request-response
2. Solicit-response
3. One-way
4. Notification

**P2P Mobile Web Services (Types and Interactions)**
Mobile Web Services
(Mobile Synchronous Interaction)

Request – Response Operation
Pros: simple, quick, reliable, widely applied ...
Cons: change management (undo, cancel...), long running tasks, no human involvement, blocked client ...

MOBILE TERMINAL 1 (MT 1)
MOBILE SYNCHRONOUS WEB SERVICES
M1-1
M1-2
... M1-n

Mobile Application (M1)
MobWS Proxy
REQUEST
MOBILE SYNCHRONOUS WEB SERVICES
MOBILE TERMINAL 2 (MT 2)
MOBILE SYNCHRONOUS WEB SERVICES
M2-1
M2-2
... M2-n

Mobile Application (M2)
MobWS Proxy
RESPONSE
REQUEST

INTERNET/NETWORK
BLOCKED
REQUEST
BLOCKED
RESPONSE

IMMEDIATE SERVICE INVOCATION
SERVICES ARE INSTANTANEOUS (SHORT-LIVED)

Request-response are transmitted over the same network infrastructure (e.g. UMTS, GPRS, WLAN ...)

Requester remains in a blocked state

Pros:
- simple
- quick
- reliable
- widely applied ...

Cons:
- change management (undo, cancel...)
- long running tasks
- no human involvement
- blocked client ...

Immediate service invocation
Services are instantaneous (short-lived)
Mobile Web Services
(Mobile Asynchronous Interaction)

Request – Response **AND** Solicit – Response Operation

Pros: two-way control, long processes, unblocked client, back-end operations, human involvement, change management, reliable ...
Cons: complex, blocked until ACKed, correlation, larger payloads ...

Supports One-way **AND** Notification Operation!

UNRELIABLE!
(no ACKs, no blocking)

Services are not instantaneous (long-lived)

Temporal service invocation possible

Support for multiple network infrastructures for service invocation and response (e.g. request: UMTS, response: WLAN)
Service-Oriented WSN Environments (1/2)

(A Collector Node Scenario)

Collector Node (A) ←
Collector Node (B) →

Asynchronous Services
(Long-Lived)

S1 S2 S3 S4

A1 A2 A3 A4

Synchronous Services
(Short-Lived)

Asynchronous Information Management (Asynchronous MWS Monitoring)

Service Discovery

Information Management (Asynchronous MWS Control)

Service Collaboration

Data Representation

Network Server

Thresholds

Events / Analyze

Service Creation

Information Sharing (Asynchronous MWS Monitoring)

Service Creation

Service Computing

Fahad Aijaz, ComNets, RWTH Aachen University
Service-Oriented WSN Environments (2/2)  
(Health Care Scenario and Requirements - MEDICARE)

Sun Small Programmable Object Technology (SunSPOT)

Specifications:
- 180 MHz 32 bit ARM920T core
- 512K RAM/4M Flash
- 2.4 GHz radio with integrated antenna
- 3.7V rechargeable 720 mAh lithium-ion battery
- IEEE 802.15.4 based radio communication
- Public Key Cryptography (Elliptical Curve Cryptography (ECC))

Sensor Board:
- 2G/6G 3-axis accelerometer
- Temperature sensor
- Light sensor
- 8 tri-color LEDs
- 2 momentary switches

Extendable with general purpose I/O and high current output pins!

Operating Modes:
- Run mode: 70ma to 120ma (10.28 to 6 hrs)
- Idle Mode (Shallow sleep): 44ma (16.36 hrs)
- Deep Sleep: 32uA (22500 hrs/ 937.5 days/2.6 years)
Service-Oriented WSN Environments (2/2)
(MEDICARE - A Health Care Prototype Screenshots)
Power Consumption of Sun SPOT Nodes

Switched off LEDs $\rightarrow$ 20 % optimized battery consumption

Further optimization is possible! (modes, payload, threads...)

Next Generation of Sun SPOTs might turn out to be SOLAR POWERED!

Source:
“Experiments with a Solar-powered Sun SPOT”
Mobile Web Services Research at ComNets

• P2P Service Level Agreements
  – Negotiations
  – Active and pending agreements
  – Per service agreement templates
  – Service Guarantees
  – REST and SOA compatible

• Service-oriented WSN Integration with IP Multimedia Subsystem (IMS)
  – JCP’s IMS Services API (JSR 281) for Java ME
  – Extended IMS integrated health care prototype
    • Server-side IMS application
    • IMS enabled Java ME application
  – High-valued context-sensitive IMS use case
Thank you for your attention!

Questions are welcome!

Fahad Aijaz
Research Engineer

Tel  +49 (0) 241 80 23923
Fax  +49 (0) 241 80 22242
email fah@comnets.rwth-aachen.de
WWW http://www.comnets.rwth-aachen.de/fah.html