Wireless Connectivity in Healthcare

Rob J Mulder – Philips Medical Systems

- Wireless connectivity market and landscape
- Application specific connectivity issues
- Recipes for the future
US Emerging Wireless Market for Patient Care

Products include: Wireless Patient Monitors, RF Access Points, PC-Cards, PC/PDA Mobile applications, RFID supply chain mgmt & tracking

Drivers:
- Cost cutting
- Error reduction
- Workflow
- Quality of care

CAGRs
- Monitoring  21%
- Clinical Care 18%
- RFID  30%

Wireless connectivity will probably become more ubiquitous & compelling for healthcare than for any other vertical industry

Source: Frost & Sullivan 2004
US Emerging Wireless Market for Patient Care

**US Wireless Market for monitoring revenues in M$**
- Blue: in hospital
- Red: remote

**US RFID in Healthcare Market revenues in M$**
- Blue: equipment mgmt SW
- Red: patient mgmt

**US Wireless Clinical Care Market revenues in M$**
- Blue: clinical handheld SW
- Red: integrated PoC

**US Clinical Care Wireless IT spending per department**
- ED 46%
- ICU 28%
- Wards 17%
- Post Anesthesia Recovery Unit 8%
- OR 1%

Source: Frost & Sullivan 2004
Wireless Connectivity in Healthcare, Philips Medical Systems, April 2005

Healthcare on the wireless frontier

The wireless invasion begins

Wireless solutions help healthcare professionals meet the need of the hour

Hand-holds capture additional patient information for physicians

The pulse of health care is wireless

Tablet PC gains widespread support from healthcare Industry

Wireless mobility: a matter of life and death

Wireless networking: the wave is here to stay

Wireless doing more than saving hospital’s money

In the wireless hospital of the future, patients are pampered guests

The hand-held health care authority

Staying healthy with wireless

A platform of freedom

Wireless doing more than saving hospital’s money

Eliminating the cables from the “Networked Hospital”

Find your resources at the click of a button

Hospitals get healthy dose of RFID

How healthcare connectivity can contribute to reducing mistakes

Putting vital information in physicians’ hands

A star is born

A platform of freedom

Press Room
Wireless network types and Healthcare applications

- **WAN**
  - Typical cell range: 1-30km
  - Technologies: GSM, CDMA, UMTS
  - Applications: voice, tele monitoring, medical information exchange

- **LAN**
  - Typical cell range: 100-300m
  - Technologies: WiFi, DECT
  - Applications: voice, telemetry, medical information exchange

- **PAN**
  - Typical cell range: 10-30m
  - Technologies: Bluetooth, Zigbee, UWB
  - Applications: medical device interconnection, patient/asset tracking

- **BAN**
  - Typical cell range: 10-300cm
  - Technologies: Zigbee, RFID/NFC
  - Applications: vital body signs collection, (patient) identification

A real-world view: fragmented heterogeneity
### Wireless WAN healthcare applications

#### Telemonitoring:

<table>
<thead>
<tr>
<th>Continuous monitoring</th>
<th>Application domains</th>
</tr>
</thead>
</table>
| • ECG, Life Threatening Arrhytmias  
• Activity, Motion  
• Blood pressure  
• Respiration | • Fitness/wellness  
• Post event Cardiac care  
• Chronically ill, e.g.  
  – Congestive Heart failure  
  – Diabetes |

#### WAN Connectivity:
- body sensor & access network interoperability
- protocols (e.g. control, latency)
- GPRS, UMTS, (BT access)

#### Other issues:
- who pays (e.g. co-payment, reimbursement)
- battery life, usability, data analysis
- sensors, clothing
- embryonic market
Wireless WAN healthcare applications

Medical Information exchange
- access patient demographics, allergy data, exams, lab results, etc
- order-entry, charge capture for medical treatments,
- access medical reference data,
- use clinical decision support tools

WAN Connectivity:
- GPRS, UMTS
- WWAN provider push

Other issues:
- hospital-centric, HIS vendor specific
- 50% of US MDs use handheld devices in their practice (*)
- only 7% of them use them to wirelessly enter/retrieve clinical data
- battery life, screen resolution, usability, privacy

(*) Forrester March 2005
Wireless network types and Healthcare applications

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- **voice**
- **tele monitoring**
- **medical information exchange**

- **voice**
- **telemetry**
- **medical information exchange**

- **patient/asset tracking**

- **vital body signs collection**

- **(patient) identification**

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A real-world view: fragmented heterogeneity
Wireless LAN healthcare applications

Telemetry - Vital signs Monitoring

Ambulatory monitoring

Patient worn device

Wireless telemetry infrastructure

Networked transport

Portable monitor

Central information centre
## Telemetry - Vital Signs Monitoring

### Mission Critical Communication

<table>
<thead>
<tr>
<th>Application requirements</th>
<th>Data Bandwidth (kb/s)</th>
<th>Power Consumption (mW)</th>
<th>Data Latency (mS)</th>
<th>Interference Susceptibility</th>
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Hospitals want a single multi-purpose WLAN network. Does 802.11 qualify for mission critical jobs?
# Telemetry - Vital signs monitoring

## Mission Critical Communication

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*Wireless Connectivity in Healthcare, Philips Medical Systems, April 2005*
# Telemetry - Vital signs monitoring

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"...a dedicated patient monitoring network for is still the only solution to meeting all requirements."
Vital Signs Monitoring and 802.11?

**Mission Critical applications require “above standard” performance:**

- Enhanced security
- Shared deployment (VoIP, QoS)
- Hand-off and Roaming
- Spectrum and Power Management

**Enhanced Security - 802.11i**
- encryption, privacy
- authentication, key management

**Radio Resource Mgmt - 802.11k**
- fast hand-off & roaming
- measurements for interference mgmt

**Quality of Service – 802.11e**
- traffic prioritization
- parameterized streaming

**Spectrum & Power Mgmt - 802.11h**
- interference management & avoidance

802.11 standards continue to evolve, medical applications will ultimately benefit. Philips makes active contributions to that process.
Wireless LAN healthcare applications

Medical information exchange
- access patient demographics, allergy data,
- exams, test results
- order-entry, charge capture, medical reference data, reporting
- use clinical decision support tools

LAN Connectivity
- WLAN (802.11) well established
- shared WLAN deployment, QoS
- integration with voice

Other issues:
- hospital centric, HIS vendor-specific
- incidental deployment
- portability ("carry or trolley"), form factor, ruggedness,
- battery life, usability, privacy
### Wireless network types and Healthcare applications

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**A real-world view: fragmented heterogeneity**
Wireless PAN healthcare applications

Medical device interconnection
• integrating Ventilators, Infusion pumps, etc in Clinical Information Systems
  – capture device/patient status, alarming
  – device programming
• imaging equipment control devices (consoles, etc)
• imaging devices/accessories
  – MRI coils, US transducers,
  – portable X-ray detectors

PAN Connectivity:
• many different RF solutions: WiFi, BT, UWB, proprietary
• frequently point-to-point, up to 500 kbit/s for images
• hostile environments, fail-safe requirements

Other issues
• contactless power transfer
Wireless PAN healthcare applications

Asset/people tracking

• increasingly using Active ("RFID") tags
• (mobile) equipment management.

ROI: equipment ownership cost
  – equipment status (in use, in repair, available, etc)
  – equipment location
• patient/staff management.

ROI: quality of care, workflow
  – patient/staff state
  – patient/staff location/movement

PAN Connectivity:

• many different RF solutions: WiFi, BT, UWB, proprietary
• mesh networks based concepts avoid backhaul network
• WiFi based systems can usually track (active) WiFi devices (no need for tags)
• triangulation using RSSI or ToA/ToF (improved accuracy)

Other issues

• lot of interest to integrate positioning other wireless healthcare applications
• site survey and system installation
• business & vendor maturity
Wireless network types and Healthcare applications

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A real-world view: heterogeneity
Ambulatory Monitoring

Wireless Connectivity in Healthcare, Philips Medical Systems, April 2005

Wireless BAN
Healthcare Scenarios
Vital Body Signs collection

At Patient’s Bedside

Handheld SpO2 meter

Bedside Monitor

Patient lying in bed

ECG

Patient Transport

ICU1

CT

ICU2

OR1

OR2

RR
Wireless BAN healthcare applications

Vital body signs collection and analysis

- ad-hoc peer-to-peer networks of smart nodes on and around the body
- multi-parameter monitoring in hospitals (and @home)
- cableless spot checking

Typical BAN connectivity requirements:

- < 32kbps/patient
- < 10 sensors/patient
- < 10 patients in range of each other
- 5m range (on or in body vicinity),
- mitigate body attenuation
- continuous streaming, predictable real-time performance
- fast network discovery/association, hot plug & play, fault recovery
- many proprietary solutions, but 802.15.4 good candidate

Other issues:

- security/privacy
- decision support
- open interfaces, MEMS-able
- energy efficient sensor design (sensor, processor, radio)
<table>
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<tr>
<th>Application</th>
<th>Power consumption [mW]</th>
<th>Battery life (2 AA batteries)</th>
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<tr>
<td></td>
<td>802.15.4 radio</td>
<td>μC</td>
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<tr>
<td>Temperature</td>
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<td>0.04</td>
</tr>
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<tr>
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<td>4</td>
<td>0.8</td>
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<tr>
<td>(continuously;</td>
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Wireless BAN healthcare applications

Identification (passive RFID)
- cheap (few cents) unpowered tag silicon
- identification, wristbands, access control
- surgical instruments tracking
- blood sample tracking, blood transfusion management
- medication management
- supply chain management, inventory management

BAN Connectivity:
- RFID fully standardized
- range typically <10cm, need for readers
- NFC for near field intra device transfer (<1 Mb/s)

Other issues:
- increasingly combined/integrated with other wireless healthcare applications
- competing against BAR-code based solutions
- immature market
Wireless network types and Healthcare applications

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A real-world view: fragmented heterogeneity
Wireless network types and Healthcare applications

- **WAN**: tele monitoring, medical information exchange
- **LAN**: medical device interconnection, telemetry, medical information exchange
- **PAN**: patient tracking, asset tracking
- **BAN**: vital body signs collection, patient identification, monitored patient transport

A real-world view: need for seamless interoperability
Concluding observations

Wireless enabled applications are and will not be served by a single “one size fits all” technology.

Many of today’s wireless application are standalone and not interoperable with other applications.

Hospitals prefer shared, multi-purpose networks.

The industry’s drive to migrate to a catalogue of specific (eg. range, bandwidth) but interoperable set of solutions will ultimately yield a much more integrated Wireless Healthcare application landscape and boost wireless connectivity deployment.

The future is for commodity technology with medical grade capabilities:

- predictable (real-time) performance
- dependable, reliable, fault tolerant
- fast network discovery/association, hot plug & play, auto recovery
- energy efficient (incl light weight protocols)
- support security & privacy requirements
- shared spectrum coexistence
Thank you,
are there any Questions?