

Pervasive Computing and Open Source Software Development in Healthcare

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Pervasive computing

- MIT's Oxygen system
- University of Aarhus pervasive computing center
- **Coordination of devices and information**
- Citizen/patient/clinician can be surrounded by the information system
- Will probably mature earlier in Europe than in the US

Requirements for architecture

- Mobile devices
- Composite devices
- Heterogeneous devices
- Discovery of resources
- Location and context awareness
- Error and fallout recovery
- Security and authentication

- Increased transmission
 - Ultrawideband wireless technology; enhanced optical fiber networks
- Increased capacity
 - 3 D microchips; “raw” chips; hybrid technology multi threaded (HTMT) computers; Internet scale operating systems (ISOS); holographic data storage; atomic resolution storage; spintronics
- **Enhanced biomedical information data bases**
 - Genomic databases linked to clinical databases (Decode); creation of proteomic (“post – genomic”) data bases; establishment of a semantic Web
- User-centered designs
 - Enhancement of speech based interfaces; location and context awareness middleware

“A lack of data communication standards between a home healthcare information system and the physician’s information system did not convey the warning of a sudden change in a diabetic patient’s serum glucose level, resulting in an emergency admission to an intensive care unit.

This admission resulted in life-threatening morbidity and tens of thousands of dollars of healthcare cost that could have been avoided.”

*Report on Uniform Data Standards for Patient Medical Record Information,
National Committee on Vital and Health Statistics (NCVHS)
July 6, 2000*

Importance of infrastructure

- “It is important to note that the provision of infrastructure services is an enabling mechanism. The infrastructure itself will deliver some benefits, but the main outcomes will be achieved by the provision of additional applications and services. As with any infrastructure, information technology infrastructure does not provide direct business performance. Rather it enables other systems that do yield business benefits.”

Some SOA principles

- Reuse, granularity, modularity, componentization, and **interoperability**
- **Compliance to standards** (both common and industry-specific)
- **Services identification and categorization, provisioning and delivery, and monitoring and tracking**
- **Encapsulation** – Programming elements are enclosed inside larger, more abstract entities
- **Loose coupling** - Services maintain a relationship that minimizes dependencies and only requires that they maintain an awareness of each other
- **Service contract** - Services adhere to a communications agreement, as defined collectively by one or more service description documents
- **Abstraction** - Beyond what is described in the service contract, services hide logic from the outside world
- **Reusability** - Logic is divided into services with the intention of promoting reuse
- **Composability** - Collections of services can be coordinated and assembled to form composite services
- **Autonomy** – Services have control over the logic they encapsulate
- **Statelessness** – Services minimize retaining information specific to an activity
- **Discoverability** – Services are designed to be outwardly descriptive so that they can be found and assessed via available discovery mechanisms

The advantage of open source

- The development process has unprecedented flexibility
 - Ability to rapidly react to technology and business changes
 - Adaptable to various environments
- Promotes the reuse of components and collaborative development
- Facilitates the rapid spread of innovation
- Enables business models that are innovative, stable and sustainable
- Transparency facilitates peer review and better quality assurance
- Low cost of ownership

Open source components

- Application Server
 - JBOSS
- Database
 - PostgreSQL
- Object-Relational Mapping
 - Hibernate
- LDAP Server
 - OpenLDAP
- Full Text Search
 - Lucene
- Business Process Engine
 - jBPM
- Base Language
 - Java J2SE V5
- Rules Engine
 - Drools

Open source infrastructure can:

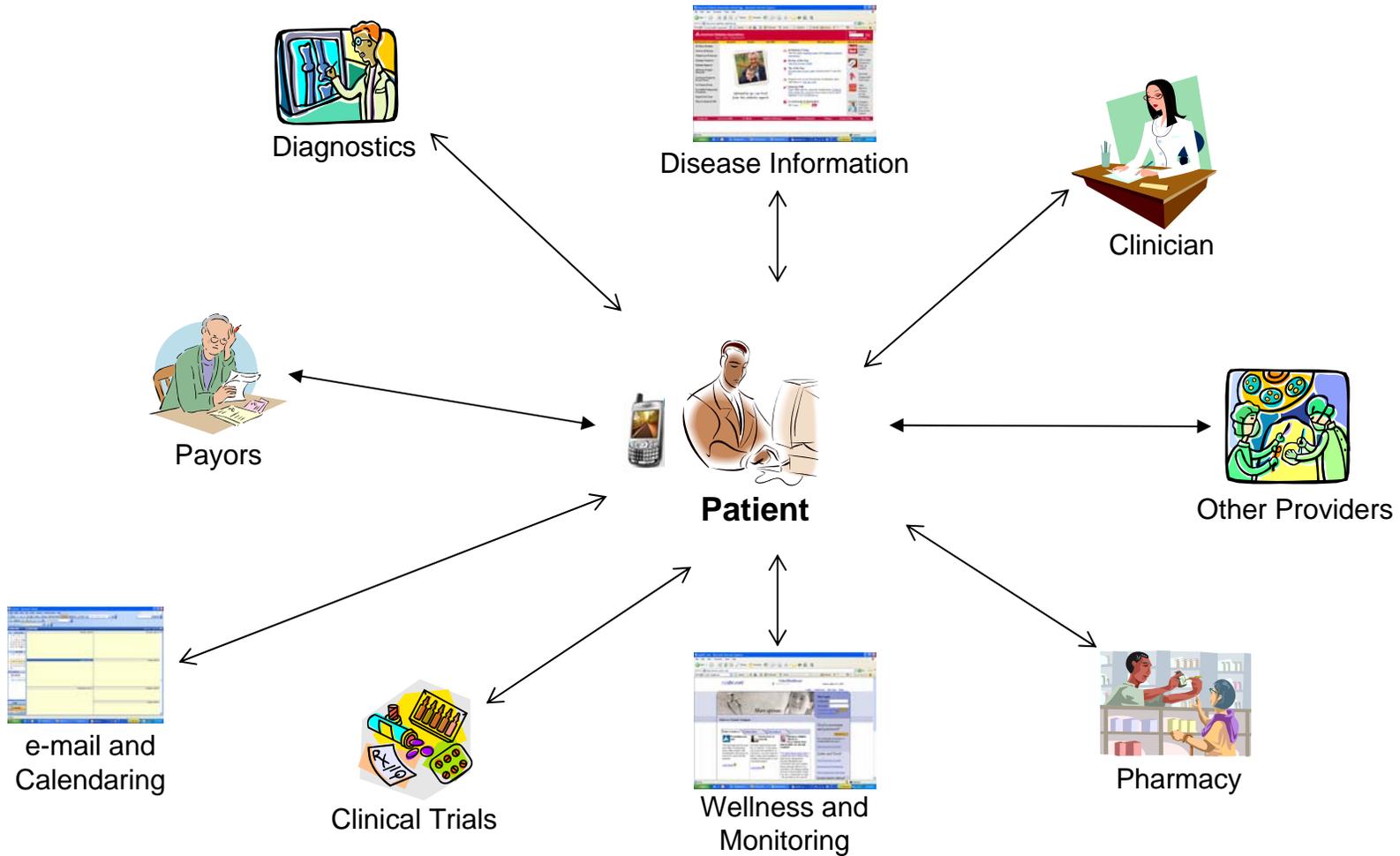


- Improve Care Delivery by enabling
 - Comprehensive patient information at the point of care
 - Online access to clinical data
 - Real-time decision support
- Be Location and Device Independent
 - Secure internet access for providers and patients
 - Accessible via static devices and mobile technology (Smartphones, etc.)
- Support Public Health Initiatives, Biosurveillance and Research
 - Identification of emerging diseases and bioterrorism threats
 - Automated reporting
 - Clinical research database

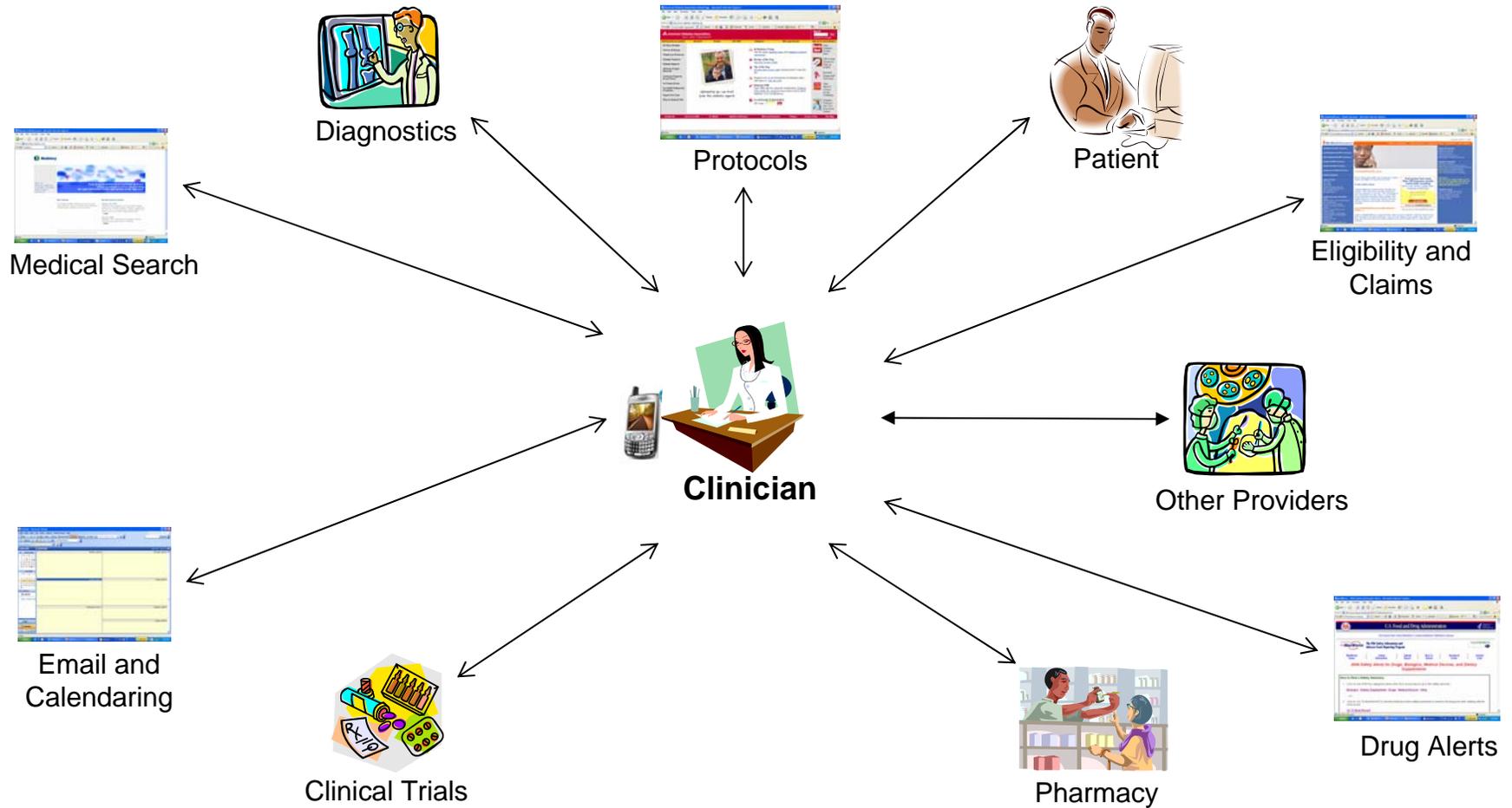
Solution characteristics

- Scalable Solution
 - Suitable for deployment in small or large enterprises
 - Extensible platform
 - Designed to interoperate with other healthcare solutions
- Support for Healthcare Industry and Technical Standards
 - HL7 standards
 - Reference Information Model (HL7 RIM)
 - Clinical Document Architecture (HL7 CDA)
 - Continuity of Care Record (CCR)
 - Unified Medical Language System (UMLS)
 - Java 5, Ajax and Business Process Execution Language, etc.

Patient collaboration



Clinician collaboration



Thanks!

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