

# Virtual Remote Nursing System

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## VRN Healthcare Today

**Opportunities**

- Telemedicine
- Clinical Decision Support Systems
- Smart home-based healthcare system
- Wireless and wearable medical sensors
- ...

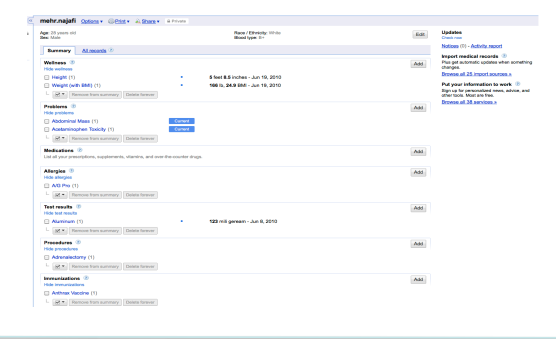
**Challenges**

- Limited resources in healthcare (e.g., nurses, physicians)
- Healthcare provisioning anywhere & anytime
- Healthcare practitioners as decision makers
- ...


## VRN Motivation Online PHR Systems

- Online platforms that record the health information of clients such as health condition, medications, allergies and lab results.
- Big players: **Google Health & Microsoft HealthVault**
- Direct access to Personal Health Services such as:
  - Import medical records
  - Explore medications and treatments
  - Convert paper records
  - Find personalized tools
  - Copy and share records

## VRN Motivation Google Health




## VRN Motivation Personal Health Services




**Blueprint for Wellness**  
Blueprint for Wellness from Quest Diagnostics provides an assessment of your personal health based on laboratory tests that you can directly order. No registration is required but fees apply.

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
**Cleveland Clinic MyConsult**  
MyConsult is an online medical service that connects anyone, anywhere, to Cleveland Clinic physicians. Top specialists provide medical second opinions, and pre-approval and nutrition consultations.

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
**Community Nursing & Rehabilitation Center**  
Community Nursing & Rehabilitation Center is dedicated to helping care of your loved ones when they are no longer able to take care of themselves. We provide speech therapy, wound care, occupational therapy, and in-home dialysis. We also offer a Secured Alzheimer's Unit, Person-Centered Care & Environmental Adaptions Designed For Safety. CHNC is Medicare & Medicaid Certified.

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**DestinationRx**  
DestinationRx is a free online tool that gives you lower cost, alternative medication options, local and online U.S. pharmacy, price comparison and more to help you make smarter prescription decisions. Free registration is required to import your data from Google Health, but you may search safe drug alternatives, compare drug prices, and compare Medicare Plan costs without registering.

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**Drug Comparison Tool**  
AnVITA Health Personal Decision Making Tool uses information in your Google Health profile to enable a personalized comparison of medications, including safety screening and average retail price. This service is free and requires registration.

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**ePillBox.info**  
ePillBox.info by Solventica is a free web application that uses information from your Google Health profile to create a medication schedule based on your prescriptions and your preferences.

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## VRN Motivation Mobile Devices


**Health Information**

- Collect patient's health data such as blood pressure, blood sugar, etc.
- Upload the collected data into websites or an online PHR system.
- E.g., Microlife's BP monitors




**Contextual Information:**

- Collect client's context such as location, temperature, timing, etc.
- Store the collected data into their internal memory.
- E.g., iPhone Apps



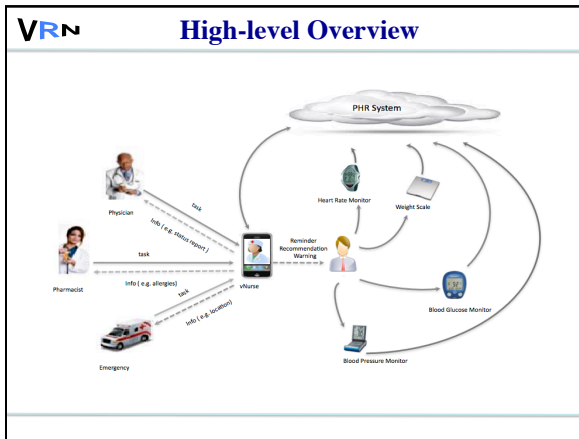
### VRN Motivation Fitbit

- Fitbit tracks the calories burned, steps taken, distance traveled and sleep quality.
- Fitbit records the person's motion in three dimensions and converts it into information about daily activities.
- Fitbit transfers the recorded data to Fitbit.com.
- Fitbit can upload the collected data into the client's Google Health account.



### VRN Virtual Remote Nursing System Objectives

- Provides a virtual nurse (vNurse) agent that is installed on client's personal computer or smart phone and performs different tasks assigned by healthcare practitioners.
- Task is defined as a function on client's health and contextual information to generate health-relevant information for both clients and healthcare practitioners (e.g., health reports, warnings).
- Healthcare practitioners are the decision makers. No decisions are made by the vNurse.
- Generic task definition mechanism for health care practitioners. Any healthcare practitioner with a basic level of computer knowledge can define tasks for the vNurse.



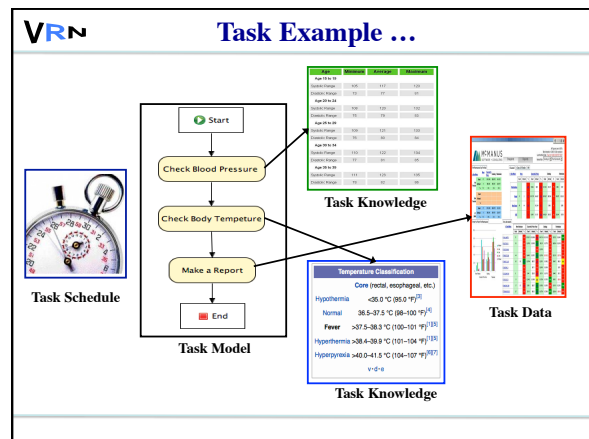
### VRN Generic Task Definition

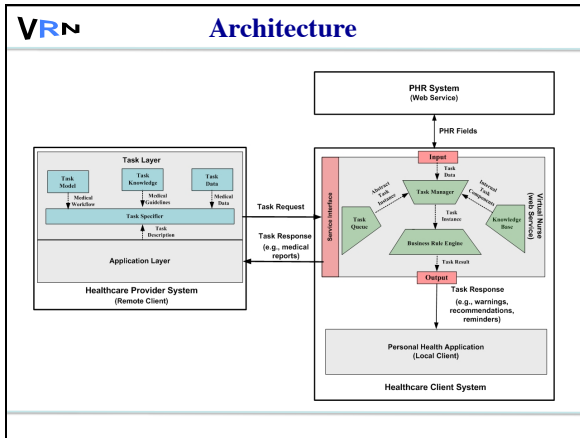
- We define "Task" formally as:
 
$$\text{Task} = \langle \text{Task Schedule, Task Model, Task Knowledge, Task Data} \rangle$$
- Task Model** : what to do (*Business Process Model*)
- Task Knowledge** : how to do it (*Business Rules & Actions*)
- Task Data** : resources (*Business Data*)

- In VRN:
  - Task Model** → **Medical Workflow**
  - Task Knowledge** → **Medical Guidelines**
  - Task Data** → **PHR & Context**

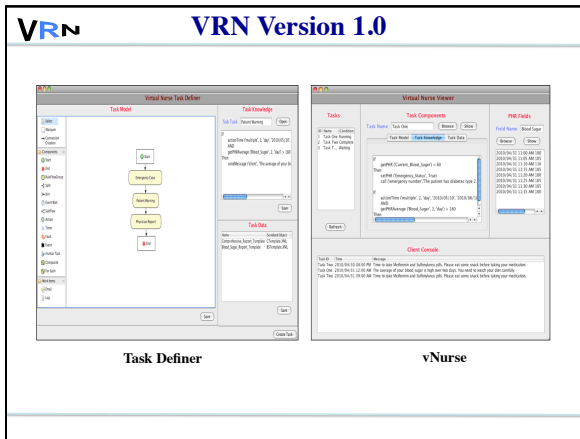
### VRN Task Example

- A physician assigns to vNurse a task to report the general health status of a client every week (**task schedule**).
- To perform this task, the client's vNurse follows a medical workflow consisting of three steps: first, checking the patient's blood pressure; second, checking the patient's body temperature; and finally make a report (**task model**).
- Each step corresponds to a set of medical guidelines that define the patient's status for each range of blood pressure or body temperature, which can be low, normal, or high (**task knowledge**).
- Finally, the information obtained is reported in a specific medical format (**task data**).





- ### VRN Version 1.0
- Developed in Java (J2EE 1.5) for PC
  - Google Health as the on-line PHR system
  - vNurse has a built-in Drool business rule engine (v5.0) to run business processes (apply business rules and execute business actions)
    - Medical workflow: Rule Flow (converted in XML)
    - Medical guidelines: Business Rules and Business Actions (converted in PMML)
    - Task Data: Java Beans (serialized in SOAP messages)
  - Provided by two Java packages:
    - Task Definer: provides graphical APIs and widgets for a medical practitioner to define tasks and send them to a virtual nurse.
    - vNurse: provides APIs to install the virtual nurse and connect it with local and remote clients.
  - VRN App for mobile devices is under construction

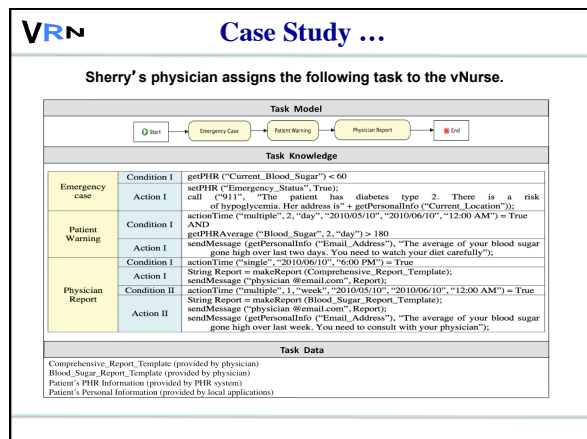


### VRN Version 1.0

Virtual Nurse basic functions stored in the internal knowledge base.

Name	Parameters	Description
getPHR()	PHR Field	Retrieves the value of the PHR field from the PHR system.
getAveragePHR()	PHR Field	Assigns the value to the PHR field in the PHR system.
setPHR()	PHR Field	Takes average of the PHR field over the defined period.
changePHR()	PHR Field	Returns true if the PHR field just changed more than its corresponding threshold.
getPersonalInfo()	Field	Returns the requested information about the client.
call()	Phone Number Message	Makes a call to the defined phone number and tells the message. It uses a text2Speech function to convert the message into a voice message.
sendMessage()	Email Address Message	Emails the message to the defined email address.
actionTime()	Frequency Period Start Date End Date Time	Returns true if the current time matches with the execution time of the action. For example, actionTime ("multiple", 2, "day", Start Date, End Date, Time) says the execution time for the next action is every two days from Start Date to End Date and at the Time.
makeReport()	Report Template	Makes a report based on the received template that specifies the required PHR information in a proper format.

- ### VRN Case Study Scenario
- Sherry is an elderly woman with type 2 diabetes. She has a vNurse installed on her smart phone and a blood glucose sensor.
  - Her physician wants to ensure that Sherry stays on her diet until her next regular monthly appointment and how well the prescribed medications work during this period. Since, Sherry is at the risk of hypoglycemia (i.e., low blood sugar level) that could result in losing consciousness. Consequently, the doctor wants to make sure she receives emergency medical services promptly in the case of extreme hypoglycemia.
  - The pharmacist wants to make sure Sherry does not forget the right dosage, time, and frequency of her medication that are prescribed by her doctor. Moreover, since the prescribed medications could cause side effects, he wants to have Sherry's doctor informed if the medications cause any complications.
  - In a case of an emergency situation, the emergency center needs to access the latest information about Sherry's health condition.



### VRN Case Study ...

Sherry's pharmacist assigns the following task to the vNurse.

**Task Model**

```

    graph LR
      Start((Start)) --> TakeMedicine[Take Medicine Reminder]
      TakeMedicine --> SideEffect[Side Effect Report]
      SideEffect --> End((End))
    
```

Task Knowledge		
Take Medicine Reminder	Condition I	actionTime ("multiple", 1, "day", "2010/05/10", "2010/06/10", "9:00 AM") = True OR actionTime ("multiple", 1, "day", "2010/05/10", "2010/06/10", "8:00 PM") = True
	Action I	sendMessage (getPersonalInfo ("Email_Address"), "Time to take Metformin (500 mg) and Sulfonylurea (5 mg) pills. Please eat some snack before taking your medication");
Side Effect Report	Condition I	containPHR (Current_Status, "Diarrhea") = True
	Action I	sendMessage (getPersonalInfo ("Physician_Email_Address"), "Your patient" + getPersonalInfo ("Name") + "has Diarrhea after taking Metformin");

**Task Data**

Patient's PHR Information (provided by PHR system)  
Patient's Personal Information (provided by local applications)

### VRN Case Study ...

Emergency center assigns the following task to the vNurse.

**Task Model**

```

    graph LR
      Start((Start)) --> InformEmergency[Inform Emergency Contact]
      InformEmergency --> PatientStatus[Patient Status Report]
      PatientStatus --> ChangeStatus[Change Status Report]
      ChangeStatus --> End((End))
    
```

Task Knowledge		
Inform Emergency Contact	Condition I	getPHR ("Emergency_Status") = True
	Action I	call (getPersonalInfo ("Emergency_Contact"), getPersonalInfo ("Name") + "is in emergency status. She is at" + getPersonalInfo ("Current_Location"));
Patient Status Report	Condition I	getPHR ("Emergency_Status") = True
	Action I	String Report = "Patient Blood Pressure" + getPHR ("Current_Blood_Pressure") + "Patient Body Temperature =" + getPHR ("Current_Body_Temperature") + "Patient Blood Sugar =" + getPHR ("Current_Blood_Sugar") + "Patient Allergies =" + getPHR ("Allergies"); sendMessage ("emergency @ email.com", Report);
Status Change Report	Condition I	changePHR ("Blood_Sugar") = True
	Action I	String Report = "Patient's Blood Sugar is changed to" + getPHR ("Current_Blood_Sugar");
	Condition II	changePHR ("Blood_Pressure") = True
Status Change Report	Action II	String Report = "Patient's Blood Pressure is changed to" + getPHR ("Current_Blood_Pressure");
	Condition III	changePHR ("Body_Temperature") = True
	Action III	String Report = "Patient's Body Temperature is changed to" + getPHR ("Current_Body_Temperature");

**Task Data**

### VRN Case Study: Hypertension

### VRN Future Work

**Interactive Virtual Remote Nursing** system where an assigned task can be accomplished through the collaboration of the patient and the virtual nurse.

**Smart Virtual Remote Nurses** system where healthcare providers will also be able to assign some simple decision making tasks to the virtual nurse.

### VRN Next Version – Smart VRN

- Each behavioral pattern is a relationship between patient's PHR and context.  
**PHR Fields \* Context Fields --> PHR Fields**
- Healthcare practitioner assigns a task to the vNurse where task knowledge is partially patient's behavior.
- Example: vNurse learns the situations when the client experiences high BP; then the client's physician assigns a task to the vNurse to remind the client to take BP medication at those situations.

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### VRN Thank You