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FHIR & devices

Wittenber, Jan <jan.wittenber@philips.com> Mon, May 28, 2012 at 8:34 AM
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Todd /Grahame,

Some verbiage @ models—gestalt-like…

Attached is a 'model of models' or framework, which bears much explanation but for this purpose—heuristic/ introductory—will be summarized with a focus on what kinds of FHIR resource types and dynamics might be apt. In this, a main consideration is complementarity among standard-based components, esp. architectural.

An overarching theme is "real-time" (RT); another is entropy, in particular, the distribution of relevant info processing inter-/trans-actions over time—retrospective, introspective, and prospective. From a patient-centric point of view, which is the main point of view, the patient care '[life] cycle' [essentially an ever-increasing set of super-positive [RT] frames] is an important theme, as well as scalability and topological distribution of distributed processing components (à systems of systems [over- and in RT]].

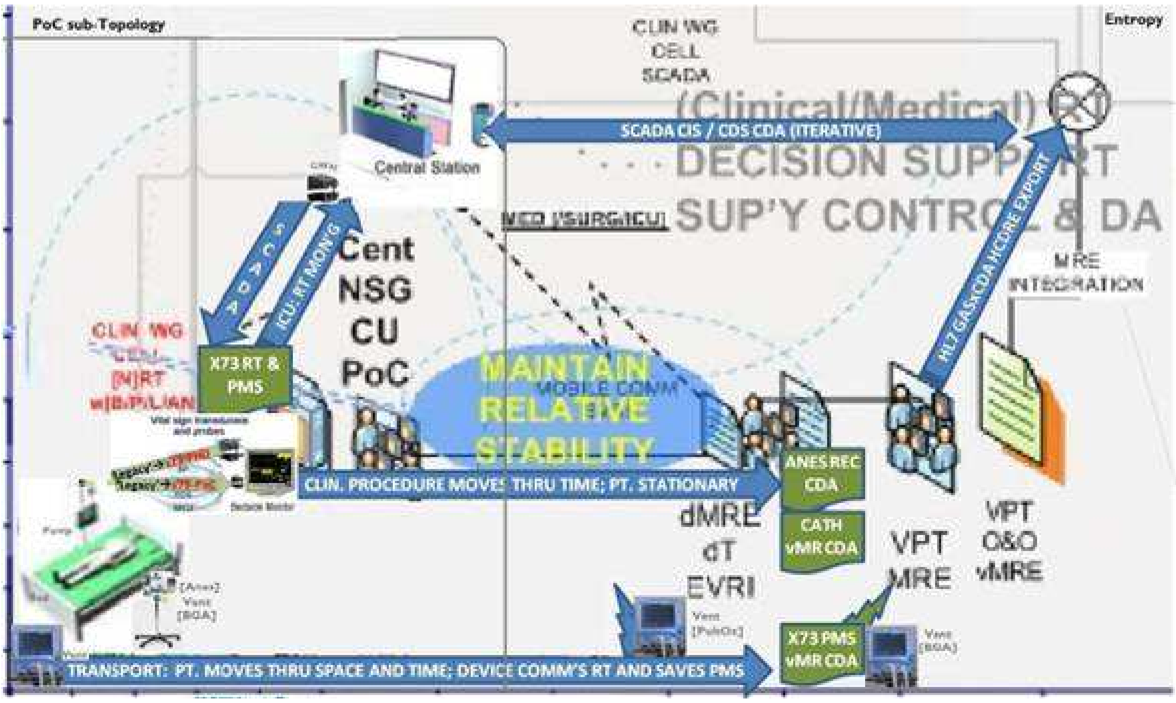
[This paradigm works for both ventilators and an infusors, considered as 'clinical modalities' (i.e. of both treatment and realization in the form of medical devices [some of which or at least key components of which are mathemagical/algorithmic, hence the concept of "virtual" medical device (VMD) as the key medical information generative (and command/control, local and remote) abstraction.]

Since the "meaning" of relevant information in this use context (healthcare delivery) is medical, and since the relatively physiological wellbeing of the patient is the 'mission', recurrences, and thus rates of recurrences, are the "key performance indicators" (KPI) of such a system.

In the in-patient use context, generally the time [and thus care] flows through the framework, with stochastic features incrementally composing the patient's informatical view. In some cases, the patient moves through the topology as well as relevant information over time; and in some cases, the patient is not "in-patient" or "in-bed"-centered topologically (hence, motivating services such as patient and equipment location and "tracking"]. The scope of retrospection is quite extensive (viz. EMRàEHRßPHR), and even the scope of introspective is quite extensive (viz. imagery; CDS/CIS).

As a result of this extensive physical-physio-spatial-temporal scope, modeling uses the "maximum entropy formalism" (MEF) [see http://homepages.inf.ed.ac.uk/lzhang10/maxent.html], the main effect of which is that space-time behavioral features are characterized as time-entropy compositions, such as a continuous or burst amount of entropy occurring, or more appropriately, recurring over time in characteristic patterns (hence, the use of pattern recognition methods].

The following figure is an extract of a larger MEF model characterizing clinical work [data/control) flow in the in-patient and [care] unitized use context, which generally is distributed among patient beds and clinician [esp. nurses'] processing and access points. In general, key physiological data acquisition, analysis, and distribution is continuous [per patient] and highly distributed in [near]RT throughout this domain. As a result, the near retrospective, introspective, and near prospective features of patient medical condition are important to the information 'namespace', although various temporal and topological distributive techniques are used to streamline processing and review from both machine (sensor through server) and human perspectives (clinical, bioclinical, IT) points of view.



See "Vent DAM" on Vent Wiki for more detail.

Not very apparent looking at the diagram is that (A) temporal-topological 'nodes' set up in a way that the representation is [largely] objectifiable (encouraging for QoS, QoM, etc., metrical analysis! :), and (B) most nodes and flows are representative of "probability distribution functions (PDF)", chiefly of patient physiological information and related controls, as part of automatic and supervisory controls by which optimization, both of patient physiological condition and system performance.

Surprise, surprise: Vent and Pump ecosystem models are analogous (and homologous w.r.t. most 'enterprise' functions), è they can [/should] be representable as specializations of a "clinical modality" generalization. W.r.t. RT PoC[U] PDFs, key modalities (Monitors, Vents, Pumps), are basically depicted through superpositive feedback control loops in which expected and observed patterns of behavior are used as a principal basis of clinical analysis.

For example, In the following diagram (see upper right-hand side of diagram), the infusion modality is characterized relationally in terms of an ordered set, or 'vector', of correlated variables, some of which are settings, esp. "Mode", and some of which are "Observations"; although most are NUMerical, some are ENUMerational.

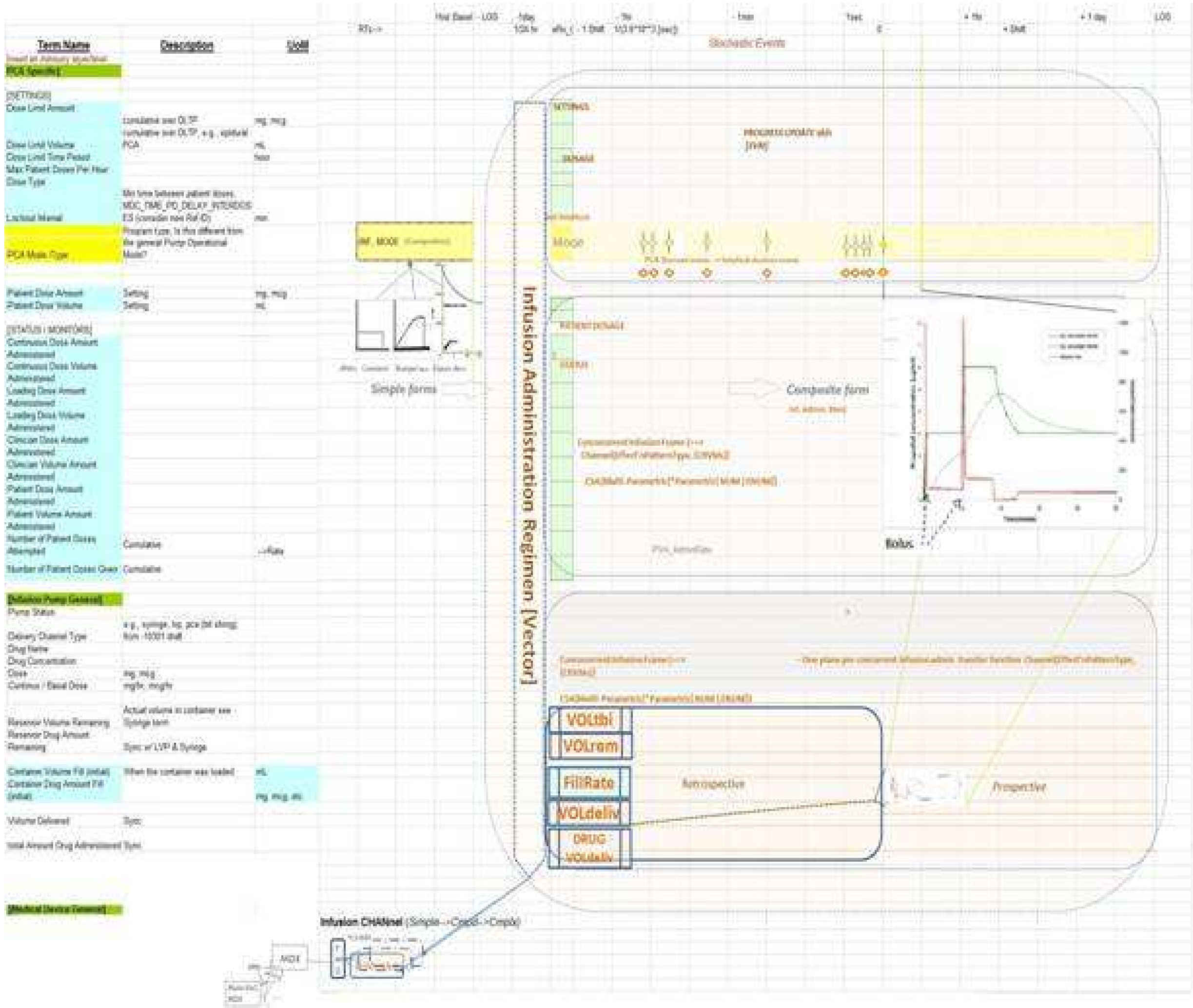
The variables (rows) are ordered in way that “PCA” (Patient Controlled Analgesia”)-related variables are layered on “General” (e.g. Large-Volume Pump, or LVP) variables, such that the related time-series graphs of the variables can be represented in the form of “trends” (or “waves” for fast-moving traces), even “schedules” (i.e.expected *effectuation* behavior if not comparison of expected and observed behaviors of correlated variables. The bordered area in the right-hand side of the diagram basically differentiates time from retrospective and prospective, with 10**0==1 sec as a nominal [exponential] demarcation.

In this perspective, prospective behavior can be characterized by expected value (if at all), retrospective behavior by the observed trend of samples, and introspective behavior by the relationships between variables (for example, in the case of Ventilation, Boyle’s Law [e.g. PV=nRT) and equations of motion are relevant). In the specific case shown, an approx. 30-40 min projection of drug delivery (through a composite mode of bolus and continuous constant, simple sub-modes). In addition, a hypothetical sequence of PCA “demand” (i.e. patient-initiated) occurrences is shown superimposed on the [Pump] Mode variable [/setting].

Ventilators have a similar behavioral morphology, with airflow and pressure being the principal setting and observation variables used for clinical decision making. See Wiki   http://ventnomjwg.wikispaces.com/Overview+and+Framework for several modeling artifacts and related methodologies.

Moreover, ventilation, oxygenation, and perfusion “loops” are correlated in pursuit of physiological/clinical optimization.

Informatical constructs such as “schedules”, “observation reports” and documents, such as “Flowsheet” and “Anesthesia Record” (see several related documents).



On the diagram, note the topology in the lower-left side area; this is intended to represent that the “[RT] Frame” should be considered to be a composite of flow-inducing components; however, context-sensitive information such as how drugs are mixed/diluted (fluid, fluidàgas, etc)., is [always ?] needed to make detailed clinical inferences. Such context-sensitive information is the ‘bain’ of informatics design and implementation, along with topological distribution and loop closure time in the case of semi-closed loop, or ‘man-in the-loop’ applications.

One really annoying aspect of Naming in this space is the significant resistance that some implementers have to normative information models that require context-sensitive and/or persistent stores of such info. Presently, commercially available systems tend to have significant RT scalability qualities, esp. @ wireless (ambulatory, mobile patient or clinician use contexts).

Architectural complementarity of predicated standards and related applications is a significant issue from a standards roadmapping perspective. Given the fairly extensive modeling and contribution of IEEE 11073 and IHE PCD, as well as the [very] general nature of ASTM ICE and the formative natures of HL7 PC DCM4MD [@ Vents], a significant amount of standards ‘space’ have been defined. As discussed at the F2F, complementary areas for FHIR are apparent at this point, so should get primary consideration, e.g.

1. **Reporting** and Documenting SCADA full-disclosure and persistent-store value sets and artifacts, particularly “MRE (Med Rec Elements)”-oriented [è could be ‘green’, such as HL7 GASx73 CDA/XML-based components or [reversibly-processible] modules (see Wiki http://cda-working.wikispaces.com/)];

2. **[Re-]Discovering** and Associating with MedDev InfoBase (MDIBs) and SvcElem (MDSE) *resources [Ha!]*,

consistent with distributed DIRectory methods and UML/XML-based schematics and using wonderful, emerging methodologies [such as FHIR! :];

3. **Tracking** Location (Patient, Device; Clinician) and operational status (Device), consistent with CoTS services, such as RTLS, SNMP, and NMDS (NetMgmtDecisionSupport) [related models cans); while the most intensive need is for in-patient and device tracking, community/wide-area-based tracking are becoming increasingly important [A "natural language"-based RTMS Tracking model has been modeled (see related documents) for this purpose, although it is somewhat-to-significantly broader, interestingly in the very direction of med dev-based and derivative info sets @ *transformative resources* having *stochastic* and *entropic morphological* and *behavioral* properties; among others, such as

4. **Transforming/Analyzing** values sets computationally for clinicological or technological reasons. These typically involve **transacting** and **distributing** related information, which involves **normalizing** semantics, including algorithmic semantics (alas, mathemagically) and methods.

> From a generalization perspective, an architecture based on complementary MDIBs and Proxies in a main/mini-Association operational framework is well-suited and actually, well-designed w.r.t. extensibility and adaptability.

So much for now…

Regards,

/Jan

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