

# Research Challenges for Smart Information Systems

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**SMART 2012**  
**Stuttgart**



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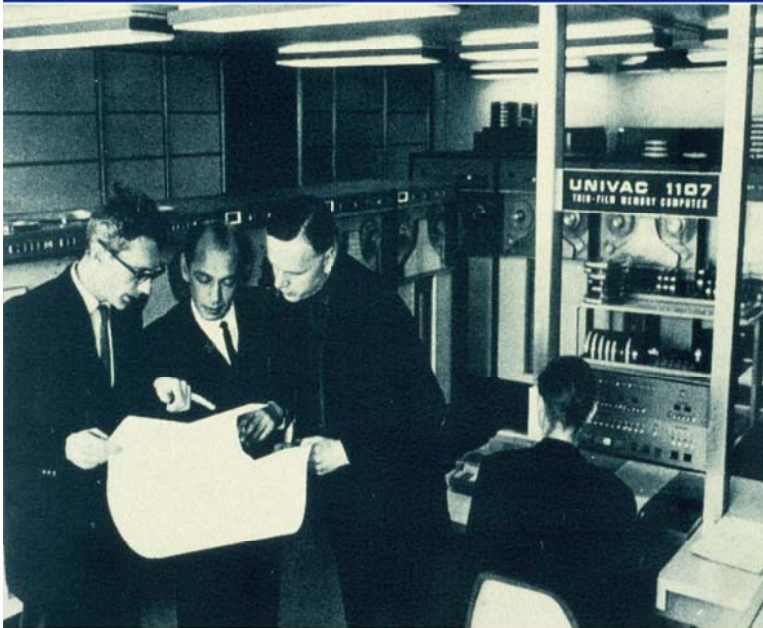
## Facts about NR

- ▶ Applied research
- ▶ Financed by
  - Domestic private companies
  - Public sector
  - The Research Council of Norway
  - EU Research Programmes
  - International companies
- ▶ Established in 1952
- ▶ 60 research scientists
- ▶ Turnover 12 M€



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# Object orientation and SIMULA



The 1965 SIMULA manual  
The first object-oriented report

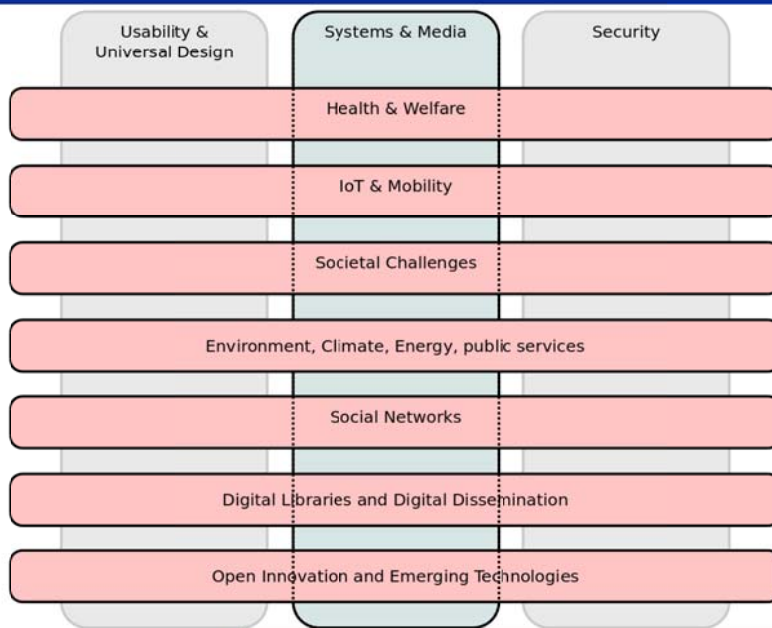


## Main Research Areas

- ▶ Information and communication technology (ICT)
  - Information Security
  - E-Inclusion
  - Quality of Experience / Smart Information Systems
- ▶ Statistical-mathematical analysis and modeling
  - Oil/Gas and natural resources
  - Health Care
  - Financial



# Smart Information Systems



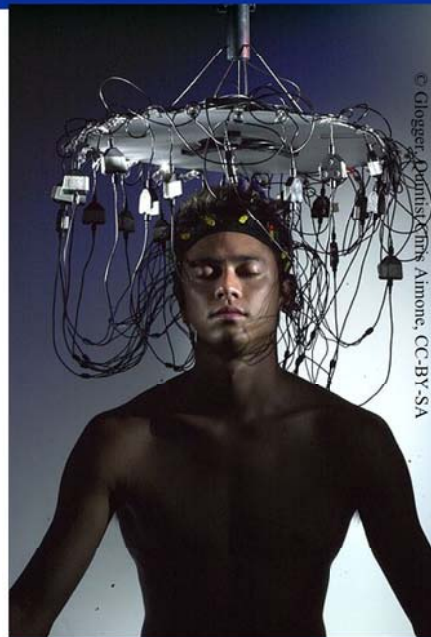
# Smart Information Systems

- ▶ Increase quality with respect to resources or experience.
- ▶ Metrics: time, money, work, energy, transmission capacity, storage capacity, etc.
- ▶ User experience (UX) → satisfied users
- ▶ Autonomous and adaptive



# Smart Information Systems

tele-presence, 3D representations, smart house, smart-health, smart metering, smart grid, smart city, open data, open source, adaptive systems, ubiquitous, sensor network, ...



# User Experience – UX

- ▶ Quality of Experience (QoE)
- ▶ a subjective measure of a customer's experiences with a service or system
- ▶ Without QoE → system will not be used
- ▶ Usability
- ▶ User experience
- ▶ Universal design

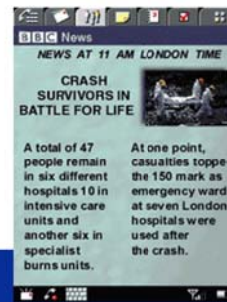




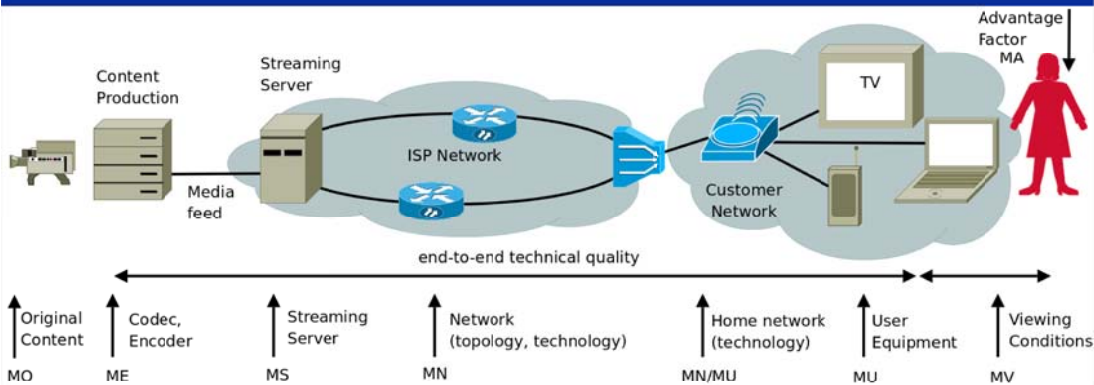
# News application – Interactive Mobile News (2000)



- ▶ Stretchable Streaming for low-bandwidth network (GSM)
- ▶ Multimedia with animated news reader
- ▶ Presented at Telekom 1999 and CeBit 2000 Expositions



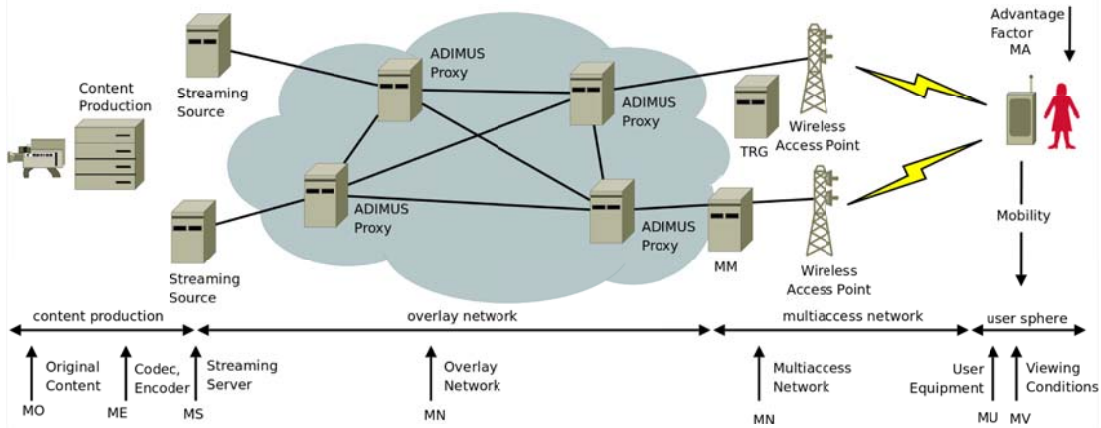
# QoE Estimate for Streaming



Quality estimation:

$$\tilde{Q} = Q_0 \cdot \prod_{i \in \{E, S, N, U, V, A\}} M_i$$

# ADIMUS architecture & QoE



# Virtual Reality + Gaming

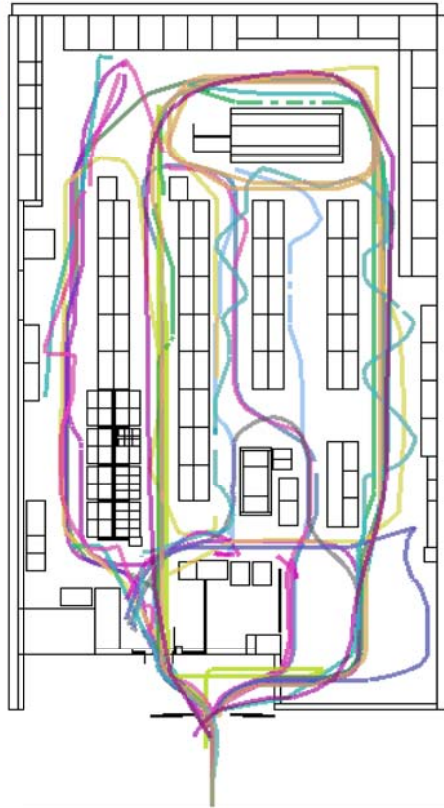
- ▶ Entertainment
- ▶ Architecture
- ▶ Museums
- ▶ Market Research



Example taken from VR project with Kon-Tiki Museum, Oslo

## Path Tracker Tool

- ▶ Hot spots
- ▶ Traversal direction
- ▶ Time spent in different areas
- ▶ Direction of gaze/attention
- ▶ Which items were picked up/examined (even if not purchased)
- ▶ Which product location generated a particular purchase



## Cultural heritage



KINECT  
for XBOX360

**OPEN KINECT**

 **blender™**

 **OGRE**





# ICT-based Exams



# ICT-based Exams

candidates

PC

class room

infrastructure & LMS  
(school, county, Directorate of  
education and training)



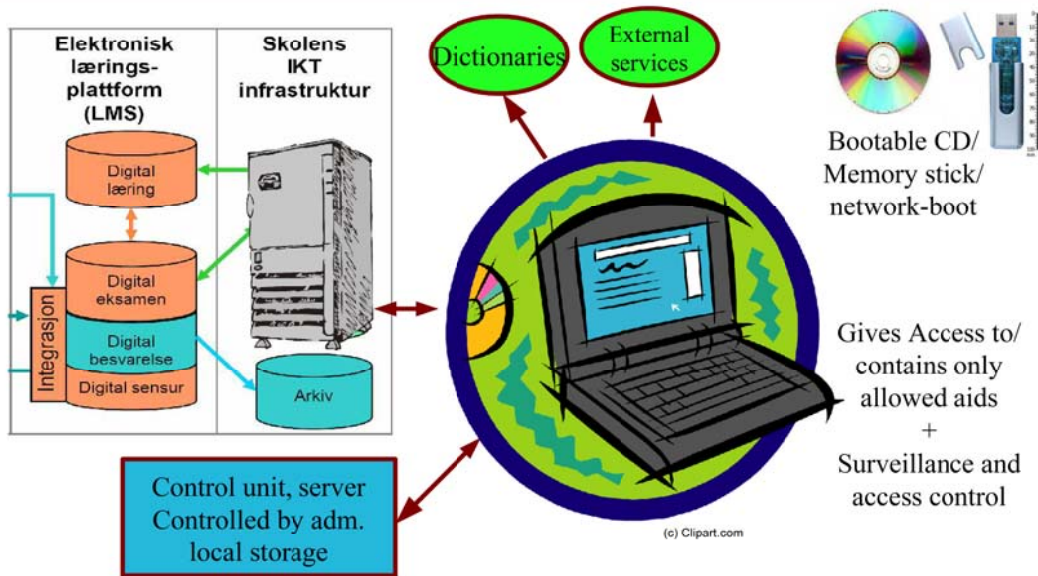
Bluetooth

Ice

3G



# ICT-based Exams



# The Internet of Things

The Internet of Things (IoT) connects a large number of communication and information systems to support and simplify everyday life by means of technology.



## Health Care ...


Das ist dz an  
der instrument / vn  
das dyener mer ob  
en vff dz haubt / das  
fünff darne / oder  
binden. Darumb dz  
es nit breyt gleych  
hat / als dz necht in  
strumit bye vor ver  
zeychnet. Und dyen  
et auch / wann die  
hyenschalunge chla  
gen ist / das man sye  
mit dize instrumēt  
wider vffschaid.



Holzschnitt aus Hans von Gersdorffs "Feldbuch der Wundarznei" (1517) Behandlung einer Schädelwunde. Zugeschriebener Künstler: Hans Wechtlin  
en: Hans von Gersdorff (surgeon) Fieldbook of medicine (1517). Treatment of a skull injury. Wood cut work attributed to Hans Wechtlin.

## MPEG-21 for Biomedical Sensor Networks



- ▶ Nationally Norwegian funded research project
- ▶ Deployment of Patient Monitoring Systems with emphasis on Biomedical Sensor Networks
- ▶ Partners: NR, SINTEF, NTNU, Rikshospitalet  Forskningsrådet

# The IoT in Health Care !

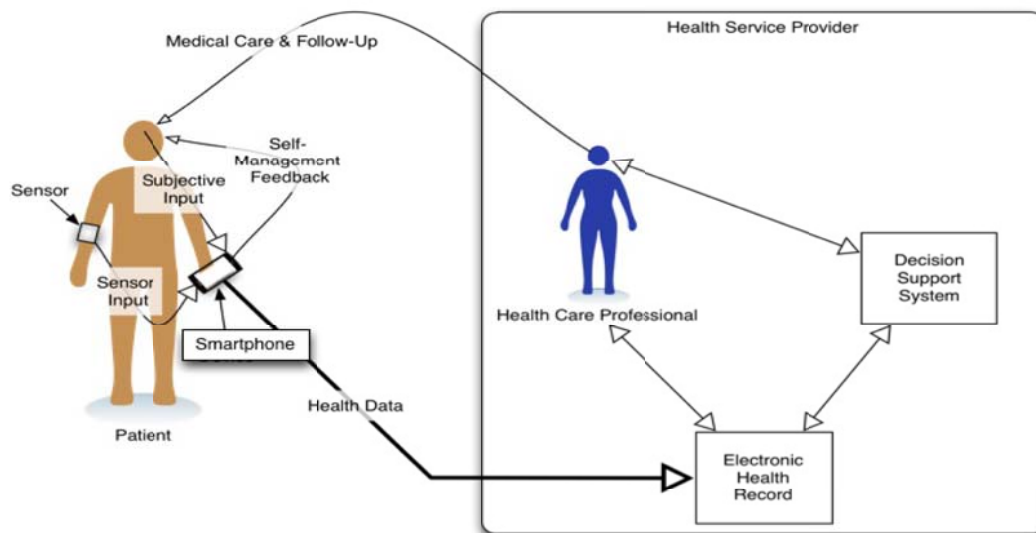


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# Help for Self-Management

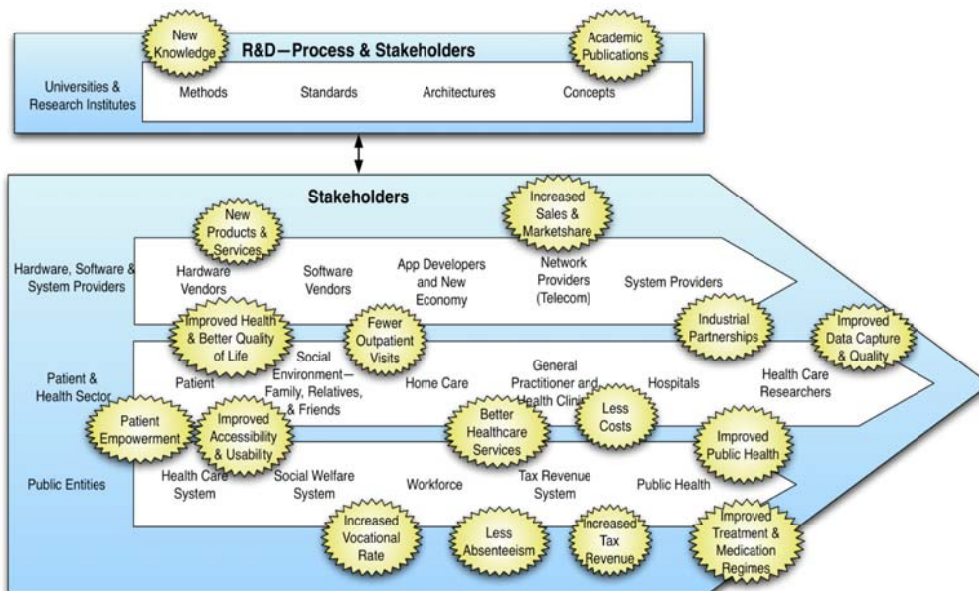


# What is Health Care ?

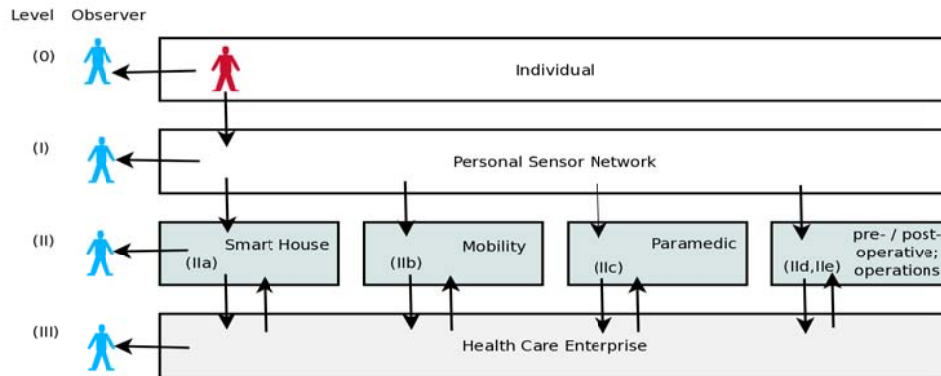
- ▶ Types of health care:
  - Hospitals
  - Primary Care / Doctors
  - Paramedic / Ambulance
  - Care (re-convalescent, elderly – home or institutions)
  - Chronic diseases
  
- ▶ Stakeholders:
  - Patient,
  - Relatives,
  - Nurses, Medical Personnel,
  - Pharmacies,
  - Service Owners,
  - ...



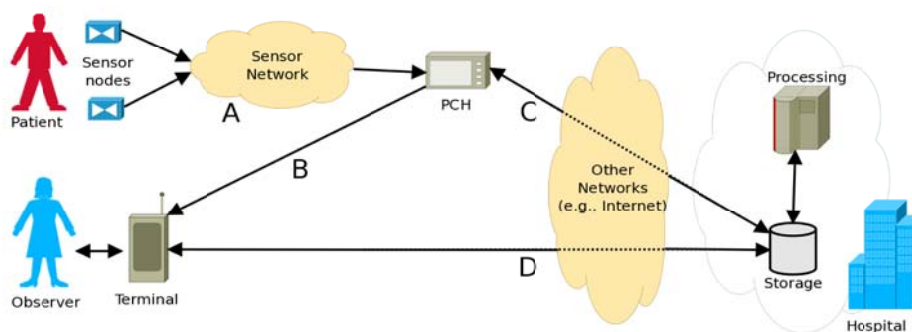
# Value chain: IoT in health care



# Structuring Personal Health



# Patient Monitoring System with Biomedical Sensor Network



# Security Goals

ua = unauthorised actor(s)

pd = patient data

- (1) **Confidentiality:** personally identifiable pd not disclosed to ua.
- (2) **Integrity:** ua cannot modify or insert data.
- (3) **Origin authentication:** identify origin of action (create, write, read, delete) performed on pd.
- (4) **Availability:** access possible at any time for authorised actors
- (5) **Patient identification:** patient to whom data pertains is identifiable
- (6) **Documentation:** constraints (battery lifetime, geographic area, etc) specified; where delivery of pd guaranteed.
- (7) **Patient notification:** kind and purpose.

# Generic threats and consequences

- ▶ Compromised/fake component
- ▶ Destroyed, malfunctioning, lost, stolen component
- ▶ Software errors
- ▶ Misuse of emergency access
- ▶ Denial of service attacks
- ▶ Compromised/fake communication infrastructure
- ▶ Unstable communication infrastructure
- ▶ Eavesdropping
- ▶ Unavailability
- ▶ Incorrect information
- ▶ Sensitive information leaked (Disclosure)
- ▶ Damages (patient, operator, equipment)

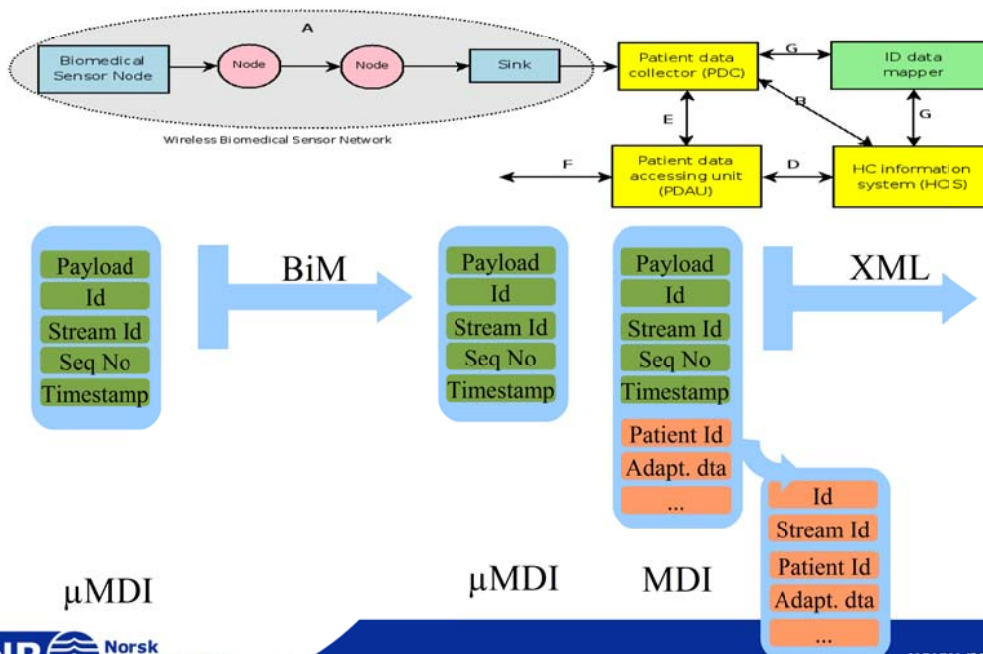


# Why must the IoT be secured?

- ▶ Control traffic attacks
  - Routing attacks
- ▶ Forwarding attacks
  - Spoofed, altered, replayed, selective forwarding, blackhole, sinkhole, sybil, wormhole, ...
- ▶ Countermeasures exist,
- ▶ Adaptive security
- ▶ Which data to which patient? (integrity)
- ▶ Alteration (integrity)
- ▶ Injection of messages
- ▶ Eavesdropping
- ▶ DoS (attacks)



# Securing the Application Layer with MPEG-21

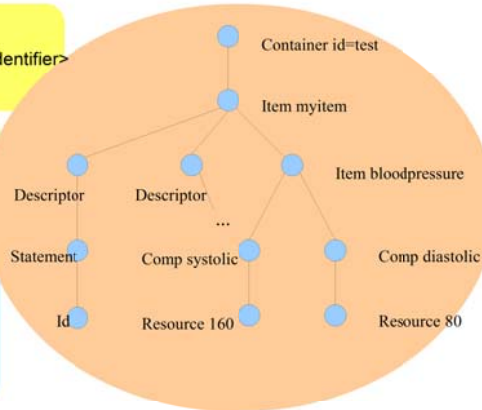




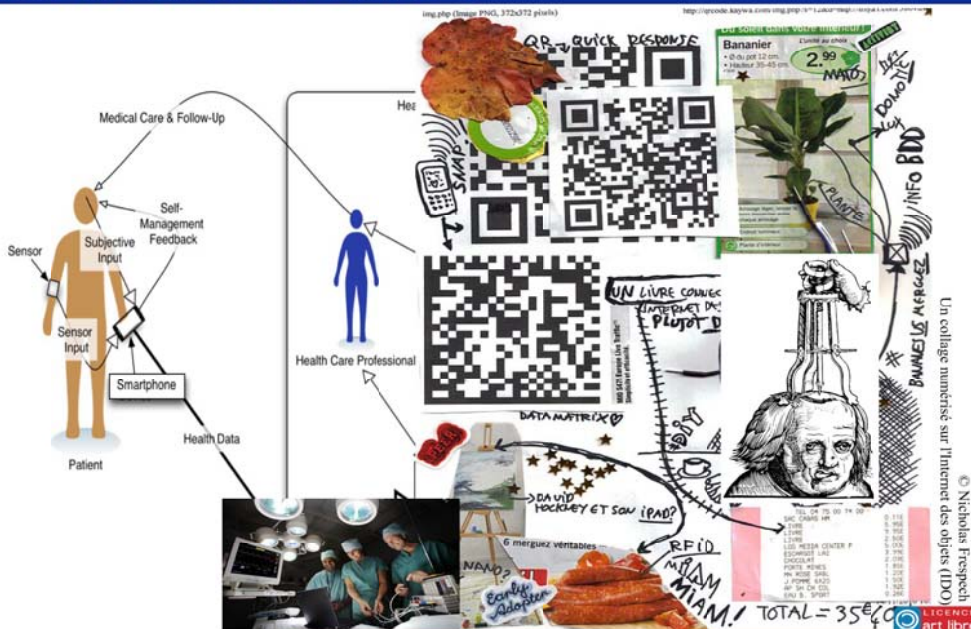
# BiM encoding a $\mu$ MDI

```

<!--DIDL xmlns="urn:mpeg:mpeg21:2002:02-DIDL-NS" xmlns:dii="urn:mpeg:mpeg21:2002:01-DII-NS">
<Container id="test">
  <Item id="myitem">
    <Descriptor>
      <Statement mimeType="text/xml">
        <dii:Identifier urn:grid:a-1-abcde-9873216540-f</dii:Identifier>
      </Statement>
    </Descriptor>
    <Descriptor>
      <Statement mimeType="text/xml">
        <dii:Type urn:sensor:bloodpressure</dii:Type>
      </Statement>
    </Descriptor>
    <Item id="bloodpressure">
      <Component id="systolic">
        <Resource mimeType="text/plain">160</Resource>
      </Component>
      <Component id="diastolic">
        <Resource mimeType="text/plain">80</Resource>
      </Component>
    </Item>
  </Item>
</Container>
</DIDL-->
  
```



# Would you trust this vision of the IoT in health care ?



# Trust

- ▶ Particular level of the subjective probability with which an agent assesses that another agent [...] will perform a particular action ...
- ▶ Distrust – no trust – blind trust =  $[-1,0,1]$
- ▶ Types of Trust:
  - Behavioural Trust – game theory, stakeholders, ...
  - Computational Trust – devices, channels, ...
  - Technical Trust – trust chains, ...



## Smart House, Smart Health, Smart Office, Smart ...

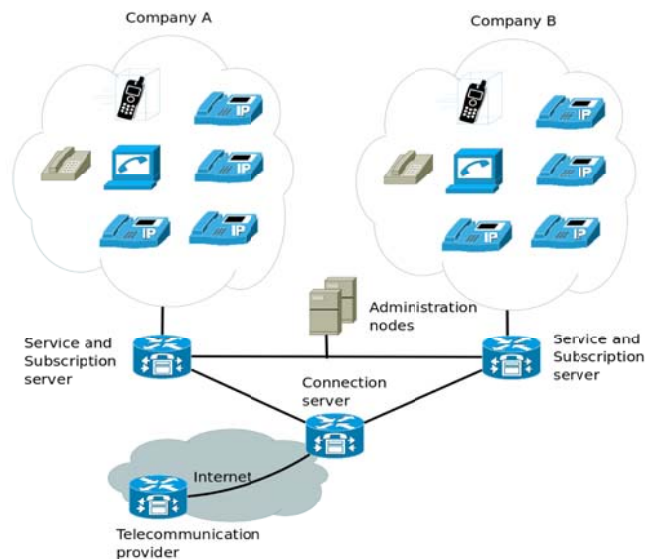


# Smart House, Smart Health, Smart ...

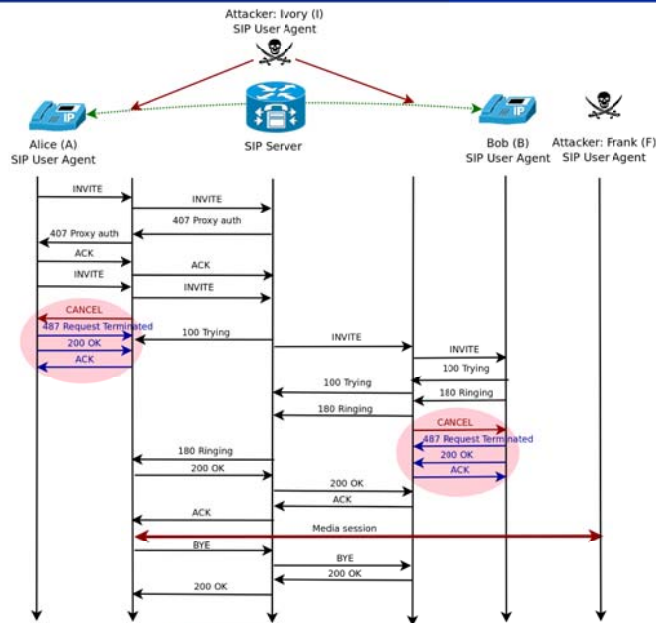


## Using VoIP is smart ...

Example VoIP scenario

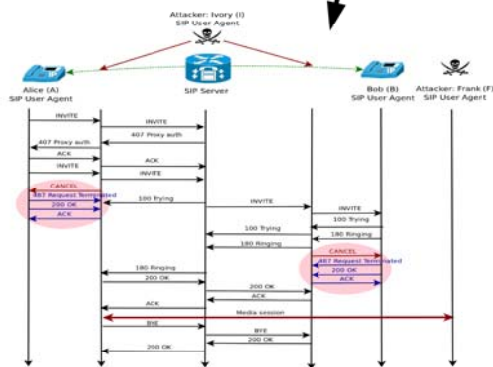


# When things go wrong ...

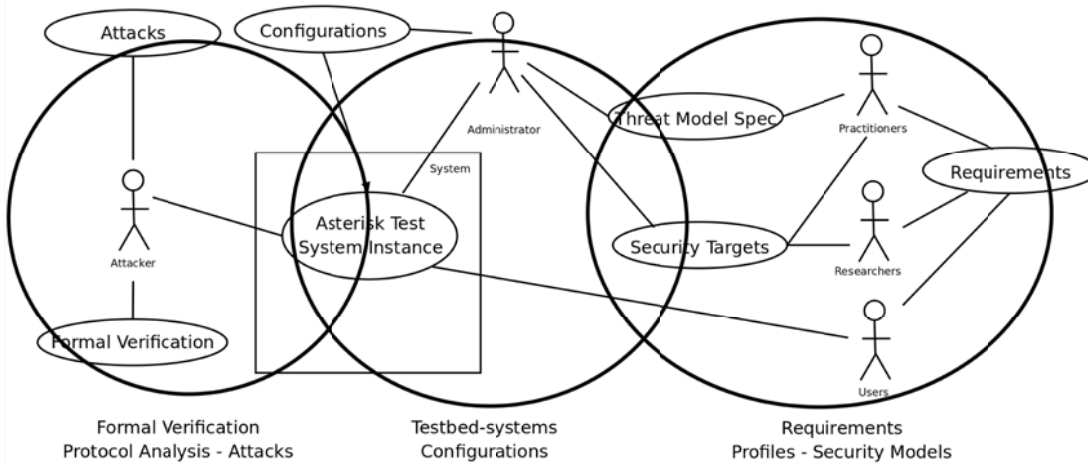


# What if ...

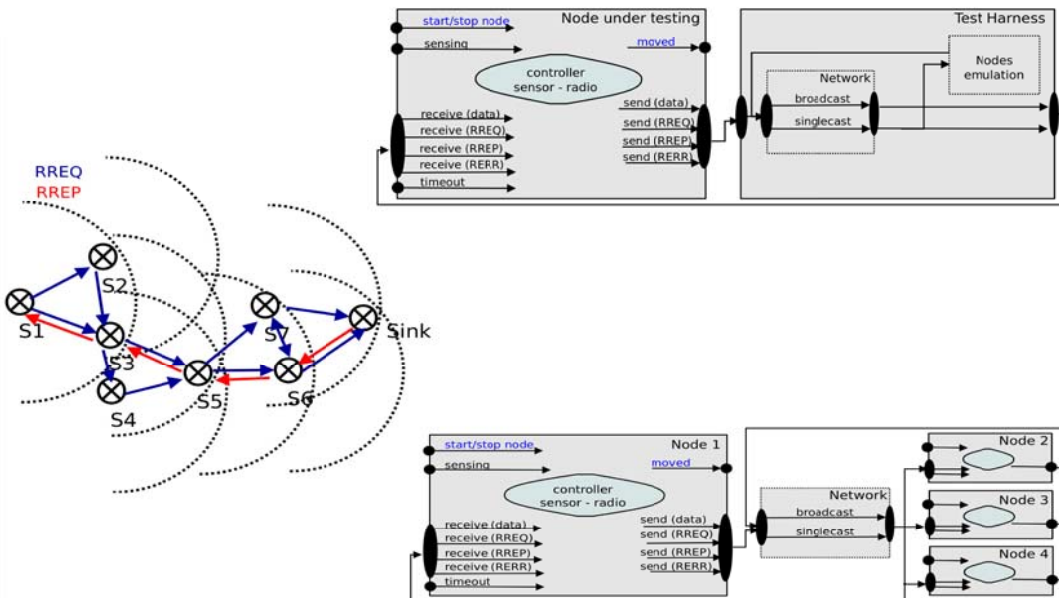
this happens here ?



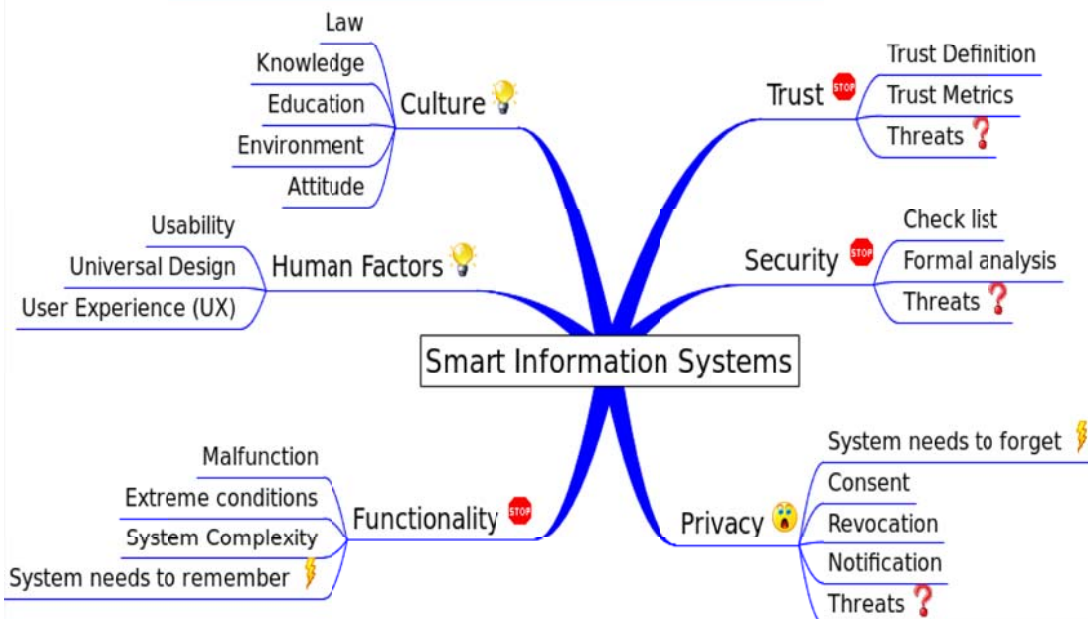
# How to analyse such systems?



# Modelling and Formal Methods



# Trust – Security – Privacy – ...



# Smart Information Systems

- ▶ Inform the User
- ▶ Think User Experience
- ▶ Think Trust
- ▶ Think Usability
- ▶ Think Universal Design
- ▶ Think Privacy
- ▶ Think Security