29- Usable Privacy and Security for Safety-Critical Devices

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Usable Privacy and Security

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Engineering & Public Policy

Today!

- Finish discussion of culture
- Clarify expectations for project report and presentation
- UPS for cars
- UPS for medical devices
- UPS for medical records

Cross-cultural issues

- What is culture?
  - National origin?
  - Demographics?
- Why does culture matter in UPS research?
  - Social norms / user expectations
  - Legal requirements and expectations
  - The availability of systems / structures
  - Media portrayals

Your stories

International Studies

- Where is your sample coming from?
  - Comparable samples?
  - Recruitment?
- Identity of moderator
  - Language? (Parallel translations)
  - Understanding cultural context
- Ethics considerations

Project

Cars

https://www.youtube.com/watch?v=oqe6S6m73Zw

Meta-issues with car privacy/security

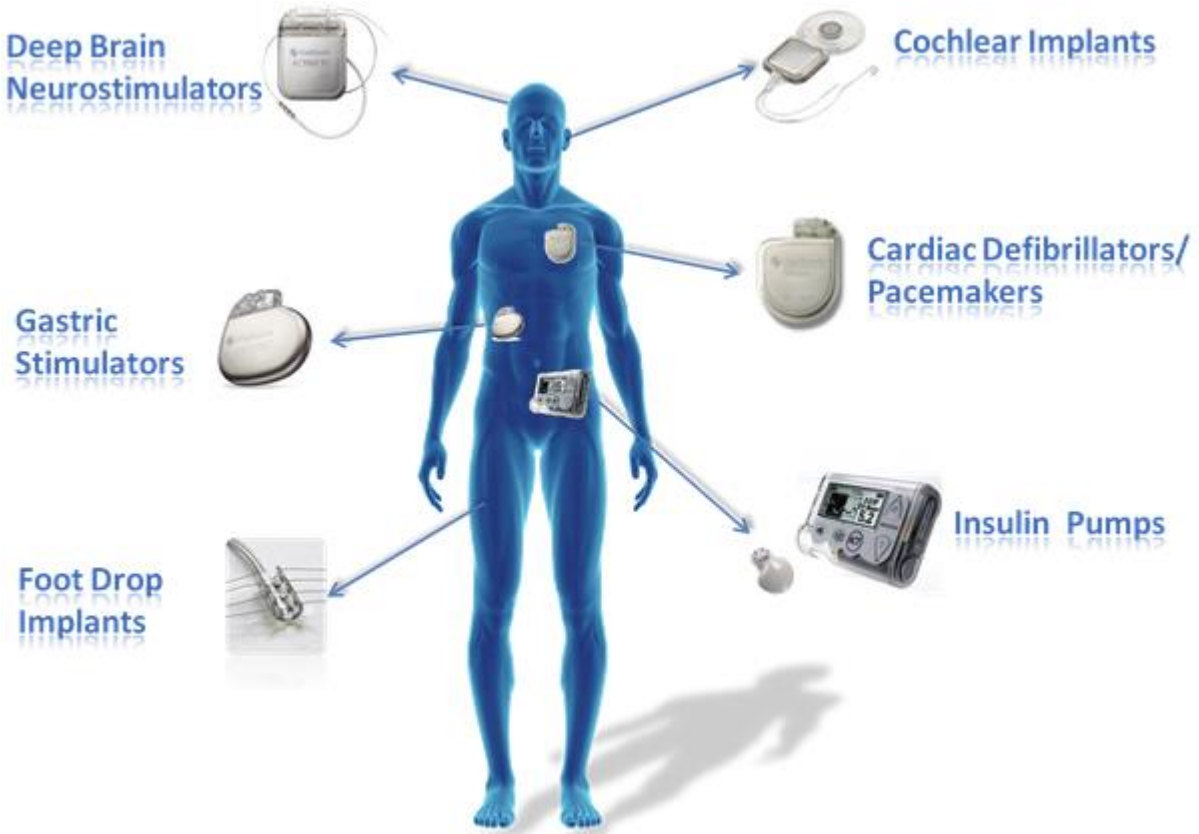
- Why are our cars run by computers?
- Why are we connecting our cars to the Internet?
  - Rich media content
  - Real-time traffic and safety info
  - OTA updates
  - Self-driving cars
  - (Surveillance)
- Are privacy/security issues the same?

Meta-issues with privacy/security

- Let’s answer the same questions for medical devices

Implantable Medical Devices (IMD)

- Embedded computers
- 350K Pacemakers & 173K Cardiac Defibrillators in 2006

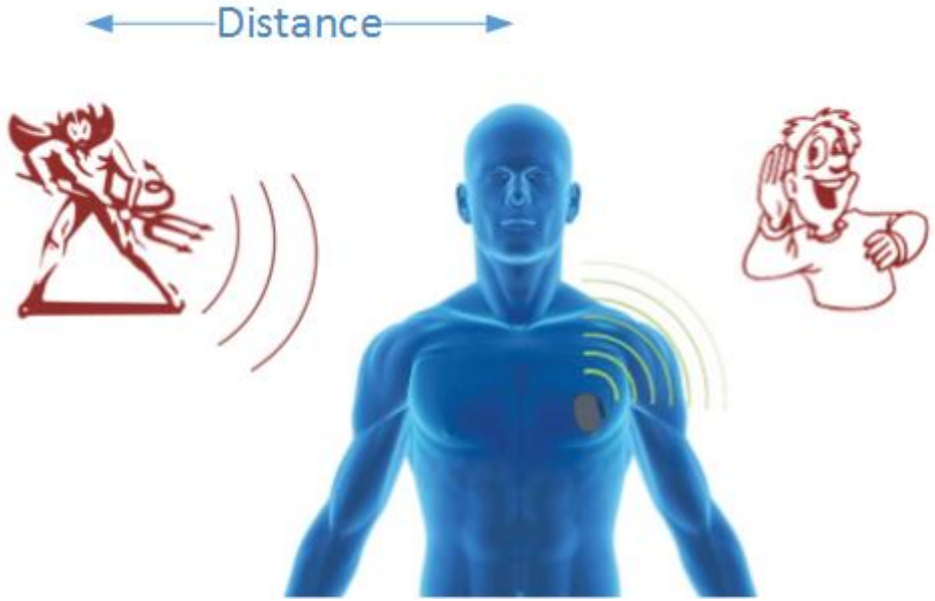


Operational Requirements

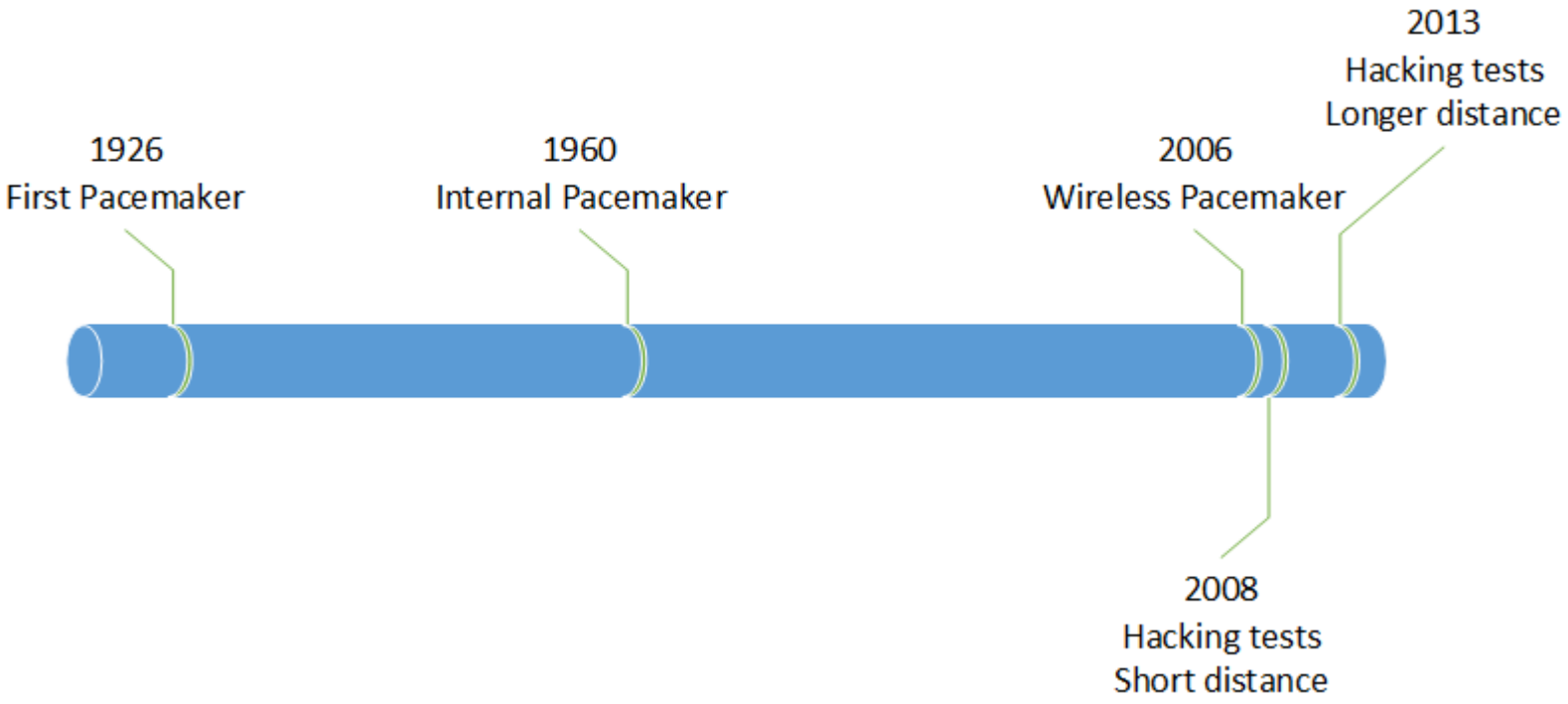
- Possible goals
  - Collect information (diagnostics)
  - Provide information (medical history)
  - Perform medical function
- Disable IMD before conducting surgeries
- Access in emergency situations
- Constraints
  - Limited capacity of battery (replacement = surgery)

Risks in Medical Devices

- Vulnerabilities
  - Authentication
- Attack Vectors
  - Passive
  - Active
- Risks / threats
  - DoS
  - Changes in configuration
  - Replace medical records -- someone having a different operation
  - Injuries, death



Pacemakers



Networking changes the treat model

Hacking Tests (1)

- **2008:** wireless access to a combination heart defibrillator and pacemaker (within two inches of the test gear)
- Disclose personal patient data
- Reprogram IMD to shut down and to deliver jolts of electricity that would potentially be fatal

Hacking Tests (2)

2011-2012-2013

- **Hacking Insulin Pumps**

-- insulinpump.com

2013 -- Black Hat /Defcon:

- **"Implantable medical devices: hacking humans"**
  - At 30 feet by compromising their pacemaker
  - Transmitter to scan for and interrogate individual medical implants
  - Security techniques for manufacturers

-- ioactive.com

Defense Approaches

- How do we achieve resistance to attacks?
  - What are the classes of attacks?
- What can go wrong?
- How do we balance utility and security/privacy?

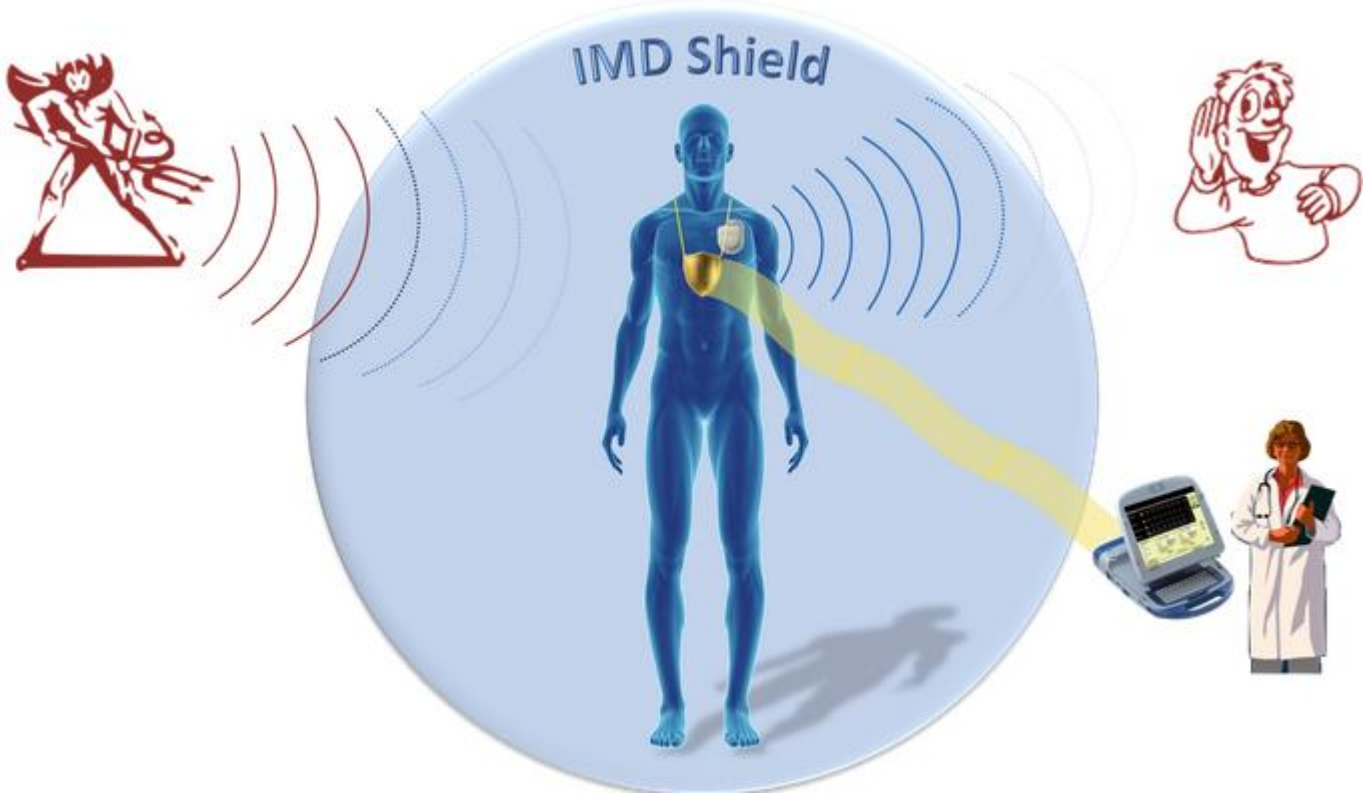
Authentication Methods

- Passwords: how to make them available?
  - Tattooed passwords (visible, UV visible)
  - Bracelet
- Biometrics (face recognition)
- Smart Cards
- Touch-to-access policy
- Key-based systems
- Shields
  - Necklace
  - Computational wristband

-- Figures from Denning et al.

IMD Shield

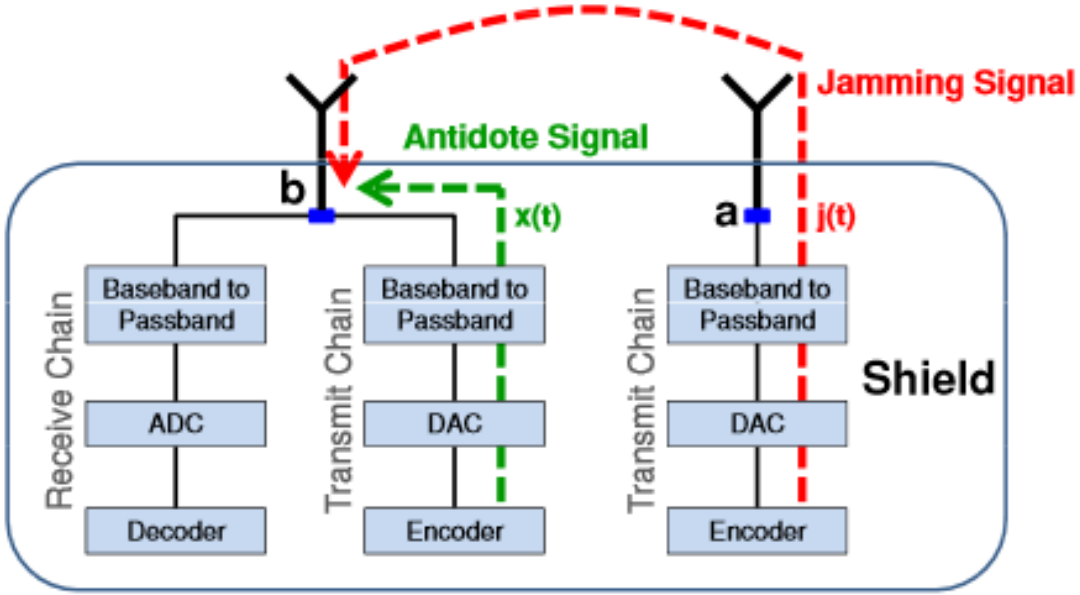
- Proxy (messages exchanges)
- Authentication + encryption (channel)



- IMDShield -mit.edu

IMD Shield - Implementation

- Jammer design (full duplex radio)



- S. Gollakota et al. MIT

Wristbands / Alert Bracelets

- Safety in emergencies
- Security & Privacy under adversarial conditions
- Battery life

Wristbands / Alert Bracelets

- Protection is granted while wearing the bracelet.
- Remove to gain access to the IMD
- Inform patients about malicious actions – But not preventive
- Authentication + symmetric encryption
- Disadvantages
  - Relies on the patient wearing the bracelet
  - Reactive
  - Cognitive effects on patients

--Denning et al.

Usability Considerations

- Hospitals not having correct equipment
- Visual indicator of patients condition (something is wrong). Personal dignity.
- Carrying one more device
- Aesthetics
  - Wristbands (especially). “Mockups are unaesthetic”
  - Tattoos
- Mental and physical inconvenience
- Cultural and historical associations

Electronic Medical Records

- Why do we want *electronic* medical records?
- What are privacy/security concerns about electronic medical records?
- How do we mitigate those concerns?

Questions?