Total Recall: *Are Privacy Changes Inevitable?*

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Total Recall Project at USC

- Continuous recording of personal experiences
  - Personal sensors for data acquisition
  - Data stored on *Total Recall* servers
    - strong encryption
    - indexing, searching, retrieving, etc.
  - Records a *individual perspective* of his/her world
    - whispers and peeks (things that environmental sensors cannot see, hear, or sense)
    - need to address *privacy* issues
  - Recall, playback
    - immersive environment, eventually

Total Recall Applications

- Not just a memory enhancer
- Health care
  - Recall a patient’s food intake and recent environments can help discovery of allergies
  - Monitoring food intake of diabetics can provide warning signals when appropriate
  - Support of elderly and people with disability
- Education

Transparent Society vs. Big Brother

- Transparent Society
  - *Total Recall* data can be used in legal proceedings
    - business dealings
    - sexual harassment and rape
  - Easy to prove who said what, if data can be *authenticated*
  - If everyone is recording, will lead to honesty
- Big Brother
  - Fear that data collected for one purpose will be used for another purpose
  - Privacy, as we know it, will be lost forever
- This talk focuses on *privacy* issues

The Role of a Technologist

- Design and build systems that provide proper *security*, *privacy*, and *integrity mechanisms*
- Make sure that these mechanisms can enable a wide variety of policies so that legal/social policy development is not hampered by a paucity of technical alternatives
  - Without technical flexibility, the inevitable development of technology may result in *poor policy by default*

The Law

- Mathematical proof is not required
  - Reasonable/plausible explanation is sufficient
- Interpretation of a law is a function of many things
  - Precedence
  - Other law
- Changing the law is difficult
  - Someone (or even many) has to die
  - Public outcry/outrage
- Is this a US issue?
- Future harm vs. profit now?

Privacy

- What is the difference between *Total Recall* and human memory?
  - A third party gaining access to *Total Recall* data
    - legal as well as illegal access
  - Having the system implies that certain records exist
  - Only way to access human memory is through questions
- All these give rise to privacy concerns

Are We Allowed to Record Everything?

- Is it legal under current law?
  - It depends...
    - different states have different laws w.r.t. audio and video recording
- Fundamental principle
  - People are entitled to privacy where privacy is their *"reasonable expectation"*
    - home vs. walking on a public street
    - tourist can record a street scene for private use
    - legally, little difference between that and *Total Recall*
    - until *Total Recall* becomes widely used -- yet unrecognized legally
    - overlapping web of recorded *memories* -- unknown impact

Consent

- Obtaining consent can be problematic with pervasive use of *Total Recall*
- Provide mechanisms for *implied consent*
  - Recurring beep, flashing lights, etc.
  - Might degrade the quality of information
- Implies understanding of data's use
  - Long standing principle of fair information practices holds that, *"information gathered for one purpose not be used for another without the subject's consent"*

What Can We Do With It?

- Security measures to protect against unauthorized 3rd party use
- Legal private use is largely unrestricted
  - Publishing without permission could give rise to liability
- Use by the judicial system
  - The US Fifth Amendment (protection against self-incrimination) would likely *not* protect *Total Recall* data
    - similar to bank records and e-mail records
  - In civil lawsuits, even an uninvolved 3rd party can be asked to produce *Total Recall* data
    - once asked, destruction or alteration is illegal
  - Threat of ubiquitous use of RFIDs
- National security concerns

Will We See Legal Support?

- The law does evolve to accommodate new technology
  - E.g., changes in rules for use of original documents
- In theory, new rules of evidence could be adopted to exclude or limit use of *Total Recall* data
  - But unlikely due to legitimate use of data
- Proactive protection is harder to achieve
  - Likelihood of protective legislation in advance is low for potential abuse of an as-yet-undeveloped technology
    - reluctance to inhibit the development of rapidly evolving technologies
  - By the time any technology has even the smallest commercial foothold, its commercial supporters are likely to oppose any restrictions

Will We See Legal Support? (Cont...)

- Law evolves slower than technology
  - As it should
  - Systems like Total Recall will be developed before comprehensive policy on private of its recordings
  - Changes in nature of privacy are likely inevitable
- Vital role still exists for technologists
  - Designing highly configurable systems with enough technical *"hooks"* to enable whatever privacy policies are eventually arrived at

Could Technology Help?

- Making other users of similar systems invisible
  - "Don’t record me" preference setting
  - Comprehensive inauthenticity could diminish utility of such systems
- Authenticity-bit
  - On if data is original/authentic
  - Off if data is modified
    - automatic or user directed
  - One-way transition from authentic to modified

Authenticity-bit

- Advantages
  - Authentic data can be used against other forms of evidence
  - If off by default, one *might* have some protection against non-consensual use of recordings in legal proceedings
- But modified data may still be admitted as evidence
  - Legal system does not require provable certainly
    - hardly recognizes absolute certainty as a concept
  - Legal system provides different levels of required proof
    - beyond a reasonable doubt vs. clear and convincing vs. strength of evidence
  - We cannot tell the legal system to ignore information, the legal system will make up its mind, even if the authenticity-bit is off

Authenticity-bit (Cont...)

- Imagined exchange in the paper
  - [...]
  - Probably the court would rule to admit the evidence under current law
- Rules of evidence could change
  - *Total Recall* records with authenticity-bit off could be made inadmissible explicitly
  - Need to be skeptical on practical and political grounds
  - Authenticity-bit could provide the hooks on which policymakers could hang a legal protection scheme

A Possible Implementation

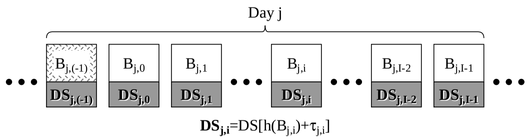
- Using currently available technology
- Wearable recording device
  - store data on removable memory card
    - user (Alice) can remove card and *edit* data
  - data is eventually uploaded to a server when device is connected to the Internet
  - data can sit on the wearable device for days
    - Alice has plenty of time to modify data
  - need to authenticate data
    - can have the wearable device *digitally sign* every data block it produces
    - but can be problematic -- e.g., Alice drains battery, time-shifts data sequence
  - (cont...)

A Possible Implementation (Cont...)

- Wearable recording device (cont...)
  - strong encryption, device equipped with a *cryptographic smartcard*
    - temper-resistant
    - contains a *private-key*
    - can perform public-key and secret-key cryptography
    - private-key is never exposed
    - in order to decrypt something encrypted with the public-key, the corresponding smartcard must be *physically* present (no copy of the private-key)

Third-party Authentication

- Use of a *notary server*
  - Similar to a timestamp server in the *Bistro System*

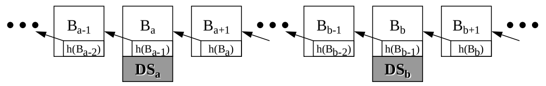


$DS_{j,i}=DS[h(B_{j,i})+\tau_{j,i}]$

- Only way to decrypt the data blocks is with the presence of the smartcard (not possible to transmit the private-key to a server)

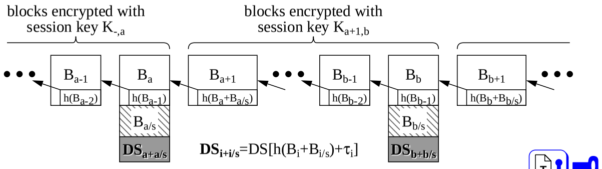
Practical Considerations

- Poor/unavailable network connectivity
  - Alice may trick the device to decrypt the special block to obtain the day key and modify data blocks
  - Although Alice is allowed to modify data, must not let Alice *claim authenticity* if data blocks are modified
- Only sign occasionally
  - Create dependencies between data blocks via *chaining*



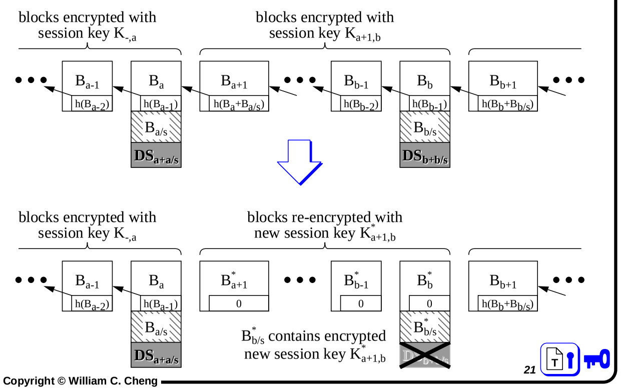
Day Key

- Day key should only be released when it's no longer used
  - Also, day key should be released in a notarized block
  - Otherwise, Alice may modify *some* data
- May be days before Alice gets network connectivity
  - Encryption key should not be associated with the calendar -- day key replaced by *session key*



$DS_{i+i/s}=DS[h(B_i+B_{i/s})+\tau_i]$

Modifying Data Blocks



Concluding Remarks

- We have explored privacy concerns in a legal/social setting, offered a potential technical mechanism (authenticity-bit) to address some of the issues
- There are other broader implications of *Total Recall* deployment
  - "So, Mr. Jones, you turned your Total Recall off when you met Mr. Smith. What were you trying to hide?"
  - Will human memorization becomes less important a skill?
- This is not intended as a definitive solution, but a starting point for future discussions
  - Much is left to consider, but the potential is great and so worth pursuing

Concluding Remarks (Cont...)

- We believe that systems like *Total Recall* will get built and will have valuable uses, and will radically change our notions of privacy
  - Useful technologies are largely inevitable
  - They often bring social changes with them
  - And we inevitably both suffer and benefit from their consequences
- There is not much preventing collection of a lot of data about someone anyway
- Our job is to provide sufficiently flexible systems