Security issues in video surveillance, secure transcoding

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Secure transcoding
Definitions

- **Transcoding**
  - Adaptation of the representation of a media in terms of format, resolution, quality, … while remaining in the same modality

- **Transmoding**
  - Adaptation of the representation of a media by changing the modality in which it is represented

- **Examples:**
  - Transcoding: MPEG-2 to MPEG-4, HD to SD conversion, …
  - Transmoding: Speech to text, Video summarization, …
Motivations behind transcoding and transmoding

- A media delivery system may need to deliver a media stream to a number of clients with diverse device capabilities, connection quality, or even user preferences.
- Adaptation solutions
  - End-to-end adaptation
  - Mid-network adaptation

Security issues in transcoding
Approaches to secure transcoding

- Progressive encryption methods encrypt plaintext into ciphertext in a sequential or beginning-to-end manner. Block ciphers in various modes and stream ciphers all satisfy this property.
End to end secure adaptation

Original Data

Scalable Coding

Scalable Data

Progressive Encryption

Secure, Scalable Data

Mid-network secure adaptation

Scalable Coding

Progressive Encryption

Secure, Scalable Data

Transcoding

Transcoded Secure, Scalable Data
Secure Scalable Streaming (SSS)

• SSS Encoder

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Media Security

Secure Scalable Streaming (SSS)

• SSS transcoder

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Media Security
Example 1

Untrusted relay node

Example 2
Example 3

- Untrusted Gateway/server with secure transcoding
- Storage unit with privacy-protected media

Surveillance
### Surveillance

- Proliferation of advanced electronics, computers, networks
  - Sensors
  - Wireless networks
  - RFID
  - Blue tooth
  - Credit cards
  - Mobile phones
  - IP/MAC address
  - ...
- It has become increasingly easy to monitor movements, behavior and habits of individuals
  - Data mining
  - Search
  - ...

### Pros and cons of surveillance and data gathering

- **Advantages**
  - User profiling
  - Personalization
  - Statistics
  - Security
  - Increased efficiency
  - Increased quality of life
- **Drawbacks**
  - Unsolicited advertisement (SPAM)
  - Spy bots
  - Privacy
Mohamed Atta
one of the terrorists
who crashed a plane on
WTC on Sept 11, 2001

Mohamed Atta
filmed by a Gas Station
surveillance camera on
September 10th, 2001
Mohamed Atta
filmed by an ATM
surveillance camera on
September 10th, 2001

Video surveillance
Applications

- **Marketing/statistics**
  - Customers habits
  - Number of visitors
- **Access to places**
  - Car license plate recognition in London
- **Traffic control**
  - Speed control
- **Surveillance of sensitive locations**
  - Embassies, airports, nuclear plants, military zone, border control, …
- **Intrusion detection**
  - Residential surveillance, retail surveillance, …
  - …
- **Event detection**
  - Child/Elderly care
- …

Why

- Often video surveillance does not prevent crime, but:
  - Discourages crime
  - Allows quick reaction
  - Psychological dimension
## Video surveillance technologies

<table>
<thead>
<tr>
<th>First generation</th>
<th>Second generation</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Analog</td>
<td>• Digital</td>
</tr>
<tr>
<td>• CCTV</td>
<td>• Recording</td>
</tr>
<tr>
<td>• Recording</td>
<td>• PC</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Third generation</th>
<th>Forth generation</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Image analysis</td>
<td>• Distributed</td>
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<tr>
<td>• Biometrics</td>
<td>• Seamless</td>
</tr>
<tr>
<td>• Search</td>
<td>• Free view</td>
</tr>
<tr>
<td>• Wireless</td>
<td></td>
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</tbody>
</table>
Example

• Automatic event detection
What’s a camera?

- Conventional camera:
  - device to capture audio-visual information from the real-world.
  - AV data from the scene converted to electrical signal (camera output).

- MPEG-1 and MPEG-2, MPEG-4 camera:
  - Compression technologies allow efficient storage of large AV data.
  - Use of standards, such as MPEG-1, MPEG-2 and MPEG-4, enables efficiency and interoperability.

- Smart camera:
  - Some level of image and video analysis is performed at the camera
  - MPEG-7 camera.

MPEG-7 standard

- Objective of MPEG-7 (the Content Description Standard)
  - standardize a content-based description of various types of AV information allowing:
    - quick and efficient content searching, filtering and identification,
    - Multi-level description of the content (low-level features, structure, semantic, etc.)
    - addressing a large range of applications.
Unstructured news image

Title

<StillRegion id = “news”>

</StillRegion>
MPEG-7 content description

<StillRegion id = "news">
  <Segment Decomposition
decompositionType = "spatial">
    <StillRegion id = "background">
      <StillRegion id = "speaker">
        <StillRegion id = "topic">
          <Segment Decomposition>
            <StillRegion>
              <Segment Decomposition>
                <DominantColor> 10 10 250 </DominantColor>
              </Segment Decomposition>
            </StillRegion>
          </Segment Decomposition>
        </StillRegion>
      </StillRegion>
    </StillRegion>
  </Segment Decomposition>
</StillRegion>
MPEG-7 content description

```xml
<StillRegion id = "news">
  <SegmentDecomposition decompositionType = "spatial">
    <StillRegion id = "background">
      <TextAnnotation>
        <FreeTextAnnotation> Journalist Judite Sousa </FreeTextAnnotation>
      </TextAnnotation>
      <SpatialMask>
        <Poly>
          <CoordsI> 80 288 100 200 ... 352 288 </CoordsI>
        </Poly>
      </SpatialMask>
    </StillRegion>
    <StillRegion id = "speaker">
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      </TextAnnotation>
      <SpatialMask>
        <Poly>
          <CoordsI> 5 25 10 20 15 10 10 5 15 </CoordsI>
        </Poly>
      </SpatialMask>
    </StillRegion>
    <StillRegion id = "topic">
      <TextAnnotation>
        <FreeTextAnnotation> Clinton’s affair </FreeTextAnnotation>
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More features

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MPEG-7 content description

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MPEG-7 camera

The MPEG-7 camera describes a scene in terms of semantic objects and of their properties.

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**MPEG-7 camera**

- **MPEG-7 Camera**
  - Video analysis block: includes video analysis algorithms (implemented on the camera DSP) such as segmentation, change detection, and tracking.
  - MPEG-7 coder: scene description represented using MPEG-7 (BIM).
  - MPEG-7 decoder: MPEG-7 description is parsed. Extraction of the information related to the specific applications.
**Virtual display**
- Extract and transmit only the relevant information (object motion).
- The virtual objects (in this case the blobs) perfectly follow the movement of the persons:
  - Privacy: in surveillance applications persons feel uncomfortable to be filmed. Only the behavior of the persons are transmitted.
  - Checking intentions in surveillance: deduce intentions by studying how a person moves.

![Real scene](image1)
![Extraction of moving objects](image2)
![Virtual objects](image3)

**Video surveillance security tools**

- **Encryption**
  - Secure communication
  - Conditional access
- **Data integrity**
  - Digital signature
  - Proof for lack of manipulation after capture
Video surveillance issues

- Technology
- Business
- Legal
- Social
- Law enforcement
- Privacy protection

Example of operational video surveillance system

e-protect by VTX
Video surveillance with privacy

- Privacy preservation

Alternatives for video surveillance with privacy

- Fully automatic surveillance without intervention of human operators
  - False positives and false negatives
- Encrypt the whole video
  - No good for monitoring
- Replace sensitive objects with a mask
  - Limited usefulness for monitoring
- Scramble sensitive regions with a key
  - Useful for monitoring
  - Privacy preservation
  - Identification can take place when crime happens
Video surveillance with privacy

Example: JPSEC

- The video under surveillance remains visible except for parts that would identify people or their goods

Video surveillance with privacy

- Authorized persons (a judge for example) can view the whole scene (including people) by means of a secret key