Identification as a Service and the future of Biometrics in the Cloud

Richard Austin Huber Jr.
Lead Architect, ABIS Search Engine and SDKs

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Goal: Map contemporary biometric identification to the NIST Cloud Computing essentials, consider future opportunities and challenges

Contemporary Large Scale Identification
- Infrastructural and Algorithmic Approaches to Scaling
- Administrative and Business Use Cases

Identification Systems Cloud Scorecard
- NIST Definition of Cloud
- Essential Characteristics as a Scorecard

Identification in Emerging Paradigms
- Applicability of the Cloud Model today
- Future directions and opportunities in the Cloud

Conclusion
Infrastructural and Algorithmic Approaches to Scaling

**Template Creation and Verification**
- Stateless and only CPU bound; scaling requires adding more CPUs to the infrastructure; simple load balancing suffices; Verification assumes template submission.

**Template Identification**
- Statefull and requiring template storage, up to TB in RAM, PB in Disk; Scaling must balance RAM, Disk, and CPUs; Architecture specific load balancing is required.

**Optimization Strategies**
- **Algorithmic**
  - Decompose biometric into multiple algorithms, pipeline strategies; Decreases latency and size.
- **Pre-Filtering**
  - Demographic, Positional, Quality Information, Data Mining with mapped identifiers from external systems; Decreases latency, improves accuracy.
- **Gallery Design**
  - Isolating dissimilar galleries; Multi-biometric results cascading; Algorithm based workflow design.
CONTEMPORARY LARGE SCALE IDENTIFICATION

Administrative and Business Use Cases

➔ Administrative Deployment
  ▪ Deploying physical and virtual assets; Deploying software and configuration; Evolution of physical assets.

➔ Administrative Provisioning
  ▪ Activating configuration; Manual and guided automatic growth; Moving and manipulating data and configuration; Design evolution over time.

➔ Administrative and Business Monitoring
  ▪ System availability; Predictive performance; Issue resolution; Logical and algorithmic transaction trace.

➔ Business Client Software
  ▪ Thick and thin client software; Data and function based access control; OS/Client image hypervisors with desktop remoting
NIST Special Publication 800-145 describes Cloud as:

(assertion)

- **Essential Characteristics**
  - On-demand self service
  - Broad network access
  - Resource pooling
  - Rapid elasticity
  - Measured service

- **Service Models**
  - Software as a service (SaaS)
  - Platform as a service (PaaS)
  - Infrastructure as a service (IaaS)

- **Deployed as:** Private, Community, Public, or Hybrid
### IDENTIFICATION SYSTEMS CLOUD SCORECARD

#### Essential Characteristics as a Scorecard for Biometric Identification

<table>
<thead>
<tr>
<th>Consideration</th>
<th>On-Demand</th>
<th>Broad Network Access</th>
<th>Resource Pooling</th>
<th>Rapid Elasticity</th>
<th>Measured Service</th>
</tr>
</thead>
<tbody>
<tr>
<td>Template Creation</td>
<td>Missing</td>
<td>Exists</td>
<td>Exists</td>
<td>Limited</td>
<td>Limited</td>
</tr>
<tr>
<td>Template Identification</td>
<td>Missing</td>
<td>Exists</td>
<td>Exists</td>
<td>Missing</td>
<td>Limited</td>
</tr>
<tr>
<td>Template Verification</td>
<td>Missing</td>
<td>Exists</td>
<td>Exists</td>
<td>Limited</td>
<td>Limited</td>
</tr>
<tr>
<td>Algorithm Strategy</td>
<td>Missing</td>
<td>Exists</td>
<td>Exists</td>
<td>Missing</td>
<td>Missing</td>
</tr>
<tr>
<td>Internal Pre-Filter</td>
<td>Missing</td>
<td>Exists</td>
<td>Exists</td>
<td>Limited</td>
<td>Missing</td>
</tr>
<tr>
<td>External Pre-Filter</td>
<td>Missing</td>
<td>Exists</td>
<td>Exists</td>
<td>Limited</td>
<td>Missing</td>
</tr>
<tr>
<td>Gallery Design</td>
<td>Missing</td>
<td>Exists</td>
<td>Exists</td>
<td>Limited</td>
<td>Limited</td>
</tr>
<tr>
<td>Multi-Biometrics</td>
<td>Missing</td>
<td>Exists</td>
<td>Exists</td>
<td>Limited</td>
<td>Limited</td>
</tr>
<tr>
<td>Deployment</td>
<td>Limited</td>
<td>Exists</td>
<td>Exists</td>
<td>Exists</td>
<td>Missing</td>
</tr>
<tr>
<td>Provisioning</td>
<td>Limited</td>
<td>Exists</td>
<td>Exists</td>
<td>Exists</td>
<td>Missing</td>
</tr>
<tr>
<td>Monitoring</td>
<td>Limited</td>
<td>Exists</td>
<td>Exists</td>
<td>Limited</td>
<td>Missing</td>
</tr>
<tr>
<td>Client Software</td>
<td>Limited</td>
<td>Limited</td>
<td>Limited</td>
<td>Missing</td>
<td>Limited</td>
</tr>
</tbody>
</table>
## Applicability of the Cloud Model today

<table>
<thead>
<tr>
<th>Consideration</th>
<th>General Character</th>
<th>Why</th>
</tr>
</thead>
<tbody>
<tr>
<td>Template Creation</td>
<td>Cloud Ready</td>
<td>Less specific hardware, few as 1 CPU core, short duration, high variability</td>
</tr>
<tr>
<td>Template Identification</td>
<td>Grid-Like</td>
<td>Specific hardware, data intensive, discrete use cases, small input, many servers</td>
</tr>
<tr>
<td>Template Verification</td>
<td>Cloud Ready</td>
<td>Less specific hardware, few as 1 CPU core, short duration, high variability</td>
</tr>
<tr>
<td>Algorithm Strategy</td>
<td>Grid-Like</td>
<td>Often predetermined, non-elastic, immutable to all typical users</td>
</tr>
<tr>
<td>Internal Pre-Filter</td>
<td>Hybrid</td>
<td>Often design determined, though application use appears elastic and on-demand</td>
</tr>
<tr>
<td>External Pre-Filter</td>
<td>Hybrid</td>
<td>Often design determined, interface specific, though appears elastic and on-demand</td>
</tr>
<tr>
<td>Gallery Design</td>
<td>Grid-Like</td>
<td>Often design determined and immutable to all typical users</td>
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<tr>
<td>Multi-Biometrics</td>
<td>Grid-Like</td>
<td>Often design determined and immutable to all typical users</td>
</tr>
<tr>
<td>Deployment</td>
<td>Cloud Ready</td>
<td>Asset virtualization, installation, and configuration are often already IaaS or PaaS</td>
</tr>
<tr>
<td>Provisioning</td>
<td>Cloud Ready</td>
<td>Gallery virtualization, growth over time, evolution over software generations PaaS</td>
</tr>
<tr>
<td>Monitoring</td>
<td>Cloud Ready</td>
<td>More transaction and user level trace elasticity is emerging; less uniformity</td>
</tr>
<tr>
<td>Client Software</td>
<td>Hybrid</td>
<td>Thick manually administered clients predominate, Thin clients emerging</td>
</tr>
</tbody>
</table>
IDENTIFICATION IN EMERGING PARADIGMS

Future directions and opportunities in the Cloud

 ➞ Identification as a Service (IDaaS); Forensics as a Service (FaaS)
   - Improved Data Elasticity; IDaaS and FaaS load response over time
   - Mission based fluid Gallery Design for On-Demand FaaS
   - Service metering for Hybrid Cloud collaborative environments

 ➞ New paradigms in ancillary External Pre-Filtration
   - Standards in heterogeneous systems interfacing for Enhanced Intelligence
   - Private/hybrid collaborative clouds for IDaaS, FaaS on a global scale

 ➞ Administrative paradigms in On-Demand Transaction Cross-Sectioning
   - Path to execution; Transaction based log intensity; API layered and transaction based performance; Multi-Modal Pipeline trace and Miss Analysis improvements
IDENTIFICATION IN EMERGING PARADIGMS

Future directions and opportunities in the Cloud

- Multi-Biometric, Multi-Vendor, Multi-Generational Use Case dynamic Gallery Design
  - Dynamic multi-stage workflow; Mixed algorithm gallery composition, Elastic and On-Demand

- Multi-view Contemporary Person View vs. Full View
  - Contemporary view IDaaS, persisted ancillary views in FaaS

- Cloud enabled client technologies
  - Thick client based utility kits for Tablet and Mobile based on capabilities by function
  - Endpoint device tailoring via ‘Client Hypervisors’ that render device, mission, and security level specific views (Reactive Web)
CONCLUSION

- Large-scale Biometric Identification not fully optimized for On-Demand, Elastic virtualization currently. Challenges exist in data and algorithm composition elasticity moving towards more Cloud-like use cases.

- Small-scale Biometric Identification, Template Creation, Verification subsystems are easily mapped to Cloud-like use cases.

- Administrative Deployment, Provisioning, and Monitoring are already moving toward IaaS and PaaS. Opportunities exist in expanding to Business Client Use Cases

- New mission possibilities are emerging with Hybrid Gallery Design, Algorithm aware workflow, and Hybrid-Private Cloud implementations to improve External Pre-Filtration with heterogeneous agency data

- New market and mission possibilities are emerging with Cloud-enabled client software and hypervisor inspired technologies
THANK YOU

Richard Austin Huber Jr

- Lead Architect, ABIS Search Engine and SDKs
- MorphoTrust USA
- rhuber@morphotrust.com