On Aadhaar Identity Management System

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Abstract
A unique identification for citizens can lead to effective governance to manage and provide citizen-centric services. While ensuring this service, privacy of the citizens needs to be preserved. Aadhaar, the identification system by UIDAI has faced some critics regarding its privacy preserving feature. This paper discusses those concerns in Aadhaar system and proposed a new model for the Aadhaar system. The proposed solution is aimed to address the issue of collusion of third party service providers and profiling of Aadhaar users. The proposed solution uses a distributed model capturing the Aadhaar system, in which data of users is decentralized and stored in zonal office’s databases as well as the CIDR. The proposed solution provides the functioning of the authentication process of the Aadhaar system more effective, as it reduces the number of requests being handled directly by the CIDR and also tackles the concern of correlation of data.

Keywords. Aadhaar system; Authentication; Privacy; Distributed System.

1 Introduction
A unique identification for all citizens has become a necessity for any Government for availing various services offered to citizens of the country. In a country like India, where a large population comes under common subsidies offered in different sectors, the unique identification can be used for direct transfer of subsidies to the citizens, which brings transparency, accountability and efficacy in the system. When the verification of the citizens is required, a centralized single identification number can help speed up the process of verification and the need of multiple documents for verification is eliminated. This greatly reduces time and effort required to avail services. Therefore, the benefits of such an identification number are enormous. Many countries have been maintaining such a system since quite long. The Aadhaar, a unique identification number [2] by Government of India enables all citizens of the country under one identification system.

Aadhaar is a 12-digit unique number assigned by the Unique Identification Authority of India (UIDAI) to the citizens of the country after satisfying the verifi-
cation process laid down by the Authority. To enrol for the Aadhaar, the person needs to visit an enrollment centre, fill the enrolment form, get biometric data, including ten fingerprints, two iris scans and a photograph, captured in the devices provided, and submit proof of identity and address documents. All these data are stored in the Central Information Data Repository (CIDR). Therefore, a huge database of individuals sensitive information is to be maintained. The While Aadhaar has its numerous benefits, the Aadhaar system has faced some criticisms for its privacy preserving features. Many questions have been raised concerning the security of the private information of the users. The problems with the initial architecture of the Aadhaar came to light stating that the private data of the users got leaked. Details including name, address, photo, phone number and email address were available. Data leaks are always a threat when dealing with a large and sensitive database. Furthermore, as Aadhaar is used for authentication by various third party service providers, these service providers could collude amongst themselves and profile a user, which is an invasion of the privacy of people. While some research works have tried to address the problems faced in Aadhaar, we present a different approach to address the same issues. A distributed approach is considered by making modifications to the Aadhaar system. The proposed architecture is using cluster-based data decentralization notion to make the Aadhaar system a secure system by addressing the concern of correlation of data and user profiling. The remaining of the paper is structured as follows. In section 2, we discuss some related works. In section 3, the proposed solution is presented. In section 4, we provide the analysis of the proposed solution. We conclude the paper in section 5.

2 Related Work

2.1 Existing Operation Model of Aadhaar Authentication

The Figure 1 describes how the different entities involved in Aadhaar system interact with each other. The authentication process works as follows.

- The Aadhaar user gives the Aadhaar number and necessary biometric, demographic data and/or OTP as input to the client application. The client application packages and encrypts these input parameters into a PID block before any transmission, as per authority standards and sends it to the server of the requesting entity using secure protocols laid down by the authority.

- After validation, the server forwards the authentication request to the CIDR through the server of ASA as per authority specifications. This request is digitally signed by the requesting entity and/or ASA.

- The CIDR validates the input parameters against the data stored in the CIDR and returns a digitally signed Yes/No response or a digitally signed
e-KYC authentication response with encrypted e-KYC data, along with other technical details related to the authentication transaction.

It is noted that the privacy of the data of the users, misuse of authentication without consent of the user are important concerns. Research and observations [5] [6] [7] highlighted security and privacy concerns in Aadhaar concerns. For better readability, we elaborate these concerns in detail and also the solutions suggested by research community.

2.1.1 Data Leaks

The CIDR stores private data of users including their biometrics and demographics. While this data may seem harmless, it can be misused in many ways like stealing the identity of the actual user. Incidences of data leaks of Aadhaar have come to light with the sensitive data of users. The UIDAI collects data using end-to-end encryption, thus preventing data leaks in transit whenever a new user enrols for the Aadhaar. However, potential threat that an employee or an intermediary with access to the CIDR data may still leaks data of Aadhaar users.

2.1.2 Authentication without Consent

Aadhaar stores biometric details of the users such as fingerprints, iris and a facial photograph. Fingerprints can easily be obtained from any household object touched. With the advent of technology, iris scans can also be obtained from a photograph of the person. As a consequence, an unknown person can identify and act as proxy authenticate pretending as some other person whose biometrics he/she has obtained illegally, which could result into serious crimes such as identity thefts. It is therefore necessary to ensure that the authentication process is started by the actual user in Aadhaar system.
2.1.3 Correlation of Data

A user may avail different services offered by service providers by using the Aadhaar number for verification purposes. These service providers could collude amongst themselves and gather different data about the user. This way, they can profile a user by correlating the data gathered. Once the profiles are generated, this information can be used in malicious ways. Facebook-Cambridge Analytica data leakage and data correlation is a good example [8], [9] to see how correlation of data can become a potential threat in Aadhaar system.

UIDAI has addressed this concern by enforcing service providers to use local ids and maintain a mapping from Aadhaar number to the local id. This, in our views, works to certain degree of trust assumption; however, the service providers still can have access to Aadhaar numbers and can track and profile users. A possible way out is to maintain a unidirectional reverse linking from the local ids to the Aadhaar numbers. Nevertheless, this solution also is not enough because if the linking is stored with service providers, they have indirect access to the Aadhaar numbers. Rajput and Gopinath [5] proposed another solution to the problem of correlation. Their solution requires the user to initiate the authentication process, thus preventing identification without consent. A third party provides a temporary id to the user requesting authentication and further authentication process is done using the temporary id. As a result, no service providers have access to the Aadhaar number of the user and hence can not collude amongst themselves to profile any user. However, it is to be noted that to generate the temporary id, the Aadhaar user does need to give his/her Aadhaar number to the third party generating the temporary id using which the third party maps the id to the Aadhaar number. Again, the question pops up. What if the third party colludes with some service provider? The assumption made in [5] is the third party is trustworthy, but a big question is can we have this hold true across the board in practice?

3 The Proposed Solution

We present a modified architecture for Aadhaar system with the basic aim to prevent correlation of data. We primarily restrict third party involvement in user’s Aadhaar number verification. Furthermore, the service provider only receives a Yes/No response from the UIDAI as far the Aadhaar number verification is concerned.

3.1 Proposed System Architecture

A decentralized approach is required, where UIDAI can divide the data processing task into different zones in the country and develops zonal offices in each zone. The zonal offices store Aadhaar card details of the users who live in their zones. A minor extension is required in the enrollment process due to this change. After enrollment of each new user and the storage of data in the
CIDR, the same data needs to be stored in the concerned zonal office as well. The Figure 2 represents the proposed system architecture.

![Figure 2: The Proposed System Architecture](image)

In precise terms, we make the following modifications to the existing operational model:

- The role of the service provider gets reduced in the verification process.
- The CIDR is replaced by the UIDAI zonal office. A database containing the data of users living in that particular zone is stored in the zonal office.

### 3.2 Authentication Process

The authentication process works in the following way:

1. The service provider gives access to a secure gateway portal provided by the zonal office of the respective zone.

2. The user provides all the information required for verification on this portal. This information is first packaged into a block and encrypted.

3. This package is forwarded to the zonal office through the server of ASA as per the specifications.

4. The zonal office then performs the authentication process by comparing the data provided by the user with the data stored beforehand.

5. If the information provided by the user is correct, then the portal transmits a digitally signed Yes/No response to the service provider over the secure line through ASA. This way the service provider can verify the user without getting any information about the user.
6 If the information of the user does not exist in the zonal database, the zonal office sends a request to the CIDR to forward the information of the user by providing the Aadhaar number. The information received from the CIDR is to be stored only in cache memory and hence, is discarded later on. Thus, only the data of users in the pertaining zone remain in persistent storage.

The following algorithm explains the authentication process.

Receive Package from ASA Server
Validate Signature and extract Aadhaar Number
if PID data for Aadhaar number found then
   Extract User Submitted Data
   if Stored PID Data matches User Submitted Data then
      “Authentication Successful”
   else
      “Authentication Unsuccessful”
   end if
else
   Send Request to CIDR for PID
   if PID data received then
      Extract User Submitted Data
      if Stored PID Data matches User Submitted Data then
         “Authentication Successful”
      else
         “Authentication Unsuccessful”
      end if
   else
      “Invalid Aadhaar Number. Please try Again...”
   end if
end if

Authentication Process Complete

It is noted that during the authentication process, no private information of the users is accessible to any third party or service providers. The proposed architecture reduces the traffic at the CIDR by distributing the data among different zonal offices.

4 Analysis of the Proposed Solution

4.1 Prevention of unauthorized consent

One of the major concerns with the Aadhaar system is that biometric data like fingerprints of a person can be easily obtained from the objects touched by that person. Iris scans can also be obtained from high resolution photos. Hardware and software that supports liveness detection could avoid this problem. Using this approach the hardware issued by the zonal office or legitimate authority
should check whether a living person is providing the biometric data and iris scans running some software. Therefore, the user will be able to provide the biometric and demographic data and that too on designated devices so that no other person will be able to retrieve any data pertaining to user authentication and verification.

4.2 Prevention of correlation and profiling

We have discussed how third party service providers can collude together to profile a person and can use the data with malicious intention. In the proposed solution, when the third party service provider asks the Aadhaar number and data for the verification the user is directed to a portal provided by the authorized zonal office. The Aadhaar number and other data pertaining to the user is then uploaded to that portal and then the verification is done by the zonal office/servicer. As the verification is avoiding the involvement of third part service providers, data correlation and user profiling can be prevented in the proposed solution.

4.3 Security and Efficiency

In the proposed solution, the data and tasks on data, both are segregated and clustered in different zones based on the users’ demography and preference. The user data is stored at zonal offices without involving any third party, so the data is stored and managed with better control and security. In case of a new entry, minimal operation as well as update is required in managing the data. Importantly, the search operation is performed locally, which is a frequent operation and the proposed solution facilitates better efficiency for Aadhaar system.

5 Conclusion

We have discussed the Aadhaar system and observed some concerns in the system. The system should ensure that authentication with the live involvement of the user in the system. Profiling of users by correlation of data due to collusion by third party service providers needs to be prevented in the system. The proposed solution addresses these concerns and ensures its security as well as efficiency.

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