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# Electronic Identify Management in Digital Service Delivery: Current State of Adoption Around the World

**Muhammad Shakil Parvez[1] and Sarker Tanveer Ahmed Rumee[2]**

[1,2] *Department of Computer Science and Engineering, University of Dhaka, Dhaka, Bangladesh*

**Abstract:** Electronic Identity Management has become a key ingredient for electronic governance. Countries around the world are using state-of-the-art technologies to digitize their citizen service delivery process. Uniquely identifying citizens and electronically managing their authentication information is a must for trust and fairness. However, at the implementation level, various modes of electronic identity management are currently in practice, primarily: centralized, user-centric, and federated models. This paper presents an overall summary of the level and type of identity management strategies adopted by different governments. We believe, this information will be valuable to the policymakers and development strategies to plan, design, implement and update the current state of the art.

**Keywords:** Electronic Identity (EID), EID Management Model, Service Delivery, Security, Federation.

## 1. Introduction

National identity management is the backbone upon which thousands of services can be generated. Providing identity verification and service delivery electronically services can be of great benefit to its citizens. All over the world, identity management plays huge benefits to government service delivery models. The scopes are not discriminating even for the private sector at all.

Developed countries have adopted Electronic Identity (EID) Management systems for quite some time [1]. However, many developing countries are still in the design and piloting phase and can learn greatly from the experience of other countries with functional EID systems.

This paper gives an overview of the current state of EID implementation and adoption by countries around the world. We believe, this report will greatly help researchers and policymakers in planning, designing and navigating resources in making EID systems more usable and available for people.

The rest of the paper is organized as follows. Section 2 introduces the necessary background on the EID Management models. Few closely related work is mentioned in Section 3. After that, the current state of EID adoption is discussed in section 4. Finally, section 5 concludes the paper with a summary of the findings.

## 2. Electronic ID Management Models

### A. Centralized Model

In the centralized architecture, the properties associated with each identifier are controlled in isolation by each Service Provider. Still today, a substantial number of Web services do work in this fashion. The primary problem of this paradigm is the enormous number of logins and passwords that must be learned by the user. Therefore, there is a substantial possibility that the user would pick the same logins and passwords for numerous of their accounts, which weakens the degree of security [6]. Here, all identities for each Service Provider are aggregated to a distinct identity provider (IdP). Service Providers have to give each identification to the identity provider (IdP). In this environment, users may have access to all service providers using the same set of identities and credentials. A centralized Certificate Authority might be built using a Public Key Infrastructure (PKI). This design is particularly efficient in a close domain where users might be recognized by a regulated email address. Although such a design looks to be scalable, the concentration of privacy-related information poses a lot of challenges to societal acceptability [4] [5] [9].

### B. Federated Model

In the federated model the Identity Provider and Service Providers gather together to establish a federation of identities and are bonded by relations of trust owing to commercial agreements and a shared technical platform (OpenID Connect, Shibboleth, WS-Federation, SAML). This federation is termed a Circle of Trust (CoT). Just as in the centralized model, Single Sign On (SSO) procedures may be built so that the user can authenticate himself/herself a single time with the IdP to access the multiple services of Service Providers that are members of the Circle of Trust (CoT). In reality, all transactions between SPs and IdP that are tied to a user are done on the basis of these pseudonyms. [6] [7] [8].

### C. User Centric Model

In the user-centric identity paradigm, administration and control of identity information are done by the user. Concretely, the user has to expressly authorize the use of his identity, allowing users themselves to have full control of their personal information and preferences. The user/object may have one or more identities issued by one or more Identity Providers. Such a system has to ensure numerous features, some of the fundamental ones are confidentiality, integrity, and unlink-ability. Only the approach given here enables the user to have total control over their qualities. From their workstation, on the Identity Provider, they have a portfolio of electronic identities for their choosing and occasionally there are identity selectors. At the request of the services, Service Providers being accessed, he/she may pick an identity and determine whether to provide particular information. Service Providers are more likely to suggest authentication of the user by letting them decide on the choice of IdP [10] [11].

## 3. Related Work

Here we confine our discussion to a few very closely related work. Tobias [2] was one of the first to analyze EID implementations and means of achieving interoperability among the European countries.

Morten [3] showed that digital identity and signature can be a cheap, easy, and secure way of getting electronic service access. But he argued that such benefits can only be achieved through the effective cooperation of all relevant stakeholders.

Some countries have well-designed and widely used EID systems already in place. Examples include Estonia [18], India [19] and UK [20], etc. However, most countries are still lacking in a fully developed and federated electronic ID system, as mentioned in [23]. Nawafleh et al. [21] were one of the first to discuss a comparative analysis of the EID adoption in developed vs developing countries. More recently, researchers further explored this issue and came up with policy recommendations [22], [24], [25], [26], etc.

The potential risks and challenges in EID management are discussed in [12], which are essential pointers to enhancing security and trust.

The emerging blockchain technology is used by some countries to design and deploy electronic identity systems [14], [15], [16], etc. Such systems provide excellent security guarantees, but they are still in the developing stage due to the high cost of infrastructure and various government regulations.

## 4. EID Management: Current Practices

This section shows the results of this study. Our study contains information about 198 countries, which is the most accepted count based on numerous sources [17].

### A. Data Collection

For information extraction, we studied the government websites, news and research articles and existing studies. We believe, the EID management information presented here is the most up to date and accurate representation of the current implementation strategies in place in these countries. The following databases were consulted to mine country specific data:

- Google Scholar
- Scopus
- ACM Digital Library
- ScienceDirect
- Web of Science
- Springer Link
- IEEE Explore
- Digital Government Reference Library

Extracted information is then organized and stored in a local database grouped by various regions.

Region specific organization of the data gives valuable insight into the current state of EID implementation in various geographical areas. These regions are listed in Table 1.

Table 1 Country Regions

| Region Name | Notation Used |
|---|---|
| South Asia | SAS |
| East Asia & Pacific | EAS |
| Europe and Central Asia | ECS |
| Middle East & North Africa | MEA |
| Sub-Saharan Africa | SSF |
| Latin America & Caribbean | LCN |
| North America | NAC |

### B. Study Results

The findings of this study is listed in Table 2. For each country, its geographic region and current state and model of the EID adoption is shown.

Table 2 Electronic Identity Management Models in Different Countries

| No. | Country | Region | EID Model |
|---|---|---|---|
| 1 | Afghanistan | SAS | A Centralized Model |
| 2 | Albania | ECS | Federated model |
| 3 | Algeria | MEA | A Centralized Model |
| 4 | Andorra | ECS | No National ID |
| 5 | Angola | SSF | A Centralized Model |
| 6 | Antigua and Barbuda | LCN | No National ID |
| 7 | Argentina | LCN | A Centralized Model |
| 8 | Armenia | ECS | Federated model |
| 9 | Australia | EAS | User-centric model |
| 10 | Austria | ECS | Federated model |
| 11 | Azerbaijan | ECS | A Centralized Model |
| 12 | Bahamas, The | LCN | A Centralized Model |
| 13 | Bahrain | MEA | A Centralized Model |
| 14 | Bangladesh | SAS | A Centralized Model |
| 15 | Barbados | LCN | A Centralized Model |
| 16 | Belarus | ECS | Federated model |
| 17 | Belgium | ECS | Federated model |
| 18 | Belize | LCN | No National ID |
| 19 | Benin | SSF | A Centralized Model |
| 20 | Bhutan | SAS | A Centralized Model |
| 21 | Bolivia | LCN | A Centralized Model |
| 22 | Bosnia and Herzegovina | ECS | Federated model |
| 23 | Botswana | SSF | A Centralized Model |
| 24 | Brazil | LCN | A Centralized Model |
| 25 | Brunei Darussalam | EAS | A Centralized Model |

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|---|---|---|---|
| 26 | Bulgaria | ECS | Federated model |
| 27 | Burkina Faso | SSF | A Centralized Model |
| 28 | Burundi | SSF | A Centralized Model |
| 29 | Cabo Verde | SSF | No National ID |
| 30 | Cambodia | EAS | A Centralized Model |
| 31 | Cameroon | SSF | A Centralized Model |
| 32 | Canada | NAC | User-centric model |
| 33 | Central African Republic | SSF | A Centralized Model |
| 34 | Chad | SSF | A Centralized Model |
| 35 | Chile | LCN | A Centralized Model |
| 36 | China | EAS | A Centralized Model |
| 37 | Colombia | LCN | A Centralized Model |
| 38 | Comoros | SSF | A Centralized Model |
| 39 | Congo, Dem. Rep. | SSF | No National ID |
| 40 | Congo, Rep. | SSF | A Centralized Model |
| 41 | Costa Rica | LCN | A Centralized Model |
| 42 | Cote d'Ivoire | SSF | A Centralized Model |
| 43 | Croatia | ECS | Federated model |
| 44 | Cuba | LCN | A Centralized Model |
| 45 | Cyprus | ECS | Federated model |
| 46 | Czech Republic | ECS | Federated model |
| 47 | Denmark | ECS | Federated model |
| 48 | Djibouti | MEA | A Centralized Model |
| 49 | Dominica | LCN | A Centralized Model |
| 50 | Dominican Republic | LCN | A Centralized Model |
| 51 | Ecuador | LCN | A Centralized Model |

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|---|---|---|---|
| 52 | Egypt, Arab Rep. | MEA | A Centralized Model |
| 53 | El Salvador | LCN | A Centralized Model |
| 54 | Equatorial Guinea | SSF | No National ID |
| 55 | Eritrea | SSF | A Centralized Model |
| 56 | Estonia | ECS | Federated model |
| 57 | Ethiopia | SSF | A Centralized Model |
| 58 | Fiji | EAS | A Centralized Model |
| 59 | Finland | ECS | Federated model |
| 60 | France | ECS | Federated model |
| 61 | Gabon | SSF | A Centralized Model |
| 62 | Gambia, The | SSF | A Centralized Model |
| 63 | Georgia | ECS | Federated model |
| 64 | Germany | ECS | Federated model |
| 65 | Ghana | SSF | A Centralized Model |
| 66 | Greece | ECS | Federated model |
| 67 | Grenada | LCN | A Centralized Model |
| 68 | Guatemala | LCN | A Centralized Model |
| 69 | Guinea | SSF | A Centralized Model |
| 70 | Guinea-Bissau | SSF | A Centralized Model |
| 71 | Guyana | LCN | A Centralized Model |
| 72 | Haiti | LCN | A Centralized Model |
| 73 | Honduras | LCN | A Centralized Model |
| 74 | Hong Kong SAR, China | EAS | A Centralized Model |
| 75 | Hungary | ECS | Federated model |
| 76 | Iceland | ECS | Federated model |
| 77 | India | SAS | A Centralized Model |
| 78 | Indonesia | EAS | A Centralized Model |

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|---|---|---|---|
| 79 | Iran, Islamic Rep. | MEA | A Centralized Model |
| 80 | Iraq | MEA | A Centralized Model |
| 81 | Ireland | ECS | User-centric model |
| 82 | Israel | MEA | A Centralized Model |
| 83 | Italy | ECS | Federated model |
| 84 | Jamaica | LCN | A Centralized Model |
| 85 | Japan | EAS | A Centralized Model |
| 86 | Jordan | MEA | A Centralized Model |
| 87 | Kazakhstan | ECS | A Centralized Model |
| 88 | Kenya | SSF | A Centralized Model |
| 89 | Kiribati | EAS | No National ID |
| 90 | Korea, Dem. People's Rep. | EAS | A Centralized Model |
| 91 | Korea, Rep. | EAS | A Centralized Model |
| 92 | Kosovo | ECS | A Centralized Model |
| 93 | Kuwait | MEA | A Centralized Model |
| 94 | Kyrgyz Republic | ECS | A Centralized Model |
| 95 | Lao PDR | EAS | A Centralized Model |
| 96 | Latvia | ECS | Federated model |
| 97 | Lebanon | MEA | A Centralized Model |
| 98 | Lesotho | SSF | A Centralized Model |
| 99 | Liberia | SSF | A Centralized Model |
| 100 | Libya | MEA | A Centralized Model |
| 101 | Liechtenstein | ECS | Federated model |
| 102 | Lithuania | ECS | Federated model |
| 103 | Luxembourg | ECS | Federated model |
| 104 | Macao SAR, China | EAS | A Centralized Model |

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|---|---|---|---|
| 105 | Macedonia, FYR | ECS | Federated model |
| 106 | Madagascar | SSF | A Centralized Model |
| 107 | Malawi | SSF | A Centralized Model |
| 108 | Malaysia | EAS | A Centralized Model |
| 109 | Maldives | SAS | A Centralized Model |
| 110 | Mali | SSF | A Centralized Model |
| 111 | Malta | MEA | A Centralized Model |
| 112 | Marshall Islands | EAS | No National ID |
| 113 | Mauritania | SSF | A Centralized Model |
| 114 | Mauritius | SSF | A Centralized Model |
| 115 | Mexico | LCN | A Centralized Model |
| 116 | Micronesia, Fed. Sts. | EAS | No National ID |
| 117 | Moldova | ECS | Federated model |
| 118 | Monaco | ECS | Federated model |
| 119 | Mongolia | EAS | A Centralized Model |
| 120 | Montenegro | ECS | Federated model |
| 121 | Morocco | MEA | A Centralized Model |
| 122 | Mozambique | SSF | A Centralized Model |
| 123 | Myanmar | EAS | A Centralized Model |
| 124 | Namibia | SSF | A Centralized Model |
| 125 | Nauru | EAS | No National ID |
| 126 | Nepal | SAS | A Centralized Model |
| 127 | Netherlands | ECS | Federated model |
| 128 | New Zealand | EAS | User-centric model |
| 129 | Nicaragua | LCN | A Centralized Model |
| 130 | Niger | SSF | A Centralized Model |
| 131 | Nigeria | SSF | A Centralized Model |

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|---|---|---|---|
| 132 | Norway | ECS | Federated model |
| 133 | Oman | MEA | A Centralized Model |
| 134 | Pakistan | SAS | A Centralized Model |
| 135 | Palau | EAS | No National ID |
| 136 | Palestine | MEA | A Centralized Model |
| 137 | Panama | LCN | A Centralized Model |
| 138 | Papua New Guinea | EAS | A Centralized Model |
| 139 | Paraguay | LCN | A Centralized Model |
| 140 | Peru | LCN | A Centralized Model |
| 141 | Philippines | EAS | No National ID |
| 142 | Poland | ECS | Federated model |
| 143 | Portugal | ECS | Federated model |
| 144 | Qatar | MEA | A Centralized Model |
| 145 | Romania | ECS | Federated model |
| 146 | Russian Federation | ECS | A Centralized Model |
| 147 | Rwanda | SSF | A Centralized Model |
| 148 | Samoa | EAS | No National ID |
| 149 | San Marino | ECS | Not Available Data |
| 150 | Sao Tome and Principe | SSF | Not Available Data |
| 151 | Saudi Arabia | MEA | A Centralized Model |
| 152 | Senegal | SSF | A Centralized Model |
| 153 | Serbia | ECS | Federated model |
| 154 | Seychelles | SSF | A Centralized Model |
| 155 | Sierra Leone | SSF | A Centralized Model |
| 156 | Singapore | EAS | A Centralized Model |
| 157 | Slovak Republic | ECS | Federated model |

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|---|---|---|---|
| 158 | Slovenia | ECS | Federated model |
| 159 | Solomon Islands | EAS | No National ID |
| 160 | Somalia | SSF | No National ID |
| 161 | South Africa | SSF | A Centralized Model |
| 162 | South Sudan | SSF | A Centralized Model |
| 163 | Spain | ECS | Federated model |
| 164 | Sri Lanka | SAS | A Centralized Model |
| 165 | St. Kitts and Nevis | LCN | A Centralized Model |
| 166 | St. Lucia | LCN | A Centralized Model |
| 167 | St. Vincent and the Grenadines | LCN | A Centralized Model |
| 168 | Sudan | SSF | A Centralized Model |
| 169 | Suriname | LCN | A Centralized Model |
| 170 | Swaziland | SSF | A Centralized Model |
| 171 | Sweden | ECS | Federated model |
| 172 | Switzerland | ECS | Federated model |
| 173 | Syrian Arab Republic | MEA | A Centralized Model |
| 174 | Taiwan, China | EAS | A Centralized Model |
| 175 | Tajikistan | ECS | A Centralized Model |
| 176 | Tanzania | SSF | A Centralized Model |
| 177 | Thailand | EAS | A Centralized Model |
| 178 | Timor-Leste | EAS | A Centralized Model |
| 179 | Togo | SSF | A Centralized Model |
| 180 | Tonga | EAS | A Centralized Model |
| 181 | Trinidad and Tobago | LCN | A Centralized Model |
| 182 | Tunisia | MEA | A Centralized Model |
| 183 | Turkey | ECS | A Centralized Model |
| 184 | Turkmenistan | ECS | No National ID |

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|---|---|---|---|
| 185 | Tuvalu | EAS | No National ID |
| 186 | Uganda | SSF | A Centralized Model |
| 187 | Ukraine | ECS | Federated model |
| 188 | United Arab Emirates | MEA | A Centralized Model |
| 189 | United Kingdom | ECS | User-centric model |
| 190 | United States | NAC | User-centric model |
| 191 | Uruguay | LCN | A Centralized Model |
| 192 | Uzbekistan | ECS | Not Available Data |
| 193 | Vanuatu | EAS | No National ID |
| 194 | Venezuela, RB | LCN | A Centralized Model |
| 195 | Vietnam | EAS | A Centralized Model |
| 196 | Yemen, Rep. | MEA | A Centralized Model |
| 197 | Zambia | SSF | A Centralized Model |
| 198 | Zimbabwe | SSF | A Centralized Model |



## 5. DISCUSSION AND CONCLUSION

This work highlights the current state and mode of electronic ID management for its citizens by different governments. The findings show some stark contrast between the developed and developing countries.

Most developed countries have a working EID policy and model currently in service. Another important fact came out from this study about the developed countries: the evolution of the national ID to a federated system encompassing multiple government services to a single identity.

In comparison to that, developing countries are still using a more traditional centralized ID system, which is less scalable in terms of accommodating numerous services seen in modern governance systems.

In the future, we plan to integrate a more structural comparison of the citizen identity systems of developing and developed countries which are expected to help the EID policymakers and infrastructure planners to come up with a more secure and user-friendly platform.

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