REPUBLIC AND CANTON OF GENEVA
State Chancellery

Warning

This is an edited translation of the official report on internet voting presented by the Geneva State Government to the Geneva State Parliament in May 2006 and adopted by the Parliament in June 2006. This report is labeled RD 639 in the Geneva official denomination of official documents.

The version of the Geneva internet voting application presented in this report is known as V2. The version currently in use is V3. Therefore, the technical aspects presented here do not anymore fully coincide with the reality of the eVoting system as of today.

July 2007

State Council's Report

to the Grand Council on the Geneva electronic voting project

Pursuing the dialogue

Switzerland is a nation built on the will of its citizens to construct a common future by inventing a model enabling the cohabitation of liberals and conservatives, Catholics and Protestants, Latin and German-speaking, town- and country dwellers. This model rests on the principle of dialogue and consensus. Elections are a high spot in the national dialogue, a chance for the people and the authorities to conduct institutionalized exchanges.

Since the advent of what is known as 'direct'[1] democracy, at the turn of the 20th century, the national Swiss community functions on the basis of a close and frequent dialogue, symbolized in the 'Landsgemeinde'[2]. These meetings offer an ideal embodiment of the proximity between citizens and between citizens and their authorities.

For a long time, the polling station was the arena for this two-way dialogue. People went there just as much to socialize as to vote. Changes in society and citizens' leisure activities have kept a large proportion of the electorate away from these focal points of civic life. Geneva realized over twenty years ago that it needed to re-establish the bases of this dialogue. And so the postal vote was born.

An ambition to reach out to citizens

The success of postal voting can be summed up in two statistics: 95% of votes transit through the post office (except when eVoting is also on offer) and, in Geneva, this ballot method has increased ballot turnout by twenty percentage points.

This second statistic is an important one. Our societies are built on universal suffrage, which has long supplanted the voting system based on the poll tax. No-one would have believed it possible; therefore, that access could be blocked to voting.

The success of postal voting lies not only in the fact that it is a comfortable means of voting, but also in the fact that the ballot comes to the voter, rather than relying on the voter to come to the ballot.

[1] *The Swiss « direct democracy » is characterized by the possibility for citizens to challenge a law (referendum), propose new laws (initiative) and to elect their representatives on a personal basis rather than on a party basis. This system, born in Zurich the 1880s and developed ever since, is replicated at the federal, cantonal and municipal levels.*

[2] *The word Landsgemeinde applies to the citizens' assembly that take place in the main square of the cantons' capital city, where people vote by raising their hands. Two cantons still maintain this voting assembly.*

However, the still high level of abstention indicates the continued existence of a barrier to participation. Voting by the internet helps to break down that barrier by reaching out to a category of the population that is defined by its use of information technologies, rather than in terms of age, gender or earnings.

Faced with this situation, jurisdictions need to show creativity to allow the greatest number access to public life. The eVoting project forms part of this goal. Ten years after the widespread introduction of the postal vote, eVoting proposes a new form of dialogue aimed at the community of internet users, a category of the population that simply did not exist ten years ago. Voting by the internet satisfies a need, as shown by all the polls conducted since 2000 on the online services that are most popularly requested by the Swiss.

The most recent poll to date, the 3rd 'eGov Trendbarometer' conducted with the support of the 'eGov' competence centre of the Bern HES higher education college and published in March 2006, indicates that 70% of the 1,006 Swiss interviewed between the ages of 18 and 74 would welcome online voting (ballots and elections). If we regroup the desired services into categories, online voting emerges as the second service most in demand, after various transactions linked to change of address.

Two complementary methods

The two existing methods of remote voting, postal and internet, are not mutually exclusive, they complement one another. The distribution of votes over time, in effect, differs depending on the method chosen. Electronic votes clearly increase in number during the final week of the ballot, whilst the number of postal votes rises gradually[3].

Impact on electoral campaigns

As stated above, the distribution of eVotes over time differs from that of postal votes. The former are concentrated within the closing period of the vote, whilst postal voters tend to cast their votes at the beginning and end of the voting period. We know, of course, that at federal level, the ballot period is established by federal law[4], a more widespread use of the electronic vote would therefore enable political forces to view differently the temporal deployment of election campaigns to take this phenomenon into consideration.

Such redeployment would enable political parties to modulate their messages over time and offer the certainty that actions implemented at the end of the campaign would reach a large number of citizens having not yet voted.

Strengthening democracy

The socio-political studies conducted as part of the eBallots ensure that democracy will emerge the winner from the widespread introduction of eVoting.

In the eight official ballots conducted via the internet in Geneva at municipal, cantonal and federal level, the share of online votes regularly exceeded 20% of all votes cast, irrespective of total turnout. The share of online votes did not vary with global turnout, but remained stable independently of the consolidated turnout rate. This offers a first indication of the fact that eVoters are not simply attracted by the novelty of the system, only to switch to another channel immediately afterwards, but that they instead constitute a group that is stable in its behavior.

This observation is corroborated by a second statistic: 90% of people having voted online remained loyal to this method. This fact is particularly important if we consider that 5% to 10% of users did not vote before. eVoting could therefore ultimately increase turnout.

Who uses the electronic vote?

Two surveys conducted by the E-Democracy Center (EDC) of the Geneva University during the municipal ballots of Carouge (April 2004) and Meyrin (June 2004), on the one hand, and the Federal and cantonal ballot of 26th September 2004, on the other, allow us to trace the profile of the typical eVoter.

In an ordinary ballot, people aged over 60 represent 5% to 6% of the registered voters, but 10% to 15% of actual voters. Conversely, young people aged under 30 form 10% of the

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[3] Under Swiss and Geneva laws, the voting period lasts for three weeks for federal ballots and two weeks at least for cantonal and municipal matters.

[4] Art. 11, para. 3 of the Federal law on political rights, (RS 161.1.; LDP).

population, but only 5% of voters. With the advent of the eVote, the proportion of young voters reverts back to their actual demographic importance, i.e. 10%.

This ballot method is neutral in terms of results, but it increases the legitimacy of decisions by widening the active voter base. Furthermore, on the basis of a representative poll, it was observed that eVoters were to be found equally in each political family.

The eight ballots held thus far in Geneva have shown that eVoting satisfies the needs of an electorate with a very clearly defined profile. That profile is not expressed either in terms of politics, education, earnings, sex or age, but in terms of attitude towards new technologies. The electronic vote attracts people who have made those technologies an instrument of everyday life, whatever their sociodemographic status.

Proven security

Security is a key component in the success and legitimacy of the electronic vote. In the voting context, optimum security means that the choice of each voter should be registered exactly as it has been expressed and that voter anonymity should be preserved. In other words, the link between the voter's PC and the eBallot box should be inviolable, as should the eBallot box itself. Furthermore, it must not be possible to have someone vote for a third party.

Both aspects have been constantly uppermost in the minds of the authorities and project group during the development of the eVoting application. In the field of computing, security is not a definitive and irrevocable given, but a permanent process of updating systems and procedures to adapt them to advances in technology and the new computing systems available. For this reason, this aspect of things is constantly monitored by the Swiss Confederation's 'eVoting' expert group.

The Geneva project group itself has continued to test, to have tested and to request studies and opinions, in order to maintain the highest level allowed by technology and compatible with a simple interface for voters. It would be therefore more accurate to speak of a 'constant security initiative', rather than just 'security measures'.

Optimum security is achieved by the proper balancing between two requirements: userfriendliness and user safety. Rather than impose the voter to a degree of discipline that would take away all the attraction of online voting, or be ignored, the canton of Geneva has opted for a concept comprising several concentric layers of measures: technical, encryption, encoding and validation, all of which guarantees both security and ease-of-use.

The entire infrastructure implemented by the State for eVoting is cloned to ensure that technical breakdowns do not interfere with the ballot or cause a loss of data. The link via which the voting transaction is conducted between the voter's PC and the state server is rendered secure in accordance with the very latest technical standards.

Engineers at the State Information Technology Centre and at the State Chancellery DOSID (Information Systems and Vote Counting Division) have upgraded the entire system (routers, firewalls, antivirus software, servers and operating systems) and 'tailored' all specific settings. Any experienced computer hacker using his own PC to attempt to activate controls normally unauthorized during the voting procedure would receive no response and see no effect of his attempts. Conversely, any behavior of this type would trigger an alarm that could allow the hacker to be traced via his address on the network.

A series of hacking attempts commissioned by the State, outside the ballot period, in order test the solidity of the application, proved this latter to have a very high degree of resistance. None of these attempts were able to penetrate the various barriers put in place.

The anonymity of online voters is firstly preserved by dint of the fact that the eVoting system contains no nominative lists. It merely contains a file comprising valid voting card numbers to admit 'genuine' voters and deny 'false' voters access. Thus, anyone managing, by an extraordinary stroke of chance, to read a vote could only discover the voter's number.

We should point out in this respect that 6 digits are added to the voting card with the effect of reducing the likelihood of someone stumbling on a valid number by accident to one in 5 billion.

Secondly, voter anonymity is preserved by mixing the contents of the eBallot box prior to opening. A mathematical algorithm is applied to the contents of the ballot box before it is opened to ensure that the eBallot papers are read randomly and not in the order in which they arrived.

For all the above reasons, eVoting is at least as secure as postal voting, which is the fundamental requirement forming the basis of this project.

There are also three additional reasons:

– no manual handling of the ballot papers is involved in eVoting;
– it is impossible to accidentally invalidate a vote and the citizen can be sure of having cast a valid vote;
– the voter receives confirmation of his vote's registration via a message displayed on-screen at the close of the transaction.

Finally, the fact that the voter is required to identify himself by providing his secret code, date of birth and place of origin, thwarts any attempts at usurping his identity. In effect, there is no public register in existence containing dates of birth or municipality of origin. Thus, the mere act of being in possession of a third party's voting card does not mean that a person can vote in his stead.

A project crowned with success

The Geneva eVoting has featured prominently in several international competitions devoted to online administration and has also been awarded a national distinction. In 2003 and 2005, it was a finalist in the eEurope Awards, a competition organized by the European Union.

In this respect, the Geneva project was included in the list of innovative European projects in Como (Italy) in July 2003 and Manchester (England) in November 2005, on the sidelines of the biennial European ministerial conferences devoted to information technologies. In both cases, it was the only Swiss project having reached this stage of the competition.

In October 2004, the Swiss society for administrative science (SSAS), presided over by the Confederation chancellor, Ms. Annemarie Huber-Hotz, awarded a prize to the Geneva eVoting application as part of its twentieth anniversary celebrations. The project was noted for its multidisciplinary, technical, sociological, politological and legal approach, as well as the care taken to keep citizens informed and in touch.

When presenting its motivations, the jury wrote in particular of an 'innovative Swiss and European level project, systematic project management, with baseline surveys and for every test, analysis of results and impacts, communication and gradual extension to Federal votes, desire to increase voter representativity (…).'

Finally, in 2006, the Geneva project was a finalist in the Stockholm Challenge, a worldwide competition for IT-based applications.

Financial aspects

According to the agreement signed with the Swiss Confederation, this latter covered 80% of development and equipment costs, namely the sum of CHF 1,411,000. Between 2001 and 2004, the equipment required by the eVoting project cost CHF 740,000 and further developments cost 1,024,000, namely a total of CHF 1,764,000. The balance, i.e. CHF 353,000 was covered by the State's budget.

Thanks to the Confederation-financed project, the network and official State web site infrastructures have been doubled in order to guarantee security. This item alone accounts for CHF 249,000.

The costs of organizing a ballot encompassing online voting were divided by a factor of three between the first ballot of January 2003 and that of April 2005. At present, a ballot conducted according to the two available channels, postal voting and polling station, costs the State around CHF 880,000. This sum may be broken down as follows: CHF 553,000 in external costs, CHF 202,000 in internal costs and CHF 125,000 in State-internal computing costs.

The sum of CHF 880,000 therefore represents, for a ballot with a 50% turnout rate, a unit cost of CHF 8.80 per vote.

For an operation at canton level, the additional operating costs required for internet voting are around 7.5% of the current cost of a ballot. Those costs are as follows: CHF 27,700 for the printing of voting cards with secret code and CHF 9,800 for digital certificates and other computing costs. A further CHF 31,500 in internal personnel costs should be added for the running of the online administration platform.

The cost of an operation held today across the entire canton would be recouped by the savings made on mailing and postal vote processing costs. For each vote, in effect, the internet helps save CHF 0.78 in mailing costs, CHF 0.22 in postal processing costs and CHF 0.25 in SVE processing costs. Overall, once the 30,000 eVote mark is achieved, the project starts reaping its rewards.

The internet voting system is entirely the property of the State. Moreover, the Geneva courts recently admitted that the State could enjoy copyright over the source code and certain aspects would even be patentable. This therefore raises the question of what would be the possibilities for marketing the concept.

Marketing in other Swiss cantons is problematic, since the financing from the Confederation necessarily entails sharing the results of the experiment with the other cantons. However, marketing abroad is certainly an option. Many foreign delegations and international companies have taken a close interest in the project, to the point of sending their representatives to Geneva during an online ballot.

The system could be marketed either by direct sales of program 'sources', the direct sale of licenses, or by creating a public law entity that could handle sales and retrocede the results to the State.

Regardless of the option chosen, it would be possible to directly or indirectly finance the future development of online administration by these means. Depending on the type and content of the licenses sold, the selling price could be estimated at between CHF 50,000 and CHF 300,000.

Conclusion

Interest in eVoting has increased since the Council of Europe passed a catalogue of recommendations in September 2004, which constituted the initial, non-binding legal basis for eVoting under international law[5]. The Federal Chancellery, as well as the Chancelleries of Geneva and Neuchâtel have taken an active part in these efforts.

Today, the use of eVoting is destined to spread across Europe. Estonia has already applied it to the whole of its territory and France, Spain and the Netherlands to their expat citizens. In this respect, it is important to underline the fact that 480,000 Swiss people over the age of 18 live outside the country, i.e. the equivalent of 10% of the 4.8 million voters registered in Switzerland. However, only 95,000 are registered as voters in their municipality of origin, notably due to practical difficulties experienced in exercising their civic rights abroad, despite the postal voting system. Both our citizens abroad and Switzerland's disabled need a system giving them effective, personal access to voting.

Finally, it is important to note that Geneva is the canton with the highest percentage of voters abroad. Geneva's expats alone represent some 12.6% of Swiss voters abroad (and some 5.3% of the cantonal electorate), whilst Geneva voters domiciled in the canton represent only 4.5% of the total of Swiss voters. Geneva's expats are clearly interested in the political life of their canton and are keen to participate therein.

Switzerland leads the world in direct democracy and therefore can and must take its place at the head of this movement towards electronic democracy, which is extending the existing possibilities of popular participation. It is the firm wish of the Federal government. True to its pioneering spirit, Geneva is able to play a key role in this movement.

You will find full technical details of the Geneva pilot project appended hereto.

IN THE NAME OF THE STATE COUNCIL

The Chancellor:
Robert Hensler

The President:
Pierre-François Unger

Appendix:
'Pilot project eVoting, appendix to the Council of State report to the Grand Council'

[5] *R (2004) 11 of 30th September 2004 can be viewed on: www.coe.int/t/e/integrated_projects/democracy/02_Activities/02_e-voting/01_Recommendation/Rec(2004)11_Eng_Evoting_and_Expl_Memo.pdf*

ELECTRONIC VOTING

Appendix to the state Council’s report to the Chamber of Deputies

RESUME

In March 2001, the Geneva State Council approved the launch of the Geneva internet voting project. A month later, a letter of intent and a contract were signed with the Swiss Federal authorities establishing norms between Geneva and two other Swiss Cantons. In January 2003, Geneva successfully organised the first online vote to be held in Continental Europe.

Since then, Geneva has organised seven other online ballots. Altogether, these eight ballots have confirmed that online voting, a system conceived and owned by the Geneva State Government, works perfectly, respecting both the Swiss Federal and Cantonal legal requirements and security guarantees. The procedures used in the online system were universally approved by the electoral commission and all the political parties involved.

Switzerland is founded on the premise that all Swiss should construct their future together by consensus and democratic dialogue. The many ballots are the culmination of this dialogue between the people and their Government on all subjects where future national policies are decided.

Since the accession to the so-called ‘direct’ democracy at the beginning of the 20th century, the national community frequently exercises its right to discuss debate and decide. The most symbolic example of these exchanges is the Landsgemeinde, because the discussion between citizens takes place at horizontal, rather than vertical level. It is the people who elect the governing Magistrates to their public responsibilities. These meetings offer an ideal illustration of the proximity of the people to their governments.

The polling station was for a long time the arena for this two-way exchange of views: people went there just as much to socialize as to vote. The evolutions of society, combined with the leisure activities of voters, have made these community focal points a thing of the past. Geneva realized more than 20 years ago that this was the case and so introduced postal voting.

In a changing society, methods of wooing voters have also evolved. Ten years after the advent of the postal vote, electronic voting permits a new form of dialogue via internet users, a category of voters that simply did not exist 10 years ago.

This observation underlines the paradox in which we live. Despite their small size, Geneva and Switzerland are not immune from social segmentation, or the breakdown of the public into groups, with sub groups becoming increasingly numerous as lifestyles evolve.

In this context, the Geneva authorities decided that in order to reach the largest sectors of the population, they had to find a creative solution to encourage people to participate more in political and civic life.

However, creativity in this domain requires precise and clear direction. It is a matter that must be decided in Parliament. New ideas do not replace existing tenets; they should complement what already exists, in order to enlarge the whole system. Albert Camus said, somewhat prophetically, that the challenge we face is to not change the world but to make sure that it does not fall apart. The electronic voting project has been conceived with this in mind.

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APPENDIX to the State Council report to the Chamber of Deputies

1. Introduction

The present report to the Chamber of Deputies, aims to sum up, 4 years' work and eight polls later, the prospects of electronic voting in the legal, political, operational, technical and socio-political areas and to initiate the adaptation of the Geneva State law of 15 October 1982 on political rights and duties.

The Geneva project on internet Voting was born in the year 2000, as discussions were underway within the Government to bring the Geneva administration on-line. The State Chancellery was mandated by the Government to develop electronic voting for Geneva. This method was not planned to replace existing methods, but to enhance them.

In the same year, the Swiss federal Parliament invited the Federal Council (government) to investigate the ways in which Information Technology (IT) could be employed in the framework of the democratic institutions.

And so the Geneva concept became part and parcel of a federal pilot project, which also included the cantons of Zurich and Neuchatel. Everybody benefited from the arrangement, the cantons were subsidized by the federal government and the Confederation was able to have groundwork performed in three different cantons, all working on their versions of the same project.

Voting is not something that can be left to the private sector. The Geneva Government is the owner of its online voting application. This application has been developed by the State Information Technology Centre (hereinafter CTI), with the collaboration of two private companies chosen by tender. This partnership allowed the Geneva Government to draw up made-to-measure specifications and to include all necessary elements to ensure the transparency and smooth running of polls. Since 2004, the operation and development has been the responsibility of the CTI and Geneva Chancellery's Information Systems and Vote Counting Division (hereinafter DOSID).

After three years successful operation of online voting, Geneva is unique in being the first State Government to have this experience. The State Council's (State government) IT delegation was the prime movers behind the project. The Political Rights Commission of the Geneva Chamber of Deputies was kept regularly up to date with developments by the State Chancellor, together with members of the working committee.

From a legal point of view, the State Council relied on article 188 of the LEDP (cantonal law on political rights), as well as on the federal law on political rights.

Numerous controls were carried out during the development stages, including controls by the State Computer Control Commission (CCIE) and the State Information Systems Committee. Their controls complemented the ongoing work being done under the auspices of the State Chancellery.

The present report has been written under the leadership of Michel Warynski, Director of DOSID, and Michel Chevallier, Under Secretary at the State Chancellery, as well as by a group composed (in alphabetical order) of Patrick Ascheri, Director of the State Votes and Elections Service (hereinafter SVE), Jean-René Eudes, responsible for the Transversal Structures division, CTI, Jean-Marie Leclerc, CTI Director General, Jean-Marc Verniory, Deputy Director of Legal Affairs, State Chancellery (hereinafter DAJ) and Fabien Waelti, Director DAJ.

2. Voting and turnout in Geneva

2.1 Ballot box voting

Ballot box voting is the traditional voting method throughout Switzerland. It has been in use since 1847. However, since the 1940's turnout has been in strong decline. Women's right to vote, at cantonal level since 1959, and federally since 1970, has not decreased this tendency.

The decline in turnout is by no means totally connected with the ballot box method, but in the 1980's it became evident that in order to increase turnout new, modern methods should be devised.

From an average of 60%-70% in the 1930's, turnout by Geneva voters in federal polls dropped to around 40% in the mid 1940's. In federal Elections, the decline is less brutal, from 60% in the 1930's to approx. 50% in the 1940's and then wavering between 35% and 45% in the 1950's.

For cantonal polls turnout during the 20th century is historically full of ups and downs. In the first half of the century, we witnessed, in one decade, turnout ranging from 8% to 80% according to the issue at stake. Rock bottom was reached between the 1960's and the start of the 1990's, when turnout fluctuated between 20% and 40%. In the mid 1990's, with the introduction of postal voting an increase was noted.

At the same time, cantonal elections evolved more steadily. In the first half of the 20th century, turnout ranged between 50% and 85%. Since the end of the 2nd World War, turnout has never been over 60% and currently stands at between 35% and 45%.

This brief synopsis shows there is a twofold question to be answered: how to increase turnout as much as possible and how to maintain a high turnout in the long term. This will allow for a strong and active democracy.

2.2 The postal vote

At the beginning of the 21st century, postal voting has become the dominant voting method in Switzerland. Two thirds of Swiss use postal voting, in Geneva the figure is 95%. At the instigation of the State Council, Geneva pioneered postal voting. First tested in 1991, postal voting was generalized in 1995.

As a result, turnout increased by 20 percentage points in 10 years. After registering an average of 30%-35% between 1960 and 1990, today Geneva registers regularly 45% to 55% turnout. Having had one of the lowest rates of turnout in the country, Geneva has now one of the highest. It is interesting to note that the political balance remains unaltered.

Systematic controls of postal voting have been made. Each card is checked to ensure that the date of birth is correct and that the card has been signed; all signatures are compared to previous polls to check for any differences and 4,000 to 8,000 voters are telephoned to ensure that they themselves voted in a free environment. In 10 years, these controls have not uncovered a single case of fraud.

Public confidence in the authorities, together with the positive controls conducted by the Geneva votes and elections service (SVE), not to mention the different political parties' own controls, have allowed postal voting to become ingrained in the Geneva State system. There is now no question of uncertainty or contesting the veracity of the results.

Should the whole system stay as it is? In fact, turnout in the under 40 age bracket is still weak and the postal vote has not improved this situation. Also Swiss expats overseas, or even in some parts of Europe, are often excluded because of the slowness of international mail. Also, handicapped and blind people cannot vote alone. So what is the answer?

2.3 On-line voting

These assessments and questions convinced the Geneva State Council, in the summer of 2000, to participate in the federal pilot project on online voting.

As with postal voting, the online vote is an absentee vote. This implies, by analogy, the following particularities:

- The State Chancellery presides over absentee voting and the handling and administration of these votes (article 36 cantonal law on political rights);
- Citizens may vote as soon as they have received the electoral material, that is usually in the three weeks preceding the actual official voting date.
- Ballot papers must arrive at the SVE by 12 noon on the Saturday preceding the closing of the polls.
- For referendums and initiatives, absentee votes may be counted on the Sunday morning of polling day witnessed by controllers appointed by the State Government.
- All necessary security measures should be taken to ensure the confidentiality of the vote count until all the polling stations have closed.http://www.ge.ch/legislation/rsg/f/s/tab/A5_05.html
- Absentee votes are verified, identified and registered on arrival. The vote is then placed in the ballot box corresponding to the correct constituency of the voter.

3. The origin of the eVoting project

3.1 The Federal context

3.1.1 The desirability of eVoting

According to the GFS Institute, which mainly conducts voting surveys for the Federal Government, between 50% and 55% of the electorate only participate in votes based on the issues at stake and the chance to build their own opinion on the topic[6]. These factors do not explain the whole story. The fact that absenteeism is more pronounced among young people is, for example, not taken into account in this reference grid.

On the basis of surveys conducted in 2003 and 2004 at the request of the Federal Chancellery and focusing on a sample of 4,018 voters, GFS underlines the fact that 79% of young people aged between 18 and 29 are planning to vote via the internet. This propensity is also strong among 30-49 year olds. GFS similarly underlines the fact that eVoting is particularly attractive to people who never participate in votes, or only occasionally.

All the opinion surveys conducted at federal level since 2000 have shown that, across all age brackets, most Swiss people would like to be able to vote via the internet. A survey commissioned by the Federal Chancellery and conducted by GFS in 2003 indicates that eVoting is considered the most desirable online service by the Swiss population, next to change of address[7].

3.1.2 Socio-political context

It is safe to say that two factors played a role in the Federal Council's decision to mandate three cantons to develop voting via the internet: firstly, the 'complementarity' of the direct democracy system and internet network, and secondly the relative tardiness on the part of the Swiss public administrations in implementing IT-based applications.

In its 'Report on eVoting, Opportunities, risks and feasibility'[8] of January 2002, the Federal Council wrote: 'With its semi-direct democracy system, Switzerland is admittedly a case apart in the community of sovereign states, but the remaining states, or at least some of them, tend eventually to extend the political rights of their nationals or inhabitants. By introducing the electronic vote, Switzerland could therefore play a pioneering role in the

[6] GFS Institute, 'eVoting potential', January 2005, www.admin.ch/ch/f/egov/ve/dokumente/potenzialwik2005f.pdf

[7] The press release outlining this poll is available at www.admin.ch/ch/f/egov/gv/themen/privatanbieter/Pressemitteilung_GFS_f.pdf. A summary of the report in French is available at www.admin.ch/ch/f/egov/gv/berichte/9c.pdf

[8] This report is available at www.admin.ch/ch/f/ff/2002/612.pdf

subject and show the world, notably the major states and supranational organisations, that electronic resources can help them, too, to introduce an element of direct democracy[9].'

In other words, the electronic vote facilitates the introduction of direct democracy, but at the same time, direct democracy also facilitates the adoption of the electronic vote.

The second trigger factor in the Federal Council's decision rests on the observation that the GDP per inhabitant in Switzerland is comparable to that of Scandinavian countries, and also the fact that this country is lagging behind these latter as regards internet access and online administration. However, it has been established that it is not the volume of IT infrastructures or the number of internet connections that determine the transition towards an economy of knowledge and information, but that this transition depends on an effective use of those technologies and the service offering available via electronic networks.

3.1.3 Facilitating factors

It may seem strange that Switzerland, a country whose inhabitants still gather to vote by a show of hands, is developing an internet voting system. Yet we are forced to acknowledge the fact that Switzerland enjoys a number of factors that facilitate the implementation of eVoting:

- Direct democracy means that citizens are called to the ballot box four or five times a year, sometimes more. Comfort and simplicity in the voting procedure are important considerations, as seen by the success of the postal vote conducted at home.
- In Geneva, the postal method accounts for 95% of votes. Its introduction has had the effect of increasing ballot turnout. Internet voting should help to consolidate this trend by offering a second method of remote voting.
- Direct democracy lends itself to eVoting, not only because it presupposes a large number of ballots, but also because by granting vast powers to citizens, it creates a 'horizontal' political system, virtually in the form of a network.
- According to the Federal Office of Statistics (hereinafter OFS), 2/3 of the Swiss population has an internet access, either at home or at the workplace. One in three Swiss people surf the web daily.
- 480,000 Swiss people over the age of 18 are expats, i.e. the equivalent of 10% of the 4.8 million voters registered in the country. Yet only 95,000 are registered as voters in their canton of origin, mainly due to the practical difficulties experienced in exercising their civic rights, despite the postal voting system. Both our citizens abroad and Switzerland's disabled need a system giving them effective, personal access to voting.
- In Geneva, there are 12,000 voters living abroad out of a total of 223,600 voters at end June 2005. In percentage terms, Geneva is the canton with the most voters abroad. Geneva's expats in themselves form some 12.6% of Swiss voters abroad, whereas Geneva voters domiciled in the canton only account for 4.5% of the total number of the Swiss electorate. Geneva's expats are clearly interested in the political life of their canton and are keen to participate therein.
- Voters under the age of forty are underrepresented at the ballot box, which weakens our democracy. Internet voting can increase their turnout.

3.2 The 'eVoting' work group

The 'eVoting' work group came into being on 30th June 2000 by decision of the Federal Chancellery. It comprised representatives of the Bern, Geneva, Neuchâtel, St-Gallen, Ticino and Zürich cantons and of the OFS. Three member cantons of this group, namely Geneva, Neuchâtel and Zürich, signed a letter of intent with the Federal Chancellery to develop an eVoting system. These are the pilot cantons. In a spirit of federalism, three other cantons sit on this work group to raise issues specific to their institutional situation and are the first to benefit from the work of the three pilot cantons.

[9] Point 3.1 letter g, page 622

3.2.1 Organisation

This work group is divided into sub-groups in the following manner:

- 'Strategy' sub-group;
- 'Technology' sub-group;
- Geneva pilot project support group;
- Neuchâtel pilot project support group;
- Zurich pilot project support group.

3.2.2 Role

This structure constantly audits and monitors the pilot projects through a number of practitioners in the various specialities (law, IT, security, ballot organisation, etc.) implemented by the three projects. Its purpose is also to permit an exchange of know-how between the pilot- and remaining cantons, in order to ensure the seamless implementation of eVoting throughout the country.

3.2.3 Work

The first task of the federal work group consisted in conducting a survey among all cantons as to their legal provisions on eVoting, their interest in the subject and their plans in this area.

In August 2004, the Federal Chancellery published an interim report entitled 'The eVote in its pilot phase'[10], in which it announced that the composition of the 'eVoting' work group would be modified in the first half of 2005 to allow it to be extended to all cantons so desiring it. This expansion marks the start of the process whereby know-how will be transferred from the pilot cantons to all cantons, a process that should ultimately lead to the widespread practice of eVoting.

The current composition of the work group is as follows: the cantons and semi-cantons of Appenzell Innerhoden and Ausserhoden, Aargau, Basel-City, Basel-Country, Bern, Fribourg, Geneva, Glarus, Grisons, Jura, Lucerne, Neuchâtel, Nidwalden, Obwalden, Schaffhausen, Schwyz, Solothurn, St-Gallen, Ticino, Thurgau, Uri, Valais, Vaud, Zug and Zürich. Its members also include the Swiss City Association, the Federal Chancellery, the Federal department of foreign affairs, the Federal department of justice and police, the Federal commissioner for data protection, the Federal computing office and the OFS.

3.3 Federal definition of eVoting

In federal terminology, the term 'eVoting' is used to describe a series of institutional acts:

- The expression of an opinion (for or against a subject put to the vote, for or against one or more candidates), at all levels of political life, using electronic means; as well as the granting and receiving, controlling and counting of electronic votes.
- The rationalisation efforts undertaken in areas such as the establishment of results, statistics and the publication of the results of votes and elections.
- The support that electronic means can provide for the administrative activities undertaken by the authorities and groups putting themselves forward for National Council (national parliament) election.
- The collection, checking and counting of electronic signatures in the framework of referendums and initiatives[11].
- The provision of electoral information to citizens ('Explanations provided by the Federal Council and Chambers', forms, etc.) in the form of electronic files.
- Electronic communication between the authorities and citizens (electronic messaging).

[10] Available at www.admin.ch/ch/f/egov/ve/dokumente/Zwischenbericht.pdf.
[11] This point, closely linked with the electronic signature, has not undergone any developments as yet.

The federal project has been conceived with precision, rigour and broad-mindedness. In its 'Report on the electronic vote, Opportunity, risks and feasibility' of January 2002, the Federal Council in particular asserts the fact that[12]:

- eVoting should be as easy, practical and safe as possible.
- It should under no circumstances penalise citizens who have no access to electronic communication methods.
- The electorate should be able to express themselves in one and the same poll on federal, cantonal and municipal issues.
- The technical infrastructure should be reliable.
- The system should make it possible to verify voting capacity.
- It should help prevent abuse, facilitate the counting of all votes and protect voting secrecy.

3.3.1 Security requirements

In the same report, the Federal Council specifies the degree of security expected of eVoting systems. In the section headed 'At least as secure as for traditional procedures'[13], the government emphasises the fact that 'the new system should be […] as secure as the current system, which does not mean it should be 100% secure.'

This requirement was adopted and developed in the Ordinance on political rights (hereinafter ODP; cf. point 5.1 below, entitled 'The legal foundations of eVoting'). This latter specifies in particular:

'Art. 27*d* Conditions for granting authorisation

[1] The Federal Council grants authorisation to the canton, providing this latter satisfies the conditions listed hereunder and under art. 27*e* to 27*p*. The canton should, in particular, ensure that:

a. only the electorate is able to take part in the ballot (after verification of voting capacity);
b. a voter will only have one vote and will only vote once (one man, one vote);
c. it is impossible for third parties to capture, modify or systematically deviate electronic votes and decisively influence the main result of the vote or election (i.e. the guarantee that the citizens' wishes are expressed);
d. it is impossible for third parties to know the content of votes (i.e. the guarantee of voting secrecy);
e. all votes cast will be taken into consideration during the count (i.e. the guarantee that the citizens' wishes are being faithfully expressed);
f. the possibility of any systematic fraud is ruled out (i.e. a ballot compliant with the rules).

[2] It can only grant the canton authorisation to proceed with pilot tests comprising an access code, access right or electronic signature if it receives the assurance that:

a. it is impossible for third parties to capture, modify or systematically deviate access codes, access rights or electronic signatures;
b. it is impossible for third parties to systematically falsify electronic signatures or systematically usurp access codes or access rights;
c. the security measures provided exclude any danger of systematic, targeted fraud.

[3] To obtain the authorisation of the Federal Council, the canton must in addition prove that it has the necessary technical infrastructure, personnel and financial resources enabling it to conduct the pilot tests in question and that it has informed or will inform the electorate, in a manner that is understandable to them, of the way in which the electronic vote is organised, technically conceived and will be handled'.

The Geneva State Council has adopted these requirements and has integrated them into the orders it has issued prior to each electronic vote organised in Geneva.

[12] Point 2.2, page 619
[13] Point 4.1, page 632

4. The Geneva approach

4.1 The internet and political life

Since 1997, the results of votes and elections organised in the canton have been available on the internet as of the Sunday afternoon of the ballot. During the 2001 cantonal elections, over fourteen million pages were visited in one month. Peaks in the consultation of the state government's web site are verified at the time of each ballot, particularly during elections, although they do not always reach such high levels.

Aside from these statistical assertions, such sudden surges in the frequentation of the State Government's web site during cantonal political elections testify to the growing role of the internet in the political information of citizens and the trust they place in the canton's official site. The search for information on this site expresses a desire for pure information, rather than information that has been massaged or annotated.

In order to satisfy this desire, the official brochures published by the authorities specifically for cantonal votes have also been provided for consultation on the state government's web site since 1998. The results of ballots since 1993 have been made available online, in archive form.

However, the internet also stands for interactivity, in other words the possibility of interacting with a correspondent via e-mail or forums. It is therefore possible to contact the authorities and members of the civil service by electronic mail. On several occasions, the cantonal departments have launched online forums, for example to promote the cantonal Agenda 21 and to answer questions on sustainable development.

4.2 Launch of the project

During the Federal Chancellery's presentation of the eVoting project in April 2000, Geneva immediately declared its interest in the concept. Under the impetus of its Chancellery, the Geneva government was at the time fully contemplating the integration of IT in its citizen relations. This thinking focused in particular on the creation of an intranet system for government employees and the development of online administration.

Moreover, the survey conducted among the cantons by the Federal Chancellery highlighted the fact that Geneva was the only Swiss canton to have a centralised computer-based voters' register - a pre-requisite which greatly facilitated the launch of the project - and a legal provision making it possible to put the electronic vote to the test, namely article 188 of the cantonal law on political rights.

On this basis, and with federal backing, the canton began towards the end of the first half of 2000 to work on the electronic vote. The first stage consisted in drafting specifications[14] and organising a tender.

From the beginning, it was decided that the government would be the contracting authority, project manager and owner of the electronic vote application, in order to offer full guarantees to all citizens concerning the impartiality of the online voting system. As a result, a series of constraints were written into the specifications, project implementation and agent management were assigned to the Chancellery and the CTI was involved from the beginning of the project.

The specifications, which were published on 20th November 2000, describe in detail the architecture required by the system. They not only recall the legal constraints applicable to ballots under Swiss and Geneva law, they also, in particular, stipulate that the server containing the electronic votes be situated in a secure place belonging to the government. They also provide that the programs implemented be audited by government-designated experts and that controllers appointed by the parties hold the encryption keys to the eBallot box.

[14] www.geneve.ch/evoting/english/cahier_charges.asp

In March 2001, the Geneva State Council appointed a consortium comprising Hewlett-Packard Suisse SARL and Wisekey, a Geneva company specialising in public key infrastructures and the provision of certificates, as the project's sponsors, under the direction of DOSID. Subsequently, the Geneva-based company Blue-Infinity, backed by its extensive know-how in the field of security, also joined the project partners[15].

In April 2001, a letter of intent and a contract were signed between the Confederation and Geneva for the latter to develop an eVoting application, with the Confederation's support.

Since 2004, the system has been developed and operated entirely by the CTI and DOSID.

5. The legal foundations of eVoting

According to federal legislation, the organisation of federal ballots falls to the cantons. Since Geneva legislation provides that cantonal votes should take place, wherever possible, at the same date as federal votes, detailed arrangements for the exercise of the right to vote during these 'simultaneous' ballots should comply both with federal and cantonal law.

It is important to point out, at the outset, that the Geneva eVoting project is fully in compliance with legal federal and cantonal requirements, as is shown by the fact that the federal Council has already authorised the canton on two occasions to use its online voting application for the federal ballots of 26th September and 28th November 2004.

It is also interesting to note that, aside from the three pilot cantons, seven other Swiss cantons have a legal basis enabling them, where necessary, to organise cantonal or municipal voting by electronic means. These are the cantons of Aargau, Fribourg, Obwalden, Solothurn, Thurgau, Uri, Valais and Vaud.

5.1 Federal law

5.1.1 Anchoring eVoting in the law

At federal level, the legal requirements regarding elections, referenda and popular initiatives are established in the federal law on political rights (hereinafter LDP) and its order (hereinafter ODP)[16]. For Swiss expats, these requirements are specified both in the federal law of 19th December 1975 on the political rights of the Swiss abroad[17] and the federal order of 16th October 1991 on the political rights of the Swiss abroad[18]. These texts provide that votes and elections be conducted by means of ballot papers completed by hand.

Article 84 LDP nevertheless allows the Federal Council to override this law. The text reads as follows:

'1 The Federal Council may allow cantonal governments to decree provisions overriding this law if they intend to use new technologies to establish the results of votes.

2 The use of technological means during ballots is subject to the authorisation of the Federal Council.'

Backed by the prerogatives conferred by this article, the Federal Council proposed the addition of a new article 8a to the LDP. This was passed by the Chambers on 21st June 2002. It came into effect on 1st January 2003 and the text reads as follows:

'1 The Federal Council may, in agreement with the cantons and municipalities concerned, authorise the eVoting experiment, if it is confined to part of the territory, certain dates and certain questions.

2 Verification of voting capacity, voting secrecy and the counting of all votes must be guaranteed. All risk of abuse must be eliminated.

[15] At the time this text is being edited (July 2007), no-one of these companies is associated with the project anymore.
[16] Available at www.admin.ch/ch/f/rs/c161_11.html.
[17] Available at www.admin.ch/ch/f/rs/c161_5.html
[18] Available at www.admin.ch/ch/f/rs/c161_51.html

[3] The eVoting experiment is subject to scientific monitoring and a survey based on the gender, age and qualifications of the electorate in question.

[4] The Federal Council establishes the terms and conditions thereof.'

On the basis of paragraph 4, the Federal Council amended the ODP on 20th September 2002, inserting section 6a on 'eVoting pilot tests' comprising 17 articles. These latter deal, in particular, with the format required for authorisation requests submitted by cantons wishing to implement eVoting, the terms and conditions governing the granting of authorisation, protection of opinions against manipulation, encoding of votes, voting secrecy, verification of voting capacity, protection of electronic votes, establishing of results and the recount of votes in case of anomalies.

Paragraph 3 requests a scientific monitoring of eVoting experiments, in other words the organisation of socio-political type surveys focusing on the impact of eVoting on turnout or electoral choices, for example.

In addition to the above, a Federal Council circular was addressed to the cantonal authorities concerning a partial revision of the ODP entitled: Terms and conditions governing the granting of authorisation to proceed with pilot tests on eVoting[19].

5.2 Geneva law

Geneva has been pinpointed above (point 4.3 'Launch of project') as being the only canton in Switzerland to have included in its legislation a provision enabling trial eVoting. This article 188 of the cantonal law on political rights (hereinafter LEDP) reads as follows:

'In cantonal or municipal matters, the State Council may, with the agreement of the municipalities concerned, to a limited extent and on exceptional grounds, override the provisions of this law establishing the methods for exercising political and vote-counting rights. This latter is with a view to implementing tests aimed at adapting the exercising of these rights to the possibilities opened up by technology.'

The article was incorporated in this way into the proposed restructuring of the LEDP submitted in 1979 by the State Council. It was neither debated nor discussed by the Legislative Council's (cantonal parliament) political rights committee, nor covered at the plenary session during the final debate of June 1982. The political class was unanimous in contemplating the idea of updating the methods of expressing popular will.

The legislative delegation in this article authorises the State Council to pass an order in 'cantonal or municipal matters'. The said article is applicable to the 'methods of exercising political and vote-counting rights, with a view to implementing tests aimed at adapting the exercising of these rights to the possibilities opened up by technology. The eVote falls fully within the scope of this article's application.

However, article 188 of the LEDP does not itself create a directly applicable legal basis. It authorises the State Council to make use of its legislative delegation by passing an act that develops and establishes the new voting system that it intends to bring into operation. Such is the underlying meaning of the orders made by the government prior to each electronic ballot that has been held[20].

5.2.1 Democratic control

Free votes confer upon citizens the right to see that the results of a vote are correctly recorded and established. It is therefore essential for a direct democratic or delegated control system to be introduced to guarantee legitimate results.

Until 1949, therefore, recapitulation and verification were carried out by the polling stations. The president and vice-president of the stations chosen from different parties verified one another.

[19] Available at www.admin.ch/ch/f/ff/2002/6141.pdf

[20] An example of an order can be found on the website www.geneve.ch/evoting/doc/ace_autorisation.pdf.

From 1949, polling station operation remained the competency of the presidents and vice-presidents, whereas recapitulation was introduced into the State Chancellery under the control of the parties' representatives and groups represented on the Legislative Council.

The importance of recapitulation was underlined with the generalization of postal vote in 1995, followed by the introduction of vote counting by optical reader.

Today, in accordance with article 48 of the Geneva constitution, 'the recapitulation of votes is performed in public the day after the polling operation by the State Chancellery and under the control of at least five voters chosen by the State Council from different parties or groups.'

The canton of Geneva therefore enjoys democratic control by delegation, which is conferred to specific 'controllers' appointed by the parties or groups represented on the Legislative Council.

However, citizens are still able to appeal to the Administrative court for complaints about inaccurate establishment of ballot results. In accordance with art. 181 LEDP, which refers to art. 74 LEDP, said court has the competence to order the opening of the ballot boxes to conduct a recount. This latter operation is performed under the supervision of the parties' respective controllers.

Moreover, according to Federal court (hereinafter TF) jurisprudence, cancelling the ballot and organising a new vote are not mandatory if it is possible to calculate the ballot papers that have been incorrectly counted and if the amount is unlikely to amend the result of the vote.

In order to take the jurisprudence factor into consideration in the particular case of eVoting, a proper 'eBallot box' has been set up in which the anonymous, encrypted electronic ballot papers are kept. The structure of this ballot box is such that it is possible to perform the operations required by the TF.

With the implementation of eVoting, the tasks consigned to the controllers are no longer confined to participation in recapitulation operations alone. In effect, they contribute directly and with sole responsibility to the guarantee of voting secrecy, compliance of the encryption program and the regularity of the vote counting operation.

The controllers therefore play a decisive role in the eVoting process, which may be summed up in 3 stages:

- They generate an encryption prior to the opening of the ballot using two encryption keys (password) known only to them. By analogy with the traditional system, the controllers verify that the ballot box is empty; they lock it up and thus prevent access to the votes.
- Together, they test the software application and vote processing by means of a test vote. Using the same procedures and access as voters, they cast a certain number of votes. The count should give the anticipated result, both in terms of number of votes and results. The votes are cast behind closed doors and the results are known only to the controllers. On opening the eBallot box, the State Chancellery announces the result of the controllers' vote and these latter are able to verify the smooth functioning of the voting and counting software.
- They then proceed to open the eBallot box and decrypt the votes (see 6.2.4). The opening of the eBallot box and the generation of the results require the presence of the parties' respective controllers. The latter are required to enter their secret keys into the system in order to decrypt the registered votes.

Therefore, the democratic control method is not fixed and final; it evolves with changing ballot procedures and new technologies. To this end, the State chancellor has left it to the discretion of the controllers appointed by the State Council to order an expert report on the functioning of the chosen system.

5.3 International law[21]

The first legal basis under international law concerning the electronic vote was passed on 30th September 2004 by the committee of ministers of the 46 member States of the Council of Europe (hereinafter CoE), of which Switzerland has been a member since 1963. The recommendations adopted are not legally binding, but due to their unique nature and the consensual process that has led to the drafting and definition thereof, they constitute an important point of reference.

The Geneva project team, heavily involved in the drafting of these standards, is assured of the fact that the cantonal eVoting system is fully compliant.

6. Description of system

The usual approach when transferring a procedure on to an electronic support is to break down the procedure into components in order to reconstruct it as simply and efficiently as possible for the subsequent data processing systems. In such cases, technology sets the precedent.

In the case in hand, the situation is quite different. A legal framework is imperative. It does not allow the structure of the voting act to be changed. Whilst at first glance, remote eVoting may seem similar to eBanking, it differs in one key aspect, namely the voter's anonymity. The approach taken in developing the Geneva online voting application has henceforth consisted in transferring the postal vote onto the internet.

In effect, whilst the identity of the authors of banking transactions must be clearly established and recorded, the identity of voters must be monitored and managed in such a way as to ensure that the same person cannot vote twice. Similarly, the name of the voter should not be stored in the memory or associated with the votes' contents.

Moreover, for internet voting to be an attractive proposition, it has to be swift and easy for the user, while offering a high level of security.

6.1 Operational description of system

The system is now able to take on voting for the entire canton's population at federal, cantonal and municipal level.

6.1.1 Initialisation of ballot

During initialisation, the system helps to loosely determine all the features of a particular ballot:

- Number and type of questions (federal, cantonal and municipal).
- Questions relating to an initiative with counter-proposal and supplementary question are grouped together.
- Municipal questions are associated with each municipality, which helps to manage several municipal polls at the same time.
- Ballot start and end dates and times.
- Links to opinions and official data relative to each question.
- Structure of polling stations and municipalities are adapted, where applicable.

6.1.2 Electoral roll and voting cards

The electoral roll is compiled six weeks prior to a ballot, by extracting data from the Cantonal population office file (hereafter OCP), which is centralised and kept regularly updated. The Geneva electoral roll for Swiss expats is managed in real time by the SVE. During an

[21] See also point 11.1.

electronic vote, this roll is added to the data extracted from the OCP to ensure that all potential voters are in the same system[22].

For each election, a comprehensive roll is compiled containing details of federal, cantonal and municipal voting rights, which may be required to comply with different rules (e.g. rule requiring three-month residency in the municipality to be able to participate in a municipal ballot). This allows the system to ask each and every citizen only those questions corresponding to their specific civic rights.

Once compiled, the three codes required for internet voting are then added to the electoral roll: the sixteen-digit voting card number, the four-character alphanumerical control code and the six-character alphanumerical secret code. These codes differ for each poll. Moreover, each citizen is associated with a list of fifty municipalities (including his municipality of origin), which he sees when validating his vote.

The electoral roll serves as a basis for the compilation of a nominative file from which the voting cards are printed. This is the only nominative file in existence. It is engraved onto a CD and transmitted by secure mode to the printer. The CD is then kept in a safe on SVE premises throughout the election and is used solely for specific controls (i.e. when there is no voting card number or reference number associated with each inhabitant of the canton in the OCP database).

An anonymous register containing the voting card number, the OCP database number and data enabling identity and voting rights to be checked is loaded into the internet voting system.

Perfect, a company based in Etoy (VD), has been chosen to print the voting cards, as it specialises in secure printing activities such as lottery tickets. The company also holds the exclusive rights for the use of multi-layer printing paper (where a carbon leaf is inserted between two sheets of paper) to prevent any attempts to read the secret code by transparency.

Perfect receives official information, ballot papers and reply envelopes from clients, whereupon it proceeds with envelope filling and mailing. Voting cards therefore only leave the company once they are placed in envelopes.

6.1.3 The online voting procedure

The voting card is renewed for each poll and constitutes the hub of the system. The cards used in electronic ballots differ from the usual cards in that the information necessary to access the eVoting system is included on the left-hand side (voting site URL, https://ge-vote.geneve.ch/votations.html, and voting card Nr.). The card also carries a pin code and the print of the voting site certificate, which allows verifying the site's authenticity, as well as the four-letter returning code designed for the same purpose.

Internet voting takes place in four stages:

1) To be admitted to the vote server, the voter is required to enter a valid voting card number into the system. The sixteen-digit encoded number cannot be discovered by chance. The likelihood of stumbling upon the same number by accident is one in five billion! Once past this stage, the voter receives an on-screen reminder of the penalties applicable in the event of fraud (similar wording to that on the back of the voting card). Once the voter has read this reminder, an electronic ballot paper appears on the screen.

2) The voter casts a vote by clicking inside the box marked 'yes' or 'no' next to each question. The voter can abstain by leaving both boxes empty.

3) The system requires the voter to recap on his choices. A 'control code' is used to enable voters to check that they are effectively voting on the official Geneva State website. The voter is then asked to identify himself by stating his date of birth, place of origin (to be

[22] Owing to Federal legislation, it has not been possible so far to allow Swiss expats the possibility of voting on line.

chosen from a scroll-down menu of 50) and the identification code on the voting card, covered by a scratch-off coating.

4) The system confirms that it has registered the vote by stating the date and time of registration. This latter information can be verified at any time by re-entering the voting card number on the State web site, as described in point 1).

6.1.4 Opening of the eBallot box and generation of results

Results generation requires the presence of the political parties' respective controllers, who are invited to enter their private keys into the system. They are required to provide the password that enables the registered votes to be doubly encrypted.

The system then generates two files:

- One file of ballots containing the image of each ballot paper registered per voting site. This file is then submitted to the SVE in order to generate the overall results.
- One file taken from the electoral roll permitting statistical turnout analyses. This contains details of gender, age, voting method, date and time of vote. It is then transmitted for processing to the Cantonal office of statistics (hereinafter OCSTAT).

The file of ballots is processed by a results management system, which also integrates the postal vote count (conducted by optical reader on SVE premises), the counting of ballot box votes (performed manually by the municipal juries and forming the subject of a report) and the decisions of the parties' controllers on void or suspect ballot papers.

6.1.5 Destruction and deletion of data

Once the legal deadline for validating a vote has passed, the information is kept until the Federal Council finally issues the voting results at national level, but only for a minimum of fifty days. Beyond this date, the ballot papers and CDs are destroyed. Other types of physical data media are erased to ensure that the information is irretrievably deleted from servers.

6.2 The infrastructure

6.2.1 The telecommunications infrastructure

All the equipment relative to eVoting is connected to a specific strand of the cantonal network and separated from this latter by a 'firewall'. The firewall only lets through traffic to those machines likely to be called up, i.e. the vote servers. The whole system is linked to the cantonal network by a single optical fibre connection. Moreover, the cantonal network itself is separated from the public and internet network by several firewalls, which provide protection against intrusion.

The machine structure is therefore camouflaged, making it impossible to obtain direct access to the database servers containing the eBallot box.

At the entry to the system, a pair of machines distributes the load between the servers so that if one server suffers power outage, the entire load is transferred to the remaining server.

6.2.2 The servers

The eVoting system uses two types of servers: the internet/application servers and the database servers.

The internet/Application servers are cloned. They ensure the dialogue with citizens by means of web pages and manage the voting process. The operating system is designed specifically for protected web-based applications. It splits the machine into two partitions. The external partition contains the Apache web server. The internal partition contains the Tomcat application server. The link between the two is controlled by the operating system. This principle protects the application server and the underlying database.

The database servers are also cloned. They store information relative to the electoral roll and the eBallot box. The system in question is the state standard Oracle version 9. Both servers are set up in automatic replication mode, which guarantees that the information is always stored twice in table form and twice in log file form. Oracle's transactional engine makes it

impossible for a vote to be partly registered. It guarantees that a vote is either fully registered (encrypted ballot paper and entry in the electoral roll), or not at all, in which case the voter may vote again.

6.2.3 The monitoring system

Any specific equipment is placed under the control of a monitoring system. This latter is itself cloned and self-checking. At the slightest sign of failure, a signal is transmitted to the operators who take the necessary measures. A crisis team can be alerted in case of major problems.

The monitoring system also checks the internet voting homepage: the slightest attempt at modification will also trigger an alarm.

The number of votes received is also compared with the number of entries on the electoral roll; any discrepancies therein will set off an alarm.

This system is used to rapidly report the slightest incident and ensure that any attempts at fraud do not go unnoticed.

6.3 Security aspects

Optimum security is achieved by the proper balancing between two requirements: user comfort and user safety. Rather than subject the voter to a degree of discipline that would take away all the attraction of online voting, Geneva has opted for a concept comprising several concentric layers of measures: technical, encryption, encoding, validation, 128-bit secret key, all of which guarantees both security and ease-of-use.

The issue of procedure security has been addressed by highlighting eleven criteria requiring total compliance in order to ensure both secrecy and security for voting and for system users. Those criteria are as follows:

- Votes must not be prone to interception, modification or deviation.
- The contents of votes must not be prone to disclosure to a third party prior to the count.
- Only those persons with a right to vote should be allowed to take part in the ballot.
- Each voter has only one vote and can only vote once.
- Under no circumstances, including during the count, should it be possible to link a voter with his vote.
- The site must be able to protect itself against service denial attacks designed to saturate the server.
- The voter must be protected against any attempts at identity theft.
- The number of votes cast should correspond to the number of votes received; any discrepancy between the two must be explained and corrected.
- It must be possible to prove that a voter has voted.
- The system does not accept votes outside the eBallot period.
- The smooth functioning of the system must be open to verification by the competent authorities.

6.3.1 Votes must not be prone to interception, modification or deviation

The purpose of this requirement is threefold: it postulates that the communication channel between the voter and the vote server should be secure, that voters are guaranteed that they are sending their votes to the official Geneva State server and that votes are protected against being read by third parties.

Communication between the citizen’s computer and the vote server is protected by the SSL128 Secure Socket Layer protocol. The vote server uses a public key infrastructure authenticated by a third party guarantor. This infrastructure creates a digital certificate for the server. By checking the digital print of the certificate, the user can be sure of the server’s authenticity.

This verification process is backed up by an automatic procedure. A ‘returning code’, i.e. a series of letters treated as an image, are ‘woven’ (embedded) into the eBallot paper confirmation page, firstly to render it illegible to third parties, and secondly to unequivocally ascertain the server from which it comes. Only the State server may allocate the corresponding returning code to each voting card number.

This randomly generated, personal code is renewed for each ballot. It is reproduced on the voting card. By simply comparing his voting card with the image displayed on-screen, the voter may verify that he is indeed voting on the official State server. This guarantee, in addition to the fact that the vote is illegible to a malevolent third party, protects voters against the deviation and modification of their votes.

Given that web navigation depends on DNS or domain name servers (i.e. the web’s points of reference), the system forces them to be refreshed far more frequently than usual (every few minutes instead of every few days). Thus, any attempt to deviate a vote can be immediately detected and countered.

Finally, votes are once again protected by encryption using a PKI, or public/private key infrastructure. This is a non-falsifiable and non-modifiable process, which may be used automatically and monitored 24/24. It is also used to verify an electronic signature and to sign electronically. The encryption is generated before the opening of the poll, at the time the seal is placed on the ballot box, by the controllers chosen by the parties represented on the Grand Council. These controllers alone are able to decrypt the votes during the vote count at the close of the ballot.

6.3.2 The contents of eVotes must not be prone to disclosure to third parties prior to the count

The vote servers are installed in the safest computing room in the State of Geneva, the basement of Geneva police headquarters. The room is secured by all the usual police-related access controls. Physical access to the servers is therefore strictly controlled, while access via the network is limited to entry via a special single optical fibre, which constitutes the only link with the web.

As explained above, each vote is encrypted by means of two encryption keys supplied by the parties’ controllers. Without these keys, it is impossible to count the votes. The digital certificates corresponding the these keys are kept in the police security officer’s safe in order to guard against loss or disappearance, but the passwords authorising sole use of the certificate are known only to the controllers. The presence of these latter is therefore essential during the count and to protect against the absence of either, the passwords are also lodged for safekeeping with a notary.

For increased security, each answer given on every ballot paper is woven into an image (the ‘returning code’), which renders the encryption inviolable. This is the result of the double encoding procedure, which is stored in the eBallot box.

6.3.3 Only those persons with a right to vote can take part in the ballot – Each voter has only one vote and can only vote once

In order to cast a postal vote, citizens are required to complete their voting card with their date of birth and signature, before sending it together with their ballot paper in a sealed blue envelope contained inside another grey envelope. Otherwise, voters can go to the polling station armed with their voting card and place their blue envelopes in the traditional ballot box after having submitting them to the scrutinizers. The voting card safeguards the ‘one man, one vote’ principle, according to which once it has been used, it cannot be used again.

In order to make eVoting as easy as the usual methods, a secret code is inserted into the voting card and hidden beneath a metallic film. To uncover the secret (alphanumerical) code, which is different for each voter, the metallic film must be scratched off like a lottery ticket. The secret code is retranscribed during the eBallot. The ‘one man - one vote’ principle is guaranteed, for once a card has been scratched, it is deemed used and therefore becomes invalid for any other means of voting.

The personalised voting card also comprises a personal number, which immediately blocks access to non-citizens. The barcode featured on the voting card corresponds to this number. It is used by the SVE to register postal votes, the purpose of which is to block the registered card's access to eVoting.

Voters having uncovered the secret code and who have not voted online can go to a polling station with a scratched card. The president of the polling station checks with the SVE by telephone before accepting the vote. In the case of postal votes, the SVE itself conducts the check.

There is no time overlap between advance ballots (postal and eVoting) and ballot box votes, since advance ballots close on Saturday at noon midday and voting at the ballot box begins on Sunday at 10 a.m.

The following table shows all scenarios for the three methods of voting and how it is possible to prevent double voting:

First vote Subsequent vote	Postal	Online	Ballot box
Postal	No longer has card	A check is conducted on receipt of the scratched card. If an eVote has already been registered, the card is blocked.	Advance vote closed
Internet	Card blocked by registration of postal vote	Card blocked by eVote	Advance vote closed
Ballot box	No longer has card	A check is conducted on production of a scratched card. If an eVote has been registered, the card is rejected by the polling station.	No longer has card

The requirement to allow only authorised voters accessing the poll means keeping away unauthorised persons. To this end, we have set up an execution time control on the homepage of the voting site, where the voter is required to enter his voting card number.

The automatic control denies access to the voting pages if the sixteen-digit card number is entered in less than two seconds. We are then alerted to the presence of a robot seeking to access the voting site. Consequently, and if by extraordinary chance, these sixteen digits should correspond to an existing card number, the request is denied. At the other extreme of the spectrum, if the user does not succeed in entering the correct voting card number within five minutes, he is also disconnected from the voting site. In the second illustration, it is most probable that an unauthorised voter is trying to guess a card number.

6.3.4 Under no circumstances, including during the count, should it be possible to link a voter with his vote

Voting secrecy and anonymity are guaranteed by means of two measures:

- The eBallot box containing the encrypted votes is not linked to the electoral roll. This latter is integrated into the system in order to check that a citizen cannot vote twice, either by eVote or postal vote.
- The vote file is sorted randomly prior to the count to prevent the ballot from being reconstituted using the database log files.

6.3.5 The site must be able to protect itself against service denial attacks designed to saturate the server

Probes are installed to detect specific events in order to protect the system against service denial or mass attacks. These probes react in particular when:

- The same address requests the same page too often.
- Systematic attempts at identification are observed (rapid entry or number sequences).

- Abnormal or unauthorised queries are conducted on certain pages.
- Equipment break down (servers, disk systems, firewalls, network equipment);
- Software (database) fails.
- Abnormal file system modification is observed.
- An unauthorised presence is detected in the system room.

When a probe is triggered, the system automatically calls an operator on his pager and an emergency procedure is launched. These procedures have been carefully planned with differing degrees of intervention.

The levels of reaction differ according to the type of problem experienced:

- The problem is easily corrected and does not affect the ballot.
- The problem jeopardises the eVoting procedure, which is then stopped and the ballot continues by postal votes and at the polling station.
- Erroneous votes are registered that cannot be eliminated, in which case all eVotes are cancelled and new voting cards sent out to the voters concerned; this would be the equivalent of seizing a post office mail bag containing falsified votes.
- In the worst case scenario, eVoting has to be stopped and voting can only continue at the polling station; this would be the equivalent of the post office being completely paralysed, or even the destruction of postal votes (by fire).

The above procedures are inspired by those provided for postal votes.

6.3.6 The voter must be protected against any attempts at identity theft

The 16-digit voting card number (four of which are required to identify the ballot and six to identify the voter) means that there is only one chance in five billion of stumbling on a valid number by accident for a given ballot. Moreover, this number is attributed to voters randomly and changes for each ballot.

A citizen's identification during online voting rests on the provision of two pieces of personal information: date of birth, as with postal voting, and place of origin, instead of the signature. There is no public register that contains this information. In case of theft or loss of a voting card, no-one may vote in place of the card holder. Furthermore, after five unfruitful attempts, the system blocks the voting card. The citizen concerned may request a duplicate.

6.3.7 The number of votes cast must match the number of votes received

To ensure that no information is lost, two vote servers run in parallel with access to one single database, which is stored on two separate disk systems. All the connection equipment is cloned.

The Oracle transactional database system is used to ensure that the electronic ballots are stored and that voters receive a confirmation of the registration of their vote. This system ensures that voters and votes are written simultaneously into two separate databases, after first having checked that the voter has not already voted.

6.3.8 It must be possible to prove that a voter has voted

The law prohibits the transmission of any formal proof of voting, since this would be contrary to the principle of anonymity and vote secrecy. However, it is possible to issue a receipt for vote registration.

At the end of the voting procedure, a confirmation page is displayed on-screen, which can be printed out by the citizen. This indicates the time and date of the vote's registration.

The voter may find out whether his vote has been registered at any time during the ballot. He simply needs to enter his voting card number on the eVoting web site to check whether his vote has been received. The system registers both eVotes and postal votes and indicates the method, date and time of the vote's registration.

6.3.9 The system does not accept votes outside the ballot period

Access to the vote server is only possible during a predetermined period, which commences, according to the law, three weeks prior to the ballot (two weeks for a cantonal or municipal vote) and finishes at noon midday on the Saturday before the Sunday which is “ballot day” (all remote voting is considered as advanced voting by the law). Automatic processes are used to ensure machine synchronisation and the management of the link to the internet.

6.3.10 It must be possible for the authorities to verify the proper functioning of the system

To check the proper functioning of the system, the political parties’ controllers are provided with a ‘test ballot box’, test voting cards and blank ballot papers. They are then required to proceed with a double vote, in other words to cast test votes via the web, while also completing the ballot papers including the number of the test voting card used.

Once the ballot is over, the test ballot papers are counted and checked by the controllers themselves. The results are compared with the test eBallot box count conducted by the system. Both counts must match and it must be possible to identify each test ballot paper. The results of this test are obviously excluded from the official voting results.

As the test eBallot box is identical to the 68 official eBallot boxes used in Geneva, this process proves the system’s valid functioning from the start to the finish of the eBallot paper journey.

6.4 Financial aspects

6.4.1 Investments

Between 2001 and 2004, the equipment required for the eVoting project cost CHF 740,000 and further developments cost CHF 1,024,000, giving a total of CHF 1,764,000. According to the agreement signed with the Swiss Confederation, this latter covered 80% of these costs, namely the sum of CHF 1,411,000. The balance, i.e. CHF 353,000, has been covered by the CTI operating budget.

The project costs may be broken down into four complementary aspects:

1. Infrastructure: servers, system licences, network equipment, physical security components.
2. Application: study, development, fine-tuning and successive improvements to the system.
3. Expert reports: specific security studies, penetration tests, legal studies, politological studies.
4. Operations: production of voting materials, explanatory brochures, online aid, operation, promotion.

6.4.2 Functioning as of cantonal implementation

At present, a ballot conducted according to the two available channels, postal votes and polling stations, costs the State approximately CHF 880,000. This sum may be broken down as follows:

External costs for the SVE, i.e. printing, envelope-filling, dispatch, postal costs, vote processing, etc.	CHF 553,000
Internal costs for the SVE, i.e. including personnel expenses	CHF 202,000
Computing costs, i.e. internal and external costs for the CTI for a given ballot	CHF 125,000
TOTAL INTERNAL AND EXTERNAL COSTS	**CHF 880,000**

The sum of CHF 880,000 therefore represents, for a ballot with a 50% turnout rate, a unit cost of CHF 8.80 per vote.

In the case of a cantonal operation, the additional operating costs required for eVoting are around 7.5% of the current cost of a ballot. These costs are as follows:

Printing of voting cards on security card with secret code	CHF 27,700
External computing costs: licences, certificates, maintenance contracts	CHF 9,800
TOTAL EXTERNAL COSTS	**CHF 37,500**
Internal computing costs: operation and maintenance of specific eVoting modules	CHF 31,500
TOTAL EXTERNAL AND INTERNAL COSTS	**CHF 69,000**

6.4.3 Savings generated by eVoting

With respect to savings, eVoting immediately helps to reduce certain costs:

Postage costs savings for each eVote received	CHF 0.78
Reduced postal preparation costs for postal votes received (batch separation and special delivery), per vote approx.	CHF 0.22
Reduced processing costs for postal votes at SVE (will be effective only after 2-3 ballots)	CHF 0.25
TOTAL SAVINGS PER VOTE	**CHF 1.25**

Ultimately, additional savings may also be envisaged, for example by dispensing with the dispatch of voting materials and reducing printing volumes, notably for Swiss expats who could receive their identifiers and material by email.

Achieving a balance between costs and savings therefore depends on the number of votes received and the number of eGovernment applications sharing the same technical platform. On the basis of ballots held thus far, the State can reckon on approx. 25,000 eVotes once the system is introduced throughout the canton. This figure takes into consideration those people who may not have voted if online voting had not been available. A positive development is foreseeable with the development of ICTs and the passing of time.

The following table shows the development in operating costs depending on the number of eVotes received after one year.

No. votes	Total cost	Savings	Net total cost	Cost per vote	Net external costs	External cost per vote
25 000	CHF 69 000,00	CHF 31 250,00	CHF 37 750,00	CHF 1,51	CHF 6 250,00	SFr. 0,25
30 000	CHF 69 000,00	CHF 37 500,00	CHF 31 500,00	CHF 1,05	CHF 0,00	GAIN
35 000	CHF 69 000,00	CHF 43 750,00	CHF 25 250,00	CHF 0,72	-CHF 6 250,00	GAIN
40 000	CHF 69 000,00	CHF 50 000,00	CHF 19 000,00	CHF 0,48	-CHF 12 500,00	GAIN
45 000	CHF 69 000,00	CHF 56 250,00	CHF 12 750,00	CHF 0,28	-CHF 18 750,00	GAIN
50 000	CHF 69 000,00	CHF 62 500,00	CHF 6 500,00	CHF 0,13	-CHF 25 000,00	GAIN
55 000	CHF 69 000,00	CHF 68 750,00	CHF 250,00	CHF 0,00	-CHF 31 250,00	GAIN
60 000	CHF 69 000,00	CHF 75 000,00	GAIN	CHF 0,00	-CHF 37 500,00	GAIN

Compared to the global cost of a ballot, the additional external costs of eVoting remain extremely modest (CHF 0.25 per vote) when the system is first introduced. Once the 30,000 voters' mark is achieved, eVoting starts generating savings in terms of external costs.

The 60,000 vote mark must be achieved before total additional costs (external and internal) can start paying off.

7. Compliance with Federal legislation

eVoting bridges the gap between law and technology. The table below describes the means implemented to comply with the articles of chapter 6a entitled 'eVoting pilot tests' of the ODP, which entail an organisational or technical involvement. These means may be as follows:

- Operational procedures and organisational measures;
- Data structure design;
- Application or software components;
- Specific equipment and infrastructure components.

Enforcement of ODP chapter 6 articles

	Geneva eVoting solution			
	Procedures and organisation	**Data model**	**Application**	**Infrastructure**
27.d	**Condition for granting authorisation**			
27.d.1.a	**Verification of voter capacity**			
	The voter must have a valid voting card number.	Electoral roll complete with identification codes and personal data	Secure voter authentication module.	PKI secure access architecture.
27.d.1.b	**One man, one vote**			
	The voting card is designed in such as way as to ensure that a vote cast via one channel will block all other channels.	Both forms of advance voting – postal vote and eVotes – are consolidated to prevent double votes.	The identities of postal and eVoters are entered into the same database.	
27.d.1.c	**No votes are systematically deviated**			
	Voters identify themselves with a password generated randomly, their date of birth and place of origin. The returning code enables them to check that they are indeed voting on the official State website.	Direct access to the ballot box is impossible. Information is also encrypted.	It is not possible to access application routines from the user's workstation. The SSL 128 link, similar to that used in eBanking, provides a secure channel between the voters' PC and the vote server[23].	An infrastructure is set up offering a high level of protection. Alarms signal any attempts to attack the system.

[23] This protection has been enhanced since the publication of this report. To have more details, see www.geneve.ch/evoting/english/securite.asp

	Geneva eVoting solution			
	Procedures and organisation	**Data model**	**Application**	**Infrastructure**
27.d.1.d	**Guarantee of voting secrecy**			
	The encryption is generated by the parties' controllers; these are the only people able to decrypt the ballot box.	The eBallot box and the voters' database are kept entirely separate. The ballot box is encrypted.	Sorting the eBallot box randomly prior to decryption makes it impossible to reconstitute the ballot.	The ballot box and the technical solution are physically located in a secure site.
27.d.1.e	**Guarantee of correct transcription of voters' expression**			
	A check is conducted to ensure that the number of votes matches the number of voters. The ballot reading takes place in the presence of the parties' controllers.			A ballot box back-up and the system's redundant architecture prevent any loss of votes.
27.d.1.f	**Impossibility of systematic fraud**			
	Voters identify themselves with a password generated randomly, their date of birth and place of origin.	Direct access to the ballot box is impossible. Its contents are encrypted.	It is not possible to access application routines from the user's workstation. A robot detection system is implemented.	The PKI infrastructure provides a high level of protection. Alarms signal any attempts to attack the system.
27.d.2.a	**Systematic inviolability of electronic codes and signatures**			
	Voters identify themselves with a password generated randomly, their date of birth and place of origin	A voter can only vote once using a single identification code.	The voting card is blocked after five unfruitful attempts at identification. A workflow system prevents any deviation from the procedure.	The PKI infrastructure provides a high level of protection. Alarms signal any attempts to attack the system.
27.d.2.b	**Impossibility of systematic falsification of electronic codes**			
	The voting card is for single use only. The voting card printing file is especially well protected.	The voting card number is linked to the alphanumerical identification code (PIN) and personal information.	The SSL 128 bit link prevents any attempted code interception.	VPN link with the certificate provider during key creation.
27.d.2.c	**Procedures for combating systematic fraud**			
	A team monitors the system during the ballots.		A robot detection system is installed in the application.	It is possible to limit access in case of any doubt regarding the origin of a connection.

	Geneva eVoting solution			
	Procedures and organisation	**Data model**	**Application**	**Infrastructure**
27.d.3	**Adequate infrastructure**			
	The online support and help team is scaled to the number of voters.			The system architecture is heavily redundant.
27.e	**Protection of public opinion against manipulation**			
27.e.1	**eVoting with forethought**			
	The online voting procedure is explained in a brochure sent out to voters with their voting materials. The voter can go back at many points in the voting process.		The application was created by ergonomists and validated by a pilot group. Its presentation complies with that of the ballot paper. Brochures and official opinions may be consulted from the voting site.	
27.e.2	**Awareness of vote participation when voting via the internet**			
	A reminder of the penalties for fraud is displayed on-screen. It contains similar wording to that on the voting card. This screen must be validated before taking the procedure further.		The application was created by ergonomists and validated by a pilot group.	
27.e.3	**Validation of legal messages**			
			Impossible to vote without first acknowledging having read the penalties reminder for fraud.	

	Geneva eVoting solution			
	Procedures and organisation	**Data model**	**Application**	**Infrastructure**
27.e.4	**No pop-ups**			
	No external information interferes with the voting process. The user interface and the screen contents are validated by the SVE. When voting in the test ballot box, the parties' controllers have access to and can verify this interface.			
27.e.5	**Possibility of going back**			
	The voter can go back at many points in the voting process.		The application was created by ergonomists and validated by a pilot group.	
27.e.6	**Acknowledgment of receipt of vote**			
			Confirmation of vote registration is displayed on-screen. The confirmation can be called up again by re-entering the voting card number in the system.	The transactional database ensures that only a finalised transaction (vote registration AND tracing of voting card in the electoral roll) generates a vote confirmation.
27.e.7	**Modified votes not counted**			
	Voters have no direct access to the ballot box.	Votes are encrypted; any modification will make the vote illegible.	The transmission is monitored by adding verification data.	The information is encrypted across the entire processing chain.
27.f	**Encoding**			
27.f.1	**Maintenance of secrecy and non-traceability**			
27.f.2	**Non-transmission of voter data**			
27.f.3	**Coded data transmission**			
		The eBallot box is not connected to the voter database. The votes are not stored sequentially.	Only the voting card number is stored in the system.	The information is encrypted across the entire processing chain. It is impossible to access the databases during the ballot.

	Geneva eVoting solution			
	Procedures and organisation	**Data model**	**Application**	**Infrastructure**
27.f.4	**Procedure to verify whether or not the person has already voted**			
	On the basis of the voting card number, the system chooses whether or not to establish the connection between the voter and the vote server, according to whether or not he has voted.			Secure link SSL128.
27.f.5	**Encrypted vote in ballot box during ballot**			
	Only the parties' controllers hold the encryption keys.	The eBallot box is encoded until it is opened by the parties' controllers.		Public/private key infrastructure.
27.g	**Voting secrecy**			
27.g.1	**Link between voter and vote**			
		The eBallot box is not connected to the voter database. The votes are not stored sequentially.	Only the voting card number is stored in the system.	
27.g.2	**The eVoting application is separate from other applications**			
			For the duration of the ballot, there is no access to the ballot box or the electoral roll other than via the eVoting application.	The infrastructure required for eVoting is specific to this application and enjoys specific protection.
27.g.3	**Presence of 2 controllers and drafting of a report**			
	Work procedures require the presence of the political parties' controllers and the drafting of a report.			

	Geneva eVoting solution			
	Procedures and organisation	**Data model**	**Application**	**Infrastructure**
27.g.4	**No processing-related information should allow violation of voting secrecy**			
	The online voting procedure reproduces the ballot box procedure and preserves voting anonymity.	No information concerning the operation is stored in the memory.	The eBallot box contents are mixed before opening to ensure that votes do not emerge in the order in which they arrived.	
27.h	**Other measures to ensure voting secrecy**			
27.h.1	**No external interventions possible during voting**			
				Protection is provided by the secure infrastructure.
27.h.2	**Random storage of votes**			
		Votes are stored without any indication of date or sequential order.	The eBallot box contents are mixed before opening to ensure that votes do not emerge in the order in which they arrived.	
27.h.3	**Deletion of votes from machine used for voting**			
	The user is advised to clear the browser's history.		All navigation functions are deactivated on voters' PCs.	No information is stored on the PC used for voting.
27.h.4	**No traces of vote remain on screen and it is impossible to print out vote cast**			
	The user is advised to clear the browser's history.		Transition from http protocol to https protocol and vice versa will delete any context.	The vote cast is encrypted and therefore cannot be printed out.
27.i	**Verification of voter capacity**			
	c.f. 27 d1a.			
27.j	**One man, one vote**			
	c.f 27 d1b			
27.k	**Backing up of eVotes**			
				Votes are backed up twice. The infrastructure used has a strong tolerance to breakdowns.

	Geneva eVoting solution			
	Procedures and organisation	**Data model**	**Application**	**Infrastructure**
27.l	**Technical state**			
27.l.1	**Technical and organisational monitoring of solution**			
	The project committee and the technical group can draw experience from other pilot projects conducted by the Confederation via the contact group.			
27.l.2	**External audit of solution**			
	The Confederation may order an audit of the system.			
27.l.3	**Protection against proven attacks**			
	The monitoring team is able to identify attacks. The operators are selected and verified by the police.			It is possible to prohibit access to the solution in the case of problematic connections.
27.m	**Establishment of results**			
27.m.1	**Intermediate counts**			
	The encryption keys are kept in a safe during the operation. The passwords of two political party controllers are required to use them.	The eBallot box contains votes in an encrypted form and only the controllers hold the keys for encryption.		During the ballots, only the link enabling the voting transactions permits access to the server. Apart from these transactions, this link only authorises the registration of postal votes and the monitoring of turnout.
27.m.2	**Decryption and vote counting**			
	The parties' controllers are convened on Sunday morning for the opening of the eBallot box.		A software program is used to establish the vote count, constituency by constituency, and question by question.	The results of the eVotes are stored on a CD signed by the parties' controllers.

	Geneva eVoting solution			
	Procedures and organisation	**Data model**	**Application**	**Infrastructure**
27.m.3	**Final results for all methods**			
27.m.4	**Audit**			
	The parties' controllers are present during establishment of the final results (consolidation of the results of the 3 voting channels) , notably in order to process any suspect paper ballots.	A database stores the results by voting method and by question.	The results of the eBallot are entered into the database, which serves as a source for all publications.	
27.n	**Recount in case of irregularity**			
		The database with the encrypted votes is kept until the final validation of results, following the recourse period.		As a last resort, the transaction journal may permit the reconstitution of the database.

8. Tests, audits, legal and sociological surveys

8.1 Technical tests and audits

In addition to tests involving the system users, the State Chancellery has mandated a variety of companies or groups of specialists to proceed with tests and specific audits.

8.1.1 The security committee report

In 2001, the State chancellery commissioned an ad-hoc group of experts specialising in online security to audit its eVoting application. The group composed of representatives of CERN, Geneva University, CTI and the University hospitals, together with the head of the State's IT security committee, conducted a study of the application's security in the application's state as of September the 23rd, 2001.

In its report[24] of January 2002, the committee describes the Geneva eVoting application as a virtually impregnable 'stronghold'. The reliability of the user's workstation (the voter's computer) nevertheless needs to be improved.

The committee proposes to increase the security of the procedure by numbering the eBallot papers from start to finish using keys defined by the parties' controllers, creating a test ballot box to collect the controllers' votes, providing an automated link to the State server, which should be clearly authenticated, and mixing the access codes before prior to each ballot, as well as the ballot papers received, prior to each count, to guarantee their anonymity.

All these measures have been gradually integrated into the system since June 2002.

8.1.2 Security of the client workstation

At the request of the State chancellery, Rolf Oppliger, who has a PhD in data processing and is the expert appointed to the Confederation's computing strategy unit (USIC), delivered a

[24] This document is available at www.geneve.ch/evoting/doc/rapports/rapport_version_internet.pdf.

report in May 2002 on the security of users' workstations[25]. In his report, he raises the issue of the vulnerability of operating systems on the common PC. The situation has since changed, notably with the new versions of Windows (Windows XP with Service Pack 2), which has been adopted wholesale by the Geneva population, as shown during the 2004 ballots.

The report also underlines the need for the voter's assurance that he is indeed voting on the State website. This recommendation led to the adoption of the 'returning code' in the Geneva eVoting application, in other words a series of letters treated as an image, which are 'woven' (embedded) into the eBallot paper confirmation page. This renders it illegible to third parties and provides unequivocal authentication of the source server.

8.1.3 Intrusion tests

Further to the Security committee's report, and with the agreement of the Confederation, the State chancellery has assigned new mandates to renowned experts focusing on this item as well as attempts at hacking into the system. In the second half of 2002 and the first half of 2003, Hacknet was asked by the State Chancellery to attempt to hack into the eVoting site. These attempts were made outside voting periods, when the application was not in use.

During normal use, the voting site is only connected to the network for a maximum of three weeks. This limitation is in itself a protection, since hacking requires a considerable amount of time for it to produce results. A web site is especially vulnerable since it is accessible on the network for a long period. However, in order to enable Hacknet to conduct sustained attempts, the State Chancellery allowed the company double the normal time required for a ballot.

In spite of the above, Hacknet did not succeed in penetrating the voting site, the structure and creation of which were concluded to be particularly robust.

9. Official ballots

Between January 2003 and April 2005, eVoting was implemented in eight official ballots in Geneva. Its gradual implementation was required to satisfy specific criteria. Each ballot registered an increase in use compared to the previous ballot, in terms of the number of people having access to eVoting, the number of questions posed within the context of the ballot, or the status of votes (municipal, cantonal or federal).

With the agreement of the Federal authorities, it was decided that the implementation of the eVoting solution would take place in successive stages. It was also agreed that, if several municipalities were called upon to vote online as part of the same ballot, the choice of municipalities would require the approval of the federal authorities, in such a way as to ensure that the sampling of chosen municipalities represented different political sensibilities.

The eight ballots, together with a consulting ballot conducted at European level on behalf of the Council of Europe, made it possible to submit the online voting system to a very comprehensive range of conditions and constraints.

9.1 Municipal ballots

In autumn 2002, the Geneva government agreed to the request issued by the executive authorities of the municipality of Anières, who wished to make the eVoting solution available for a referendum ballot scheduled for January 2003. This vote was the first in a series of five successfully organised online municipal votes:

- Between 7th and 18th January 2003, the citizens of the municipality of Anières (1,162 registered voters) were able to vote by the internet in a referendum to contest a loan to renovate a municipal building. Turnout reached 63.7% and the number of eVotes cast totalled 323, i.e. 44% of all votes cast.
- Between 17th and 29th November 2003, citizens of the municipality of Cologny (2,521 registered voters) were able to vote by the internet in a popular initiative entitled the

[25] This document is available at www.geneve.ch/evoting/english/doc/rapports/rapport_oppliger_en.pdf.

'Safeguard Cologny' initiative. Turnout reached 59% and the number of eVotes cast totalled 432, i.e. 29% of all votes cast.

- Between 2nd and 17th April 2004, citizens of the municipality of Carouge (9,049 registered voters) were able to vote by the internet in a referendum to contest the city's purchase of a cinema. Turnout reached 44% and the number of eVotes cast totalled 1,024, i.e. 26% of all votes cast.
- Between 28th May and 12th June 2004, citizens of the municipality of Meyrin (9,180 registered voters) were able to vote by the internet in a popular initiative concerning the creation of 'Vernes Lake', the counter-proposal and supplementary question aimed at deciding between the two. Turnout reached 39% and the number of eVotes cast totalled 788, i.e. 22% of all votes cast.
- Between 8th and 23rd October 2004, citizens of the municipality of Vandoeuvres (1,382 registered voters) were able to vote by the internet in a referendum to contest a traffic plan passed by the Municipal Council. Turnout reached 59.55% and the number of eVotes cast totalled 240, i.e. 32% of all votes cast.

9.2 Two federal ballots, one cantonal ballot and a European consultation

With the agreement of the Federal Chancellery and the formal consent of the Federal Council, Geneva implemented its online voting application in the second half of 2004 for federal ballots. During these six months, three official voting operations were held, including the Vandoeuvres operation described above. In addition, the State Chancellery organised a consultation on behalf of the Council of Europe.

- Between 3rd and 25th September 2004, citizens of the four municipalities of Anières, Carouge, Cologny and Meyrin (some 22,000 registered voters in total) were able to vote by the internet in the popular ballot of 26th September 2004. This latter comprised four federal questions, two cantonal questions and one municipal question. The number of eVotes cast totalled 2,723, i.e. 21.8% of all votes cast.
- At the same time as the Vandoeuvres operation in October 2004, the Geneva government placed the Geneva online voting system at the disposal of the Council of Europe (CoE) for a consultation in which some 27,000 pupils from 81 schools in twenty countries were able to participate. In all, 16,400 pupils voted by the internet. The operation concerned a 'Charter for a democratic school without violence' and allowed to verify the feasibility of eVoting for Swiss expats by ascertaining the fact that the Geneva application worked smoothly with votes transiting through foreign ISPs.
- Between 5th and 27th November 2004, citizens from the eight municipalities of Anières, Carouge, Collonge-Bellerive, Cologny, Meyrin, Onex, Vandoeuvres and Versoix (a total of 41,200 registered voters) were able to vote by the internet in the popular initiative of 28th November 2004. This comprised three federal questions and two cantonal questions. The number of eVotes cast totalled 3,755, i.e. 22.4% of all voters.
- Between 9th and 23rd April 2005, some 88,000 voters in the municipalities of Anières, Bernex, Carouge, Chêne-Bourg, Collonge-Bellerive, Cologny, Grand-Saconnex, Lancy, Meyrin, Onex, Thônex, Vandoeuvres, Vernier and Versoix were able to participate in the eight cantonal questions put to the vote online. eTurnout reached 20.35%, i.e. 7,911 eVotes.

9.3 Observations

9.3.1 Turnout

At present, there are only theoretical studies on the impact of eVoting on turnout.

The ballots held so far in Geneva do not allow us to gauge its impact, due to lack of sufficient data. Only the municipalities of Anières and Cologny and the cities of Carouge and Meyrin were able to vote four times online, and a city such as Vernier was only able to vote once.

Based on the studies conducted by the E-Democracy Center (hereinafter EDC) of the Geneva University outlined below under point 10, it is nevertheless safe to assert that the

share of young voters aged under 30 in ballots in which online voting was available was higher than usual.

The various questionnaires submitted to eVoters during the municipal ballots of 2003/2004, as well as EDC studies, also show that, depending on the ballot, 12% to 25% of eVoters were occasional or regular abstainers. Eighty percent of these people confirmed that they would vote more if eVoting were more widespread. Despite this being merely a statement of intent, the statistics seem to indicate a potential for increased turnout with online voting.

Another striking aspect regarding turnout in ballots in which eVoting is available is the stability of the percentage of votes cast electronically, regardless of the global turnout rate. In other words, eVoting appears relatively unaffected by fluctuations in turnout, as shown in the table below:

Ballot	Total turnout	Online turnout
Anières, January 2003	64%	44%
Cologny, November 2003	59%	29%
Carouge, April 2004	44%	26%
Meyrin, June 2004	39%	22%
Federal and cantonal ballots of 25th September 2004	57%	22%
Vandoeuvres, October 2004	60%	32%
Federal and cantonal ballots of 27th November 2004	41%	22%
Cantonal ballot of 23rd April 2005	44%	20%

A study of the electoral rolls in the ballot of 26th September 2004 also revealed an interesting fact in the temporal behaviour of eVoters, compared to postal voters:

% of total votes	Week 1	Week 2 (cumulative total)	Week 3 (cumulative total)
Postal vote	20%	36% (56%)	44% (100%)
EVoting	23%	25% (48%)	52% (100%)

As indicated in the table, there is a linear progression in postal votes over time. On the other hand, more than 50% of eVotes are cast in the last week of the ballot. Clearly, two different attitudes may be observed, with online voters taking more time to follow the progress of the campaign and listen to the arguments for and against the various proposals put to the people.

9.3.2 Electoral choices of online voters

From the point of view of results, it appears constant that people voting by the internet are half as likely to cast a blank vote as voters using the other channels. Likewise, eVoters globally have a more clear-cut opinion than others (3 to 5% more ‘yes’s’ when the result is yes, and ‘no’s’ in the case of a negative result).

Having said this, eVoters’ choices do not differ from those of the rest of the electorate. Of the 26 questions asked during the eight official ballots held in Geneva using the internet, the same majority emerged from the online votes as from the two other voting methods.

It is safe to assert that in the case of all eight ballots, online voting strengthened the legitimacy of popular choices by, firstly, confirming the choices expressed via the two remaining channels and, secondly, restoring the age balance in the breakdown of the active voter population.

9.3.3 Technical observations

It should be pointed out that the eVoting system serves as a test bench for all future developments in the field of online administration. Thanks to the eVoting project, it has not only been possible to double the State internet and network infrastructures, but also to assess the difficulties linked to an around-the-clock service, as well as the problem of digital identification and the introduction of online transactions.

The eVoting project may therefore be considered as an investment for the future, conducted in agreement with the decisions of the State Council IT delegation.

9.3.4 Telephone support

For each of the online ballots, a hotline was set up for voters. This is standard procedure in the case of systems enabling online transactions (and beyond cf. the telephone help line set up by the Finance department to help taxpayers fill in their returns) and forms part of the 'good practices' of present-day service providers.

Call distribution was as follows:

	Number of eVotes	Number of calls	Number of calls per 100 eVotes	Main reasons for call
Anières, January 2003	323	18	5.6	Place of origin
Cologny, November 2003	432	18	4.2	Place of origin
Carouge, April 2004	1024	114	11.1	Place of origin
Meyrin, June 2004	788	24	3	Place of origin
26th September 2004	2'723	178	6.5	Microsoft Service pack 2 Place of origin
Vandoeuvres, October 2004	240	30	12.5	Microsoft SP 2 Place of origin
25th November 2004	3,755	453	12.1	Microsoft SP 2 Place of origin
24th April 2005	7,911	456	5.8	URL of voting site to be entered manually Place of origin

Two main factors explain the variation in the number of calls per 100 votes:

- Total novelty of the situation (Anières, Carouge);
- Modifications to systems installed in private homes or to the application:
    - Distribution of Microsoft Service Pack 2 in summer 2004 resulted in double the number of calls per 100 votes for Meyrin (June 2004) and the Federal ballot of 26th September 2004 and once again double for the two subsequent ballots;
    - The introduction of a URL requiring manual entry in April 2005 generated some 200 calls from citizens who had entered it incorrectly.

10. Telephone survey conducted after the ballot of 26th September 2004

In the weeks following the first online Federal ballot in Switzerland, held on 26th September 2004, 1,014 citizens living in one of the four municipalities involved in the online vote (Anières, Carouge, Cologny and Meyrin) were interviewed by telephone on the subject of their electoral attitudes during the vote. The sample comprised 149 residents of Anières, 151 of Cologny, 356 from Carouge and 358 living in Meyrin. The over-sampling conducted in Anières and Cologny helped strengthen the accuracy of the results for these municipalities.

The sample was composed on the basis of the state of the electoral role of the four municipalities at the close of the ballot, in order to calculate the percentage of voters and

abstainers and to quantify the proportion of people in the global population having voted at the ballot box, by post and by the internet.

The specificity of this survey was that it focused on municipalities that had already had the opportunity to vote online and therefore comprised a temporal aspect that was missing from the previous surveys.

Before presenting the detailed results of this study, it is important to underline the key point highlighted therein, i.e. the total neutrality of all three ballot methods: ballot box, postal voting and eVoting. In other words, it is impossible to guess the political choices of a voter on the basis of the method he chooses in order to cast his vote. The factors determining the use of online voting are not linked to age, revenue, qualifications, or political stance, but to the user's confidence in internet communications and the trust placed in one's computer.

Thus, the use of online voting appears to be a personal choice and an indication of a way of life in which information technologies are a pivotal factor. It doesn't provide in any case a marker that would help distinguish between eVote users and non-users based on aspects related to social 'rank'.

10.1.1 Behaviour of online voters

The tendency to vote online is very similar regardless of municipality. The highest percentage of online voters is to be found in Anières (26% of votes cast online) and the lowest in Meyrin (20%).

Nine in ten people having already voted online for a previous ballot once again used this method of voting. The series of votes on 26th September, compared to the usual methods employed by voters in the four municipalities, may be broken down as follows:

Ballot of 26th September 2004	**Usual voting method**			
	at the ballot box	**by post**	**by the internet**	**Total (%)**
at the ballot box	76.0%	2.0%	5.3%	5.5%
by post	12.0%	81.2%	5.3%	73%
by the internet	12.0%	16.8%	**89.5%**	21.5%
Total (n)	100.0% (25)	100.0% (501)	100.0% (38)	100.0% (564)

The data collected 'in vivo' complements and confirms a series of statistical data gathered since 2000 regarding the desirability of eVoting:

	c2d study, Geneva, March 2001	**Vox 2003-2004 (GFS Institute, post-ballot surveys: *'If eVoting were available, would you use it?')***	**GFS survey 2003 The most strongly desired persistent services**	**Ballot questionnaires Anières and Cologny *('Do you think you'll vote online again?')***	**EDC study September 2004**
Desirability of electronic voting	68.5% of Geneva citizens favourable to online voting	54% of Swiss favourable, and 79% of 18-29 year old	72% of Swiss people interviewed wish to vote online	90% positive answers	89.5% of people having voted online once have done so again

It would appear from the above table that the fact of having been able to vote online provokes a massive increase in the desirability of this method of ballot.

A striking fact to emerge from the survey conducted by the EDC in September 2004 is that the less accustomed one is to voting, the greater the tendency to vote by the internet:

Current voting method…	Usual voting frequency …					
	always	often	now and again	hardly ever	never	Total (%)
at the ballot box	4.5%	4.9%	15.4%	16.7%	33.3%	5.7%
by post	76.8%	68.9%	53.8%	0.0%	66.7%	72.6%
by the internet	18.7%	26.2%	30.8%	83.3%	0.0%	21.7%
Total (n)	100.0% (396)	100.0% (122)	100.0% (39)	100.0% (6)	100.0% (3)	100.0% (566)

10.1.2 Socio-demographic profile of online voters

10.1.2.1 Influence of age and gender

Online voting is the preferred method of voting for men aged up to around 60 and women to around 50. At these ages, the curves are inverted between mainly online voting and mainly postal voting. However, owing to the fact that people over the age of 60 vote 'en masse', postal voting remains more prevalent in terms of the absolute number of votes received.

Women use online voting slightly less than men, but the same curve persists across women of all ages.

10.1.2.2 Study level

An analysis of the answers to the questionnaire contained in this survey clearly highlights three key facts regarding the impact of level of education on turnout to the ballot of 26th September 2004 and the use of eVoting:

- Regardless of the voting method, turnout to the ballot is positively correlated to the level of education. In other words, the less one had studied, the less one took part in the ballot. This phenomenon, which had already been observed during the municipal ballots of Carouge and Meyrin in spring 2004, is familiar to political science experts and therefore does not come as a surprise.
- The use of eVoting is positively correlated to the level of education. Voters who have a low level of education are not particularly inclined to vote by the internet. Conversely, the use made of eVoting by citizens with a higher level of education (HES, EPF or University level) is proportionate to their level of study;
- The level of education does not impact on the choice of postal voting or ballot box voting.

10.1.2.3 Earnings

Earnings are positively correlated to the use of online voting, while its influence on the two remaining voting methods, at the ballot box and by post, is not proven. It should be pointed out however that earnings are also positively correlated to turnout, regardless of the chosen channel.

10.1.3 Political profile of online voters

The questionnaire included a question concerning self-classification on a left-right scale. In the case in hand, it was a matter of determining whether the choice of one voting channel in preference to another was linked to voters' political tendencies.

It would appear that the proportion of eVoters is stable across the political spectrum, with a slight bias towards the left. This question also revealed the fact that extreme right and extreme left sympathisers vote more than the average individual.

If the same question is asked with regard to political parties and not simply in relation to the left-right scale, it would appear that of all voters identifying with a given party, 15.4% vote by the internet. This proportion remains stable across all political parties with two exceptions: the Greens, 20% of whose sympathisers vote online and the UDC (populist right), 7.3% of whose sympathisers vote online.

10.1.4 Influence of eVoting on vote results

Does the voter's choice of voting method have an effect on the voting result? To find out, the survey authors took each of the six questions put to the vote on 26th September and tried to ascertain whether the accept or reject rate varied as a result of the voting method. To achieve this, they established a multivariate model per voting subject, with dichotomous dependant variables (1=accept; 0=reject). Each model included the socio-economic/demographic and political variables presented above, plus another variable aimed at dividing voters into 'eVoters' and 'traditional voters'.

Voting by the internet is politically neutral. In none of the votes, does voting by the internet have any impact whatsoever on the decision of voters to accept or reject.

In five cases out of the six (the exception being the cantonal law on the demolition, conversion and renovation of buildings), the left-right variable had a significant impact on the result. It would appear, therefore, that during the votes of 26th September 2004, in the four municipalities under analysis, the voters' decisions were above all determined by their political leanings on the left-right scale.

10.2 Conclusion

First and foremost, it is important to underline the constancy of answers from online voters and of the results of surveys conducted in Geneva in the course of time. Age, gender, habits, past voting frequency… the profile revealed by the different surveys converges regardless of the survey in question.

At first glance, one might be disappointed by the immense predictability of the results of these surveys. More men than women vote online, more young than elderly people and more well educated than unqualified individuals. This relatively unsurprising result is nevertheless a guarantee of the seriousness of the surveys and the results obtained.

From this viewpoint, we should welcome the few new lessons that can be drawn from these surveys and be pleased to see confirmation of the instincts which our own 'realism' prevented us from believing. Therefore, the confirmation of the fact that a major share of online voters do not vote regularly points to a potential increase in turnout, notably among young voters. The neutrality of online voting as regards both the vote results and the political profile of users is therefore encouraging.

Finally, the conclusion to which these surveys lead is that the internet and politics form a happy alliance for the greatest good of our institutions.

11. International feedback

The Geneva online voting application has been operational since early 2003, whilst the two other applications backed by the Confederation were only used for official ballots during the second half of 2005. The Geneva application is also one of the only ones in the world to be used in official ballots. The canton of Geneva therefore benefits from that unique experience.

Consequently, it is only natural that such an application should arouse interest beyond Swiss borders. That interest manifests itself not only in requests for information, but also in visits from official delegations[26] and numerous invitations to speak at conferences and conventions. Understandably, it is not possible to accept them all.

The European commission has taken an interest in the Geneva project and chose the city as a finalist in the eEurope Awards competition in 2003 and 2005. The project was thus invited to participate in an exhibition of innovative European projects in Como (Italy) in July 2003 and Manchester (England) in November 2005, on the sidelines of the biennial European ministerial conferences devoted to ICTs.

[26] For the ballot of 26th September 2004, the State Chancellery, for example, welcomed a delegation from the Taiwan foundation for democracy, sent by the country's Ministry of foreign affairs. On 28th November, members of the Norwegian eVoting work group and a representative of the British deputy prime-minister's office (ODPM), attended the count and met with the project managers.

In Como, the Geneva project, the only Swiss representative at this event, received a visit from the Federal Councillor, Moritz Leuenberger. The State chancellor, Robert Hensler was then invited to present the project in Brussels, in February 2004, during a workshop organised by the General directorate for the information society, in the presence of the then European commissioner for enterprise and the information society, Mr. Erkki Liikanen.

In March 2006, the Geneva online voting project was designated as one of the 151 finalists in the Stockholm Challenge, out of 1,165 competing projects. This worldwide competition has been organised by the Swedish municipality since 1993 in order to boost the original applications of information technology, especially those with high social added value. It is encouraging to note that the Geneva project was immediately a finalist in the first worldwide competition in which it took part. The presentation of the application at ITU Telecom World in October 2003 and at the World Information Society Summit held in December by the United Nations was hugely successful. Further to these presentations, the State Chancellery received numerous invitations and requests from public authorities wanting to know more about the new voting system. Not one month passes without the Chancellery receiving a foreign delegation on an eVoting study trip.

The list of foreign invitations accepted by the project includes the international eVoting seminar organised by the Austrian Ministry of foreign affairs in December 2004, the Council of Europe conference on the future of democracy in November 2004 and the World Forum on Electronic Democracy held every year in Issy-les-Moulineaux (France) by the former minister, André Santini. At each edition of this event, the State Chancellery is given the chance to present an update of its project. In December 2004, the Swisshouse Boston (US) organised an evening event on eVoting, which featured a presentation of the Geneva application.

The foreign press has also been following the official ballots held in Geneva, the English-speaking press in particular (New York Times, International Herald Tribune, Associated Press newsagency, BBC radio and TV, Newsweek, Technology review of the Massachusetts Institute of Technology – MIT, etc.).

11.1 The Council of Europe eVoting work group

At the beginning of summer 2002, the Council of Europe asked the State chancellery to attend a preparatory meeting on eVoting. This meeting spawned a work group whose task consisted in drafting the technical and legal standards for eVoting applications, inspired by the European Convention on Human Rights, of which CoE is custodian. The State Chancellery was represented in the Swiss delegation at every meeting of the work group, which ran from December 2002 to June 2004[27].

The standards developed by the group provide the legal and technical markers for any State wishing to embark on the path to eVoting, be it a question of ‘voting machines’ in polling stations or internet polls as in the case of Geneva. These standards were adopted in the form of recommendations[28] on 30th September 2004 by the committee of ministers of the 46 member States of the CoE. This therefore constitutes the very first legal basis in international law for eVoting.

It is no exaggeration to say that the Swiss, or more particularly the Geneva, contribution, has been decisive within the work group, owing to the unique experience that this canton enjoys in the field of eVoting and the quality of experts working for the State.

[27] The group’s work is published in a section of the CoE website devoted to eVoting, www.coe.int/T/E/Integrated%5FProjects/Democracy/.

[28] R (2004) 11 of 30th September 2004 can be viewed on: www.coe.int/t/e/integrated_projects/democracy/02_Activities/02_e-voting/01_Recommendation/Rec(2004)11_Eng_Evoting_and_Expl_Memo.pdf.

12. An application crowned with success

Aside from being selected twice by the European commission to be presented on the fringe of the Como and Manchester ministerial conferences, and being placed as finalist in the Stockholm Challenge, the Geneva eVoting application has so far received two distinctions.

12.1 National distinction

In October 2004, the Swiss society for administrative science (SSAS), presided over by the Chancellor of the Confederation, Ms. Annemarie Huber-Hotz, awarded the Geneva eVoting application a prize as part of its twentieth anniversary celebrations. The prize was presented to Mr. Robert Hensler, State Chancellor, during the anniversary conference of the SSAS in Lucerne, in the presence of Federal Councillor, Mr. Rudolf Merz.

The jury was composed of figures from the fields of politics, administration, science, civil society and the private sector. The project was noted for its multidisciplinary, technical, sociological, politological and legal approach, as well as the care taken to keep citizens informed and in touch.

When presenting its motivations, the jury wrote in particular of an 'innovative Swiss and European level project, systematic project management, with baseline surveys and for every test, analysis of results and impacts, communication and gradual extension to Federal votes, desire to increase voter representativity (…).'

12.2 International distinction

In order to popularise the online voting application operating concept, the Chancellery produced a video presenting a figurative overview of the internal functioning of the system[29]. The Pirelli foundation, in Rome, which awards prizes to popularised scientific multimedia works every year, included the video in its 2004 list of winners, alongside the work of Nasa and the US public service television.

[29] This video can be viewed at www.geneve.ch/evoting/telechargement.asp.

13. Abbreviations

BO CE: Official Bulletin of the Council of States

BO CN: Official Bulletin of the National Council

c2d: Research and documentation centre on direct democracy at the University of Geneva

CCIE: State information systems committee

CoE: Council of Europe

CTI: Information and technology centre, attached to the Geneva State Chancellery

DOSID: Direction of organisation, information systems and centralised vote counting, attached to the Geneva State Chancellery

EDC: E-Democracy Center of the University of Geneva

FF: Federal Journal

GCSI: Swiss federal information society coordination group

JAAC: Jurisprudence of the administrative authorities of the Confederation

LDP: Federal law of 17th December 1976 on political rights (RS/CH 161.1)

LEDP: Geneva cantonal law of 15th October 1982 on the exercise of political rights (RS/GE A 5 05)

OCP: Geneva Cantonal population office

OCSTAT: Cantonal statistics office

ODP: Swiss federal order of 24th May 1978 on political rights (RS/CH 161.11)

OFS: Federal office of statistics

REDP: Regulations of 12th December 1994 implementing the Geneva law on the exercise of political rights (RS/GE A 5 05.01)

SVE: Geneva votes and elections department

Appendices:

1. Inventory of risks and their equivalent in traditional ballot methods

2. The voting card

Appendix 1: Inventory of risks and their equivalent in traditional ballots

This appendix lists the risks associated to internet voting and the legal basis applicable for each. It also lists the equivalent risks existing with the current voting channels (postal voting and polling station voting), their past occurrences and the jurisprudence of the Swiss courts in respect.

1) A citizen disputes the fact that his vote has been registered	
Legal principles and observations:	ODP art. 27d para. 1 let. e, art. 27m para. 3, art. 27n. The eBallot box count is used to determine whether the number of votes matches the number of votes cast.
Comparable risks in traditional voting:	Such a risk is also foreseeable in postal voting.
2) A citizen claims to have been able to enter the system and modify the votes	
Legal principles and observations:	ODP art 27d para.1 let. c, art 27k, art 27l, art3. Legal action is taken as a matter of course. Anyone making this claim runs the risk of penalties. The security measures in place make this intrusion virtually impossible. The encryption of votes renders it unlikely that someone could modify their contents without making them impossible to read subsequently. Moreover, the eBallot box is replicated several times and the contents compared to confirm or deny this claim.
Comparable risks in traditional voting:	Falsification of results during count. Deviation of votes: Vote trading, Fed. el. 26.10.1975 Henniez VD Ballot box theft: Ballots 26.02.1979 Moutier BE Ballot box theft: Ballots 26.09.1982 Vellerat BE Theft of votes from mailboxes in the municipality of Littau LU, Fed. el. 24.10.1999 BO CN *1975* 1538f BO CE *1978* 209 BO CN *1982* 1275 Q 23 FF *2000* 2249 ff..
3) Service denial (inability to access and/or vote) or 'brute force' attack	
Legal principles and observations:	ODP art. 27l. The presence of several servers complicates this type of attack. Citizens cannot be unaware of the constraints inherent in each voting method. E.g.: in mountainous regions, if it snows heavily during the night of Saturday to polling Sunday, some voters might be prevented from voting. In the case of eVoting, there are similar illustrations.
Comparable risks in traditional voting:	Major delays in post. Access to ballot box is blocked: Bad weather, ballots of 26.09.1993 Brig etc. VS, FF *1993* IV 282; Landslide, ballots of 26. 11. 2000 Gondo/Zwischbergen VS Not found in the FF.
4) Voting site fraud; DNS and/or homepage	

Legal principles and observations:	ODP art. 27d ff.. Generally speaking, we equip citizens with the means to protect themselves against voting site fraud (e.g. returning code). It is up to them to verify which site they are on.
Comparable risks in traditional voting:	Someone seizes a large number of postal ballot papers or several ballot boxes. Vote deviation: Vote trading, Fed. el. 26.10.1975 Henniez VD Ballot box theft: Ballots 26.02.1979 Moutier BE Ballot box theft: Ballots 26.09.1982 Vellerat BE Theft of votes from mailboxes in the municipality of Littau LU, Fed. el. 24.10.1999 BO CN *1975* 1538f BO CE *1978* 209 BO CN *1982* 1275 Q 23 FF *2000* 2249 ff. http://www.bk.admin.ch/ch/f/ff/2000/2249.pdf Possibility of violation of voting secrecy: Transparent ballot papers, Tessin Fed. el. 22.10.1995 Envelopes opened or missing, situation tolerated in St. Gall until 1997, Tessin 2003 BO CN *1995* 2340-2342; FF *1996* II 1292f; JAAC *60*.69 UAG SG Art. 32; RLEDP TI Art. 34 http://www.vpb.admin.ch/franz/doc/60/60.69.html
5) Proven Virus/Trojan Horse in course of distribution/already distributed	
Legal principles and observations:	ODP art. 27d para. 1 let. c, art. 27k, art. 27l para. 3. When assessing risks, it is important to take into account the following aspect: the ODP requires that votes cannot be captured, modified or deviated systematically and decisively for the results. This must be taken into consideration when determining the risk involved with a virus or Trojan horse: can it affect a wide population without being spotted?
Comparable risks in traditional voting:	Vote theft or deviation, falsification: Vote trading, Fed. el. 26.10.1975 Henniez VD Ballot box theft: Ballots 26.02.1979 Moutier BE Ballot box theft: Ballots 26.09.1982 Vellerat BE Theft of votes from mailboxes in the municipality of Littau LU, Fed. el. 24.10.1999 BO CN *1975* 1538f BO CE *1978* 209 BO CN *1982* 1275 Q 23 FF *2000* 2249 ff. http://www.bk.admin.ch/ch/f/ff/2000/2249.pdf Possibility of violation of voting secrecy: Transparent ballot papers, Tessin Fed. el. 22.10.1995 Envelopes opened or missing, situation tolerated in St. Gall until 1997, Tessin 2003 BO CN *1995* 2340-2342; FF *1996* II 1292f; JAAC *60*.69 UAG SG Art. 32; RLEDP TI Art. 34 http://www.vpb.admin.ch/franz/doc/60/60.69.html
6) Software/hardware failure on central site <u>with no</u> impact on data	
Legal principles and observations:	Citizens cannot be unaware of the constraints inherent in each voting method. E.g.: in mountainous regions, if it snows heavily during the night of Saturday to polling Sunday, some voters might be prevented from voting. In the case of eVoting, there are similar illustrations.

Comparable risks in traditional voting:	Major delays in post. Access to ballot box blocked: Bad weather, ballots of 26.09.1993 Brig etc. VS, FF *1993* IV 282; Landslide, ballots of 26. 11. 2000 Gondo/Zwischbergen VS Not found in the FF.
7) Software/hardware failure on central site <u>with loss</u> of data	
Legal principles and observations:	ODP art. 27d para. 1 let. e, art 27k, art. 27m para. 3, art. 27n. The ODP insists on highlighting risks relating to mishandling. The loss of votes is not a risk specific to eVoting.
Comparable risks in traditional voting:	Fire, bad weather destroying ballot papers, ballot boxes, polling stations, chancellery premises, etc.
8) Successful attack on central site <u>with</u> loss of data (external or internal)	
Legal principles and observations:	ODP art. 27d para. 1 let. e, art. 27m para. 3, art. 27n. The ODP insists on highlighting risks relating to mishandling. The loss of votes is not a risk specific to eVoting.
Comparable risks in traditional voting:	Arson or other sabotage (destruction of ballot papers, ballot boxes, polling stations, chancellery premises, etc.)
9) A citizen disputes the fact that his vote has been counted	
Legal principles and observations:	ODP art. 27d al. 1 let. e, art. 27m al. 3, art. 27n. The eBallot box count helps to determine whether the number of votes matches the number of votes cast. Do traditional voting methods help to obtain such proof?
Comparable risks in traditional voting:	Such a risk is also foreseeable for postal voting, and indeed for votes at the ballot box (ballot papers stuck to bottom of box).
10) Unavailability of network or State access server	
Legal principles and observations:	Citizens cannot be unaware of the constraints inherent in each voting method. E.g.: in mountainous regions, if it snows heavily during the night of Saturday to polling Sunday, some voters might be prevented from voting. In the case of eVoting, there are similar illustrations.
Comparable risks in traditional voting:	Major delays in post. Access to ballot box blocked: Bad weather, ballots of 26.09.1993 Brig etc. VS, FF *1993* IV 282; Landslide, ballots of 26. 11. 2000 Gondo/Zwischbergen VS Not found in the FF.
11) A citizen claims to know the contents of stored votes prior to end of ballot	
Legal principles and observations:	ODP art 27 f , art 27 g. Legal action is taken as a matter of course. Anyone making this claim runs the risk of penalties. The security measures in place make this intrusion virtually impossible.

Comparable risks in traditional voting:	Such a claim could also arise with traditional voting, but the probability is lower. Cf. also cases of violation of voting secrecy: Transparent ballot papers, Tessin Fed. el. 22.10.1995 Envelopes opened or missing, situation tolerated in St. Gall until 1997, Tessin 2003 BO CN *1995* 2340-2342; FF *1996* II 1292f; JAAC *60*.69 UAG SG Art. 32; RLEDP TI Art. 34 http://www.vpb.admin.ch/franz/doc/60/60.69.html. Possibility also of cases of vote deviation: Vote trading, Fed. el. 26.10.1975 Henniez VD Ballot box theft: Ballots 26.02.1979 Moutier BE Ballot box theft: Ballots 26.09.1982 Vellerat BE Theft of votes from mailboxes in the municipality of Littau LU, Fed. el. 24.10.1999 BO CN *1975* 1538f BO CE *1978* 209 BO CN *1982* 1275 Q 23 FF *2000* 2249 ff.
12) During the count, it is noted that discrepancies are appearing between the results of the eVote and the other voting methods	
Legal principles and observations:	A major discrepancy may help detect an error/attack that has hitherto passed unnoticed.
Comparable risks in traditional voting:	This phenomenon is also possible with postal voting. Cf. also cases of vote deviation: Vote trading Fed. el. 26.10.1975 Henniez VD Ballot box theft: Ballots 26.02.1979 Moutier BE Ballot box theft: Ballots 26.09.1982 Vellerat BE Theft of votes from mailboxes in the municipality of Littau LU, Fed. el. 24.10.1999 BO CN *1975* 1538f BO CE *1978* 209 BO CN *1982* 1275 Q 23 FF *2000* 2249 ff.
13) Malevolent attack by a State employee	
Legal principles and observations:	ODP art 27d para.1 let. c, art 27k, art 27l, art 3. This is an offence that is automatically followed up.

Comparable risks in traditional voting:	Mishandling by a person dealing with votes. Vote deviation: Vote trading, Fed el. 26.10.1975 Henniez VD Ballot box theft : Ballots 26.02.1979 Moutier BE Ballot box theft : Ballots 26.09.1982 Vellerat BE Theft of votes from mailboxes in the municipality of Littau LU, Fed. el. 24.10.1999 BO CN *1975* 1538f BO CE *1978* 209 BO CN *1982* 1275 Q 23 FF *2000* 2249 ff. Violation of voting secrecy: Transparent ballot papers, Tessin Fed. el. 22.10.1995 Envelopes opened or missing, situation tolerated in St. Gall until 1997, Tessin 2003 BO CN *1995* 2340-2342; FF *1996* II 1292f; JAAC *60*.69 UAG SG Art. 32; RLEDP TI Art. 34 http://www.vpb.admin.ch/franz/doc/60/60.69.html.

Appendix 2: The voting card