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Technical dialogue on system for e-voting in Denmark – Summary report

Rapport om teknisk dialog om et e-valgsystem i Danmark

Dansk resumé

På baggrund af en skriftlig anmodning af 27. januar 2012 fra borgmestrene i 12 af landets kommuner samt formanden for KL om tilladelse til at afholde bindende forsøg med e-valg ved lovbestemte fremmødevalg besluttede regeringen den 6. marts 2012 at fremsætte et lovforslag, der vil tillade kommunerne at afholde forsøg med digital stemmeafgivning og digital stemmeoptælling, hvor resultatet af afstemningen er bindende.

Grunden hertil er, at det vil kræve en ændring af valglovgivningen, hvis kommunerne skal have mulighed for at gennemføre forsøg med digital stemmeafgivning, hvor resultatet af afstemningen er bindende, da den danske valglovgivning forudsætter, at afstemningen foregår med en papirstemmeseddel og en eller anden form for skriveredskab. Økonomi- og Indenrigsministeriet vil fremsætte et lovforslag om digital stemmeafgivning og digital stemmeoptælling i januar 2013.

Som et led i forberedelsen af den lovgivningsmæssige proces og det efterfølgende udbud ønskede ministeriet forinden at undersøge de muligheder, som markedet aktuelt kan tilbyde, og at få et overblik over de økonomiske konsekvenser af at introducere e-valg i Danmark. Ministeriet har derfor afholdt en teknisk dialog med 7 leverandører i perioden 21. august – 3. september 2012. Den tekniske dialog blev gennemført i overensstemmelse med reglerne i EU's udbudsdirektiv og de retningslinjer, der er beskrevet i informationsnote nr. 2012/S 122-201846 af 28. juni 2012.

De 7 leverandører blev udvalgt blandt i alt 11 ansøgninger på basis af deres dokumenterede erfaring med udvikling, implementering og betjening af elektronisk stemmeafgivnings- og stemmeoptællingssystemer ved valg til folkevalgte organer. Leverandørerne blev informeret om, at et fremtidigt e-valgsystem i Danmark alene vil blive anvendt til fremmødevalg i et kontrolleret miljø på afstemningssteder på valgdagen og/eller til brevstemmeafgivning i kommunen, ikke til stemmeafgivning via internettet eller andre fjernvalgskanaler.

Den tekniske dialog har efterladt ministeriet med det indtryk, at der findes mange leverandører, der beskæftiger sig seriøst med e-valg, og som bringer kunden en vidtstrakt erfaring på området, idet mange leverandører har arbejdet med at udtænke og levere digitale stemmeafgivnings- og stemmeoptællingsløsninger igennem en række år. De leverandører, der var indbudt til den tekniske dialog, har været involveret i at levere e-valgløsninger til lovbestemte valg i mange forskellige lande i verden og til et større antal organisationer.

Ifølge de leverandører, der deltog i den tekniske dialog, kan man særligt fremhæve følgende fordele ved at anvende et digitalt stemmeafgivnings- og/eller digitalt stemmeoptællingssystem:

A. Hurtigere stemmeoptælling og resultatberegning samt reducering af administrative ressourcer til manuel stemmeoptælling.

B. Mere præcis stemmeoptælling og resultatberegning.

C. Vælgeren kan gives mulighed for at verificere, at stemmenindgår i stemmeoptællingen.

D. Handicappede vælgere kan gives mulighed for at stemme uden hjælp.

E. Utilsigtet ugyldige stemmer kan så godt som elimineres samtidig med, at muligheden for at afgive en blank stemme kan opretholdes.

F. Mulighed for ekstra 'back-up' lagring af stemmesedler.

Ifølge de konsulterede leverandører er den største risiko eller ulempe ved at introducere og anvende digital stemmeafgivning og/eller digital stemmeoptælling ikke så meget et spørgsmål om tekniske fejl eller sikkerhedsmæssige aspekter, men mere et spørgsmål om vælgerens *perception* og *tillid*.

Af den grund anbefaler nogle af de konsulterede leverandører, at man introducerer e-valg i små skridt, hvor man i første omgang anvender systemet i beskeden målestok og giver vælgerne tilstrækkelig tid til at vænne sig til ændringerne, og derved giver dem tillid til systemet ved at lade dem se det virke på en tilfredsstillende måde igennem flere valg og afstemninger, før det evt. rulles ud på landsdækkende plan.

De økonomiske udbydere arbejder i forskellige lande med et vidt spænd imellem de respektive valgsystemer. Den vigtigste erfaring som leverandørerne har opnået derved var, at der ikke er to valgsystemer, der er ens – nogle gange ikke engang inden for det samme land (f.eks. i USA).Alle de leverandører, som ministeriet har konsulteret, kan derfor levere skræddersyede løsninger og anvender en modulær metodik, dvs. hvor systemet kan sammensættes efter kundens ønsker ud fra nogle basiselementer.

Der findes ikke nogen ufejlbarlig løsning, der blot kan tages ned fra hylden og anvendes med succes til e-valg i ethvert land, inklusiv i Danmark. Derfor skal Danmark, hvis der gås videre med planerne om at gøre egne erfaringer her i landet med e-valg, foretage en række beslutninger om, hvilket e-valgsystem, Danmark ønsker, herunder om Danmark skal vælge en løsning, som genererer en fysisk manifestation af stemmen (print af stemmen), eller gå efter en løsning med en optisk scanner, der kan optælle en manuelt udfyldt stemmeseddel digitalt og generere et samlet resultat på baggrund heraf.

Andre forhold, der ifølge leverandørerne skal overvejes, er for eksempel:

- fordele og ulemper ved at vælge en løsning baseret på dedikeret hardware, der alene kan anvendes til e-valg, over for standardhardware som f.eks. tablets, pc'er m.v.,
- hvordan stemmerne skal registreres (f.eks. i selve stemmemaskinen eller af et scanningsmodul koblet til stemmekassen),
- hvorvidt – hvis der vælges en stemmemaskine, der producerer en fysisk manifestation af stemmen (print af stemmen i menneskelig læsbar form eller lignende) – vælgerne skal have mulighed for også at verificere indholdet af en evt. stregkode, som maskinen måtte printe sammen med det menneskeligt læsbare stemmevalg,
- hvilke funktionaliteter til handicappede vælgere systemet skal tilbyde,

- hvorvidt der skal stilles krav om åben kildekode, og i hvilken grad, og
- systemets anvendelighed: skal det kun anvendes på afstemningsstederne, eller skal det også kunne anvendes til mobil brevstemmeafgivning?

Det har under den tekniske dialog været vanskeligt at opnå et præcist overblik over de økonomiske konsekvenser af at indføre digital stemmeafgivning og/eller digital stemmeoptælling i Danmark. De økonomiske konsekvenser vil ifølge leverandørerne således i høj grad bl.a. afhænge af, hvilke valg man træffer i forhold til den anvendte teknologi og modellen for implementering, lagring og vedligeholdelse af denne. På den baggrund har det alene været muligt at angive en bred foreløbig spændevidde for de økonomiske konsekvenser. De endelige økonomiske konsekvenser vil blive nærmere fastlagt i forbindelse med et kommende udbud.

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Executive summary

Following a written request of 27 January 2012 from the mayors of 12 municipalities in Denmark and Local Government Denmark (KL)for permission to conduct binding trials with e-voting at statutory elections, the Danish government decided on 6 March 2012 to introduce a Bill to the Danish parliament that will allow the municipalities to conduct e-voting pilots, where the result of the poll is binding.

The reason for this is that the Danish election legislation will have to be amended in order for the municipalities to be able to conduct binding e-voting pilots, as the law currently implies that voting for statutory elections is done by using a paper ballot and some sort of writing utensil. The Minister for Economic Affairs and the Interior will introduce a Bill to the Danish parliament in January 2013.

As part of the preparation of the legislative and subsequent tender processes, the Ministry of Economic Affairs and the Interior wished to explore the possibilities that the market has to offer at this point in time, and to get an overview of the economic implications of introducing e-voting in Denmark. The Ministry has therefore conducted a technical dialogue with 7 economic operators in the period of 21 August – 3 September 2012.The dialogue was carried out in accordance with the rules of the EU Procurement Directive and the lines indicated by information notice no. 2012/S 122-201846 of 28 June 2012.

The 7 economic operators were selected out of a total number of 11 applications on the basis of their documented experience with development, implementation and operation of electronic voting and counting systems for elections to popularly elected organs.The economic operators were informed that a future e-voting system in Denmark will be used only for non-remote electronic voting in a controlled environment at polling stations on election day and/or for advanced voting on the premises of the municipalities; not for voting over the internet or by other remote voting channels.

The technical dialogue has brought to the Ministry the recognition that there are many economic operators working seriously with e-voting that bring to the customer a wide experience in the field and which have been designing and providing e-voting and e-counting solutions for a number of years. The economic operators invited to the tech-

nical dialogue have been involved in providing e-voting solutions for statutory elections in many different countries in the world as well as for numerous organisations.

In the opinion of the economic operators participating in the technical dialogue, the following main advantages can be derived from employing a digital voting and/or counting system:

G. Faster count and results + reduction of administrative resources for manual count
H. More accurate count and tally
I. Voter verifiability that the vote has been counted
J. Provides the disabled with the opportunity to vote without assistance
K. Eliminates involuntarily spoiled ballots while keeping the option to cast a blank vote
L. Additional 'back-up' storage of ballots

The Ministry recommends that the municipal councils which are considering to engage in e-voting pilots have a thorough discussion of these and other possible potential benefits of e-voting and/or e-counting, and ultimately decide which of these should be guiding for the municipalities' overall strategy for conducting e-voting and/or e-counting pilots.

In the opinion of the consulted economic operators, the greatest risks or disadvantages of introducing and employing e-voting and/or electronic counting is not so much a question of technology flaws or security issues, but more of *perception* and *trust*.

For this reason, some economic operators recommend introducing e-voting by a step-by-step approach, starting out slowly and giving the voters sufficient time to familiarise themselves with the changes and get to trust the system by seeing it work in a satisfactory way in numerous elections.

All economic operators that the Ministry has consulted can provide customized solutions and employ a modular methodology. The economic operators operate in several different countries with a large variety of election systems, where the lesson learned and imparted to the Ministry during the technical dialogue is that no two election systems are the same, sometimes not even within the same country (e.g. USA).

There is no 'fool proof' ready-made solution that can just be picked off the shelf and employed successfully for e-voting in any given country, including Denmark. Hence, if Denmark proceeds with the plans to make its own experiences with e-voting, a number of **choices** will have to be made, *inter alia*whetherwe should opt for a solution that generates a ballot, or opt for an electronic optical ballot scanner solution with a counting and tallying functionality.

Other things to consider are for example the pros and cons of choosing a dedicated versus a commodity hardware solution, how the votes should be recorded, e.g. on the e-voting machine or by a scanning device connected to the ballot box, whether – if opting for a ballot generator of some kind – voters should be offered the opportunity to verify not only the human readable imprint of their vote, but also any electronic record (bar code or similar), the kind of accessibility functionalities the e-voting solution should offer for the disabled, whether it should be a requirement that the system is open source, and to what extent, and the intended use of the system: is it just for voting at polling stations on election day, or should it also be able to handle mobile advance voting in a controlled environment?

1. Introduction

This report contains a summary of the information received during the technical dialogue between the Ministry of Economic Affairs and the Interior with 7 economic operators on a system for electronic voting in Denmark, as well as a short description of the technology demonstrated by the economic operators. In addition, the report includes a tentative estimate of the probable economic implications of introducing e-voting in Denmark for statutory elections based on the data delivered by the economic operators in the technical dialogue.

Following a written request of 27 January 2012 from the mayors of 12 municipalities in Denmark and Local Government Denmark (KL)[i] to be allowed to conduct binding trials with e-voting at statutory elections, the Danish government decided on 6 March 2012 to introduce a Bill to the Danish parliament that will allow the municipalities to conduct e-voting pilots, where the result of the poll is binding.

The Minister for Economic Affairs and the Interior, who *inter alia* is responsible for all statutory elections in Denmark, stated the following in her press release of 13 April 2012 on the government's decision to allow pilots on electronic voting:

> "We have to modernise the public sector, which makes it natural to exploit the opportunities offered to us by new technology – also with regard to elections. The pilots will show whether e-voting offers any significant benefits, which can entail that we should consider digitalising the polling in the longer term.
>
> One of the benefits is that e-voting can eliminate the pile of spoiled ballots, where the election officials are in doubt about where the voter intended to cross the ballot. Another benefit is that e-voting will enable the visually impaired to vote without assistance. Also, e-voting can render the manual count unnecessary on the longer run, which can save the municipalities some resources.
>
> The challenge is whether it is possible to make e-voting secure enough and keep it within an over-all proper financial framework, which the pilots shall also contribute to clarify. I hope that the municipalities will draw some good experiences from the e-voting pilots so that the technology can be spread out to the whole country."
>
> *MargretheVestager*

Before the government and municipalities can move on to a procurement process, the Danish election legislation will as mentioned before have to be amended, as it currently implies that voting for statutory elections is done by using a paper ballot and some sort of writing utensil. The Minister for Economic Affairs and the Interior will consequently introduce a Bill to the Danish parliament, currently scheduled for January 2013.

Purpose of e-voting pilots from the municipalities' point of view

In their letter of 27 January 2012, the 12 municipalities stated that the overall purpose of carrying out one or more e-voting pilots would be to obtain experience with e-voting in a Danish context that could feed into the decision process re. a more general introduction of e-voting in Denmark. The municipalities therefore stressed the importance of a thorough evaluation following the first pilots. The evaluation should *inter alia* focus on technical security, possibility of independent auditing and public control and the

voters' experiences related to the employment of an e-voting system with the aim of securing public acceptance of digitally supported elections.

The aim of the municipalities with regard to conducting the first binding e-voting pilots are in particular to establish whether e-voting can:

- improve the accessibility for voters with disabilities, in particular for the blind and visually impaired as well as dyslectics, and to enable more voters to vote independently,
- eliminate the involuntarily spoiled votes (i.e. not the blank votes, which should still be allowed),
- be carried out while retaining a high degree of public control and high system and operational reliability,
- make the recount redundant, or at least lead to a reduction of the administrative resources deployed for the count and recount,
- result in cost improvements for the municipalities on the longer run.

The starting point of the municipalities was thus to gain some experiences on the operation of a system for electronic ballot generating to be employed at the polling stations and/or for advance voting in a controlled environment, and that offers special accessibility functionalities for the disabled and can provide an electronic count and tally.

In order to increase the Ministry's and the municipalities' firsthand knowledge of different e-voting solutions to the challenges mentioned above it was decided to engage in a dialogue with key stakeholders at this early stage about the advantages and risks/disadvantages of e-voting and which requirements should be made to allow e-voting in a Danish context, and to get an overview of different e-voting solutions.

Process preceding the technical dialogue

As a first step, the Ministry organised a workshop[ii] on 15 May 2012 in collaboration with the Demtech research project[iii] at ITU (IT-University of Denmark) and the Danish Board of Technology with the participation of more than 40 representatives from the IT-community, the municipalities, IT- and social sciences researchers, election experts, interest organisations for *inter alia* the disabled, civil and human rights, the elderly, etc. The purpose of the workshop was to engage key stakeholders as early as possible in the process and gather their input on the desired requirements for a future e-voting system in Denmark, including the necessary procedures for the preparation, safeguarding and carrying out of electronic voting and -counting.

The Ministry works in close collaboration with the municipalities and participates in the steering committee set up by the 12 municipalities and KL to monitor the e-voting project. In consultation with the steering committee, the Ministry decided in the late spring of 2012 to conduct a technical dialogue with economic operators in the field of electronic voting to acquaint itself with the current technological solutions.

In return for the commitment of the Danish government to introduce a Bill that will permit those municipalities that wish to do so to employ electronic voting and counting at statutory elections, the Minister for Economic Affairs and the Interior has asked the municipal councils of the 12 municipalities that originally applied for permission to conduct e-voting pilots for a binding declaration by the 1st of October 2012 of their commitment to allocate the necessary economic and administrative resources required for conducting one or more e-voting pilots.

Shortly after 1 October 2012, the Ministry will decide whether to proceed with its efforts to create the necessary statutory authority to enable municipalities to employ e-voting at statutory elections. If a sufficient part of the 12 municipalities have committed themselves, the Ministry will as previously mentioned prepare the necessary draft legislation during the autumn 2012 with the aim of introducing a Bill to the Folketing (the Danish parliament) in January 2013. Provided that the Bill is passed, the Ministry and the municipalities will work together to present an invitation to tender in the spring, summer or early autumn of 2013, depending on when the legislative process is concluded.

2. Purpose of the technical dialogue

As part of the preparation of the probable tender process for the supply of a system for non-remote electronic voting and counting (hence referred to as an 'e-voting system'), the Ministry of Economic Affairs and the Interior wished to explore the possibilities that the market has to offer at this point in time, *inter alia*to get an overview of the economic implications of introducing e-voting in Denmark.

The Ministry of Economic Affairs and the Interior has therefore conducted a technical dialogue with 7 economic operators with documented experience with development and implementation of electronic voting and counting systems for elections to popularly elected organs, i.e. elections for national or local parliaments or governments etc.

3. The official announcement

The dialogue was carried out in accordance with the rules of the EU Procurement Directive[iv] and the lines indicated by the prior information notice no. 2012/S 122-201846 of 28 June 2012.

Invitation for participation requests to the technical dialogue was issued on 28 June 2012 in TED, the online version of the 'Supplement to the Official Journal of the European Union' dedicated to European public procurement, where the conditions for participation were also stated.[v] The deadline for request by economic operators to participate in the technical dialogue was set to 3 August 2012 at 12:00 noon CEST.

The rules on the right to enter into a technical dialogue with the market are found in point 8 of the recital in the EU directive on public procurement. The rules have been implemented into Danish law by Executive Order no. 712 of 15 June 2011[vi] (in Danish) on the procedures for the award of public works contracts, public supply contracts and public service contracts.

4. Selection of participants and procedure for the technical dialogue

Selection criteria

Particularly out of regard for the resources allocated by the Ministry to carry out the preliminary study, the Ministry decided that a maximum of eight economic operators/partnerships would be invited to the technical dialogue. In the event that more than eight economic operators/partnerships requested to participate in the technical dialogue, the Ministry of Economic Affairs and the Interior would invite all economic operators/partnerships that have documented experience with development, delivery, implementation and operation of electronic voting systems for larger organisations/institutions, including in particular public institutions. If more than eight economic operators/partnerships could document such experience, the Ministry would select those economic operators/partnerships that have documented experience with the development and implementation of electronic voting and counting systems for elections to popularly elected organs, i.e. elections for national or local parliaments or

governments etc. In the event that there henceforth were more than eight economic operators/partnerships qualified for selection according to the above mentioned criteria, lots would be drawn amongst these.

Economic operators selected

The Ministry received 11 requests for participation, of which the following 7 economic operators/partnerships were invited to individual meetings on basis of the enclosed documentation of experience with e-voting at statutory elections:

- Indra
- Opt2vote
- Everyone Counts
- Assembly Voting (Aion & Siemens)
- Scytl & Zetes
- KMD & Smartmatic
- DRS Data Services & Dominion Voting

Procedure

For each invited economic operator or partnership the technical dialogue consisted of one bilateral meeting between the economic operator(s) in question and the Ministry of Economic Affairs and the Interior and its partners. The meetings each lasted approx. 3 hours, of which approx. 45 minutes were set aside for a demonstration of the e-voting system of the economic operator(s) in question.

The meetings took place during the period of 21 August – 3 September 2012. All applicants were informed that participation in the technical dialogue is neither a precondition for participation in the anticipated procurement, nor will it improve the chances of participating economic operators for eventual prequalification. The economic operators were informed that the Ministry as a public authority is subject to the Danish Public Records Act and thus can be obliged to give access to documents etc. to the extent following from its obligations under this Act, but that any request for confidentiality re. information imparted during the oral technical dialogues would be respected by the Ministry as far as possible.

5. Framework and meeting agenda

Framework

The economic operators were informed that a future e-voting system in Denmark will be used only for **non-remote electronic voting** in a controlled environment at polling stations on election day and/or for advanced voting on the premises of the municipalities; not for voting over the internet or by other remote voting channels. The system should thus be employable for the following phases: preparation of the equipment before the election, polling, counting and notification of the results as well as packing and storing.

The system should also be adaptable to the Danish context and election legislation and traditions, i.e. *inter alia* be designed to secure a high degree of recognisability for voters and a continued high trust in elections. The Danish turn-out is among the highest in the world for countries where voting is not mandatory (87.7 per cent at the last general election in September 2011; approx. 65 per cent at local elections). The system must therefore be designed in such a way that the high turn-out and trust in elections are maintained.

Digitalization of the polling implies that some of the control mechanisms meant to ensure public control with the elections will be replaced by digitalized procedures, which can only be checked by specialists with particular insight in it-systems etc. Public con-

trol mechanisms in a Danish context would e.g. be the demonstration and subsequent sealing of the empty ballot boxes in front of the voters in attendance before the elections commence at 9:00 a.m., and the voters' right to watch the manual count of the votes after the election is closed at 8:00 p.m. To ensure a continued high trust in elections – hitherto obtained and preserved *inter alia* via the aforementioned public control mechanisms – the Ministry was therefore also interested in obtaining information on alternative control mechanisms, which provide the voter with a comparable high degree of trust that the polling has progressed correctly, i.e. without system failures or any manipulation with the elections. The system should also be trustworthy and robust and ensure that the election can continue even if the system malfunctions partly or completely during the polling.

The system should also guarantee the secrecy of the vote, which in the Danish context entails that the voter not only has the *right* to keep his/her vote secret, but is also under the *obligation* to do so, i.e. the voter is not free to show his/her vote to others. In addition, it must be impossible to connect a voter and the vote he/she has cast, including indirectly by e.g. logging or electronic detection of screen displays or the like by external devices etc.

The system should finally also be user-friendly and readily accessible to all voters, including voters with disabilities. The Ministry was therefore interested in a presentation of any measures that could render the polling more accessible to voters with disabilities, preferably allowing them to vote without assistance.

Agenda

Before each meeting, the Ministry of Economic Affairs and the Interior sent out an agenda to all participating economic operators reflecting the general framework, where it was stated that the Ministry wished to gain closer insight into *inter alia* the following issues:

1. Protection of the secrecy of the vote in general by the e-voting system.
2. Protection of the secrecy of the vote in particular by the use of dedicated hardware vis-à-vis the use of non-dedicated hardware, including processes for safe destruction of sensitive data.
3. The securing by the e-voting system that the polling has passed off without incident, including by the production of a physical manifestation of the vote (VVPAT or similar) that can both offer sufficient proof to the voter that the polling has passed off correctly and be included in a manual recount.
4. The safeguarding by the system of correct polling and registration of the vote and the possibility to control that the system has not failed or been manipulated along the way (security).
5. The possibility to secure accessibility to the system for the disabled.
6. The economic implications of introducing the e-voting system of the company/ies in question in Denmark, divided into the expenses for a) the purchase or leasing/accommodation of hardware, b) the purchase or leasing of soft ware, c) service and operation, back-up, training, maintenance etc.
7. Possibilities for further development of the system and possibilities to adjust the e-voting system for future needs and update it to exploit new technological possibilities (possibility for agile development and innovation).
8. Possibility of scaling of the system, including information on the possibility to separate the polling and counting functionalities, so that the system initially could be limited to ballot marking, but later can be connected to a digital counting device if desired.
9. Usability in general and for the disabled in particular
10. Advantages and gains of e-voting in general and in particular from employing the e-voting solution demonstrated

6. Demonstration of solutions

The Ministry was presented with 7 solutions for digital voting and/or counting. Based on the description given in the EU information notice of the preliminary considerations by the Ministry and municipalities as to the framework of the upcoming e-voting pilots, the economic operators presented **six different ballot generating systems** with the optional possibility of adding e-counting/scanning devices and **one ballot scanner solution**. The economic operators offered a demonstration of some of their voting/counting equipment that the economic operators estimated would be relevant in a Danish context.

The e-voting and e-counting solutions demonstrated were for the most part only one of more options among many other different solutions and services that the economic operators could provide. Examples of other electronic voting schemes and services were briefly touched upon during the economic operators' presentations (e.g. internet voting remotely or via connected terminals at polling stations, central optical scanners, DRE's with or without paper trail, election management solutions, etc.), but will not be further discussed or described in this report.

A. Ballot generator solutions

All ballot generator solutions demonstrated are more or less structured in the same way:

After being matched against the electoral register at the polling station, the voter is handed a tokenwhich can either be a smartcard with a chip similar to a credit card or a cardboard card with an integrated RFID-chip. The token can either be handed to the voter, or the voter can choose any random token from e.g. a tray to enhance the voter's trust that his/her privacy is protected and that the token does not contain any personal information on the particular voter.

The token can be initialized before the election (which will take time) or for reasons of time constraint and transparency be initialized at the polling station by the election official in front of the voter or ultimately by the voter him/herself. The token can be stored with particular information identifying e.g. the voting district that the voter belongs to (which is relevant if the voter is e.g. voting in advance and needs a different ballot than the one that corresponds to the particular municipality where the advance voting is taking place) or whether the voter is disabled and special features need to be activated in the ballot generator, e.g. the screen should be turned off etc.

The voter inserts the token into the ballot generator placed in the polling booth. The token initializes the machine and activates the ballot interface. All solutions demonstrated employ a touch screen, where the voter makes his/her choices by touching the different options on the screen. Most solutions offer a multiple layer solution, in which the voter first is presented with a frame enlisting the different parties and the option to cast a blank vote. If the voter wishes to cast a preferential (personal) vote for a particular candidate, the voter has to choose the party that the candidate belongs to in order to be presented with a new frame showing the different candidates that are standing for the party in question. The interfaces shown varied a great deal in design and usability, but all economic operators assured that the interface could be customized to fit the customer's wishes.

The voter then has to confirm his/her choice and a ballot is printed by the machine. Systems employing smartcards will print a separate ballot on paper (different qualities and thicknesses were demonstrated, but can almost always be customized), where the vote is printed in both a human readable format (fonts etc. can be customized) and a 2D bar code thatenables electronic counting and tallying. The bar codes displayed on the ballot papers are encrypted and cannot be read with mobile phone QR-scanners or similar. Systems employing a card board card with RFID will print the vote

in a human readable format on the same card used to initialize the ballot generator and store the encrypted electronic readable reproduction of the vote in the RFID (other solutions are also being considered).

All solutions that include storage of the vote on a 2D bar code offer some kind of verifiability functionality, so the voter can choose to scan the bar code and verify that it corresponds to the human readable text imprinted on the ballot paper. The verifiability scanner can either be integrated in the ballot generator so the voter can immediately check the bar code in the same voting booth after the ballot is printed, or be placed in a separate location, e.g. a secluded booth.

Solutions that employ a smartcard entail that the smartcard has to be deposited by the voter after the voting is completed; different solutions for this were demonstrated.

The voter then proceeds to the ballot box and scans the ballot him/herself and deposits it in the ballot box. Some solutions entail that the voter has to scan the ballot and then insert it manually in the ballot box, while others offer transactional operation, meaning that the ballot is placed manually in a slit or similar in the ballot box and then trapped and deposited mechanically into the ballot box. According to the economic operators, either solution will require a trade-off between the benefits the different choices offer and some of the disadvantages they result in in return.

When the polling is closed at 8:00 p.m, the votes can either be counted manually and/or electronically, where after the system procedures a report of the electronic count and tally. The electronic counting solutions can produce reports on both the number of party cotes and personal votes etc. The results can be transmitted to the central tabulation computer either by a secure wireless internet system, modem or 3G or by a USB-stick protected by passwords and encryption, etc. and then collected and inserted into the central computer and tallied there.

Common to all solutions demonstrated is that the ballot is not stored in the ballot generator, but only on the printed ballot, until it is introduced in the ballot box, where it can be scanned and stored electronically or simply inserted for manual count without any electronic recording of the ballot. Other options briefly discussed besides printing of individual ballots include real-to-real and cut-&-drop paper recording of the vote.

B. **Optical ballot scanning and e-counting solutions**

One vendor demonstrated an alternative approach, in that this vendor unlike the other six does not supply a ballot generator, but an optical scanner that can scan paper ballots marked by hand by the voter.

After being checked in the electoral register, the voter is handed a paper ballot similar to the one currently used. The design of the ballot can be customized according to the customer's wishes. The voter marks the ballot with a pen, ticking off or filling in a box or circle beside the party or candidate of his/her choice.

The voter then proceeds to the ballot box, which is mounted with a scanning device,a tabulator and a screen. The voter inserts the ballot in the scanner, which will read the ballot and show the result on a screen so the voter can verify his/her selections. The machine can via the screen alert the voter if he/she has invalidated the vote by filling it out incorrectly or not filling it out at all (a blank vote). The voter can then decide whether to cast the vote or retract it if it has been filled out incorrectly and the voter wants to exchange the ballot. The ballot is transitioned mechanically into the ballot box. The solution includes measures for protection the secrecy of the vote (e.g. a card board folder).

7. Questions discussed

Apart from the demonstrations of their e-voting and e-counting solutions, the economic operators provided answers to the Ministry's questions related to the different topics listed on the agenda, cf. section 5 above. Among these were:

7.1. Protection of privacy and the secrecy of the vote

All economic operators have been required to identify the greatest risks to privacy and the secrecy of the vote and to demonstrate how their solution mitigates the risks identified, as well as to share their experience on what technical and procedural safeguards it would be recommendable to implement.

Most solutions do not entail any connection between the identity of the voter and the ballot, as they are based on the hand out of a randomly chosen token to the voter for initialisation of the ballot generator and do not store the vote on the ballot generator, or are based on the hand out of a paper ballot like today. Some of the systems have originally been developed for the internet and do require an initial storage of both the authentication data and the vote, but these systems nevertheless have technical solutions in place to protect privacy and the secrecy of the vote (separation of databases for authentication and storage of votes and 'double envelope'[vii] systems).

All economic operators have considered the secrecy of the vote in the handling of the ballot.

The electronically generated ballots can be folded to hide the human readable depiction of the vote and only expose the 2D bar code, which is not readable by the human eye. In addition, the bar codes are encrypted so that the bar code cannot be read by a scanner in a mobile phone or other device except for the system scanners containing the algorithm to decrypt the bar code, and no two bar codes are alike irrespective of the choice they represent. The economic operators are also all aware that the ballot should be the same length regardless of the choice it contains to retain the secrecy of the vote.

Most economic operators prefer smartcards to RFID-cards stating security reasons, claiming that cards with RFID-chips could be read or jammed from a distance by hardware that is relatively cheap and easy to buy from the internet. Additionally, smartcards can be reused many times; it is also not necessary to procure a smartcard for every voter, as they can be reinitialized after being used by a voter.

Economic operators favouring RFID have countered that the use of RFID allows the token to be used both to initiate the machine and to store the vote, thus reducing the complexity of the voting procedure for the voters. Additionally, the RFID-chip can according to the economic operators be protected against eavesdropping or jamming by putting the right procedural safeguards in place. Finally, the economic operators offering a RFID-solution contested that RFID-cards are more expensive to procure than smartcards, although it was not disputed that an RFID-solution will entail the need to buy one card for every voter and that they *ipso facto* cannot be reused.

Most solutions shuffle the votes before decryption to ensure that they are recorded in a random and different order than they were cast, so no one can restore a connection between the voter and the votes on the basis of electronic or manual time-logging or similar.
Regarding optical ballot scan systems that scan a regular hand-filled ballot, the ballot has to be inserted into the scanner in its full length, i.e. it cannot be folded to protect the secrecy of the vote. However, as mentioned in the description of the system above, a card board folder can be provided to hide the text of the ballot, which can also be inserted with the text down or in a secluded environment.

7.2. Dedicated versus non-dedicated hardware

Most economic operators employ dedicated hardware in their solution, although in combination with commodity hardware for e.g. optical scanners, touch screens etc. The hardware encased in the ballot generator machines is mostly industrial standard components. The dedicated ballot generator machines have an average life span of 15-20 years according to the economic operators . The main argument of these economic operators for employing dedicated hardware is *security*, claiming that dedicated hardware offers better security against visual and electronic eavesdropping, and better logical protection. Also simplified installation, deployment and maintenance are cited by the economic operators as some of the important benefits of dedicated hardware as opposed to a solution based solely on standard off-the-shelf components.

A couple of the solutions demonstrated to the Ministry were based solely on commodity 'off-the-shelf' hardware; one of the economic operators providing such solutions argued that the trend in their opinion is moving away from procurement of expensive dedicated hardware with what it entails of warehousing, maintenance, and obsolescence issues to software and services. Economic operators that base their solutions on commodity hardware offer to install their software in a wide variety of hardware components, and claim that it is possible to reduce costs further by leasing the hardware, arguing that the commodity hardware can be securely wiped after elections and reused for other purposes.

The economic operators have summed up the advantages and disadvantages of dedicated hardware versus non-dedicated hardware as follows during the dialogue:

	Dedicated hardware	**Commodity hardware**
Easier to restrict access to parts and internal hardware	✓	
Easier installation and technical assistance	✓	
Easier to use for voter and election officials	✓	
No need for software portability (software only needs to be developed and tested for one type of hardware)	✓	
Replacement of components	✓	✓
Ensure privacy	✓	✓
Less costly		✓
Possibility to reuse HW for other purposes		✓
HW independence		✓

7.3. Voter-verifiable paper audit trail (VVPAT)[viii]

All solutions presented by the economic operators at the technical dialogue provide some sort of paper trail in accordance with the framework set out in the information note. Most solutions were presented as "ballot generators", as it was the understanding of most economic operators that the Danish authorities preferred a solution that generated an actual paper ballot that would not be counted in the ballot generator, but should be inserted in a ballot box with the option of optical scanning for rapid re-

cording of the vote (by adding a 2D bar code or OCR imprint of the vote). The optical ballot scanning solution presented by one of the economic operators also involves a paper ballot, as it relies on a traditional hand filled ballot.

7.4. Security and safeguarding

The question of ensuring security against malfunction and internal as well as external attacks was one of the primary focus points of the discussions during the technical dialogue. All economic operators have a great range of different technological and procedural safeguards in place to mitigate these risks.

Among the safeguards mentioned were the following, which do not necessarily apply to all solutions, but are useful to keep in mind when considering the requirements for a future Danish e-voting solution:

- Strong **layer-upon-layer cryptography** applied to ballots, software, etc.
- Production of **zero tallies** before the polling commences to prove that the ballot box is empty – the zero tally can be designed in such a way that it will automatically erase anything in the memory component if something should accidentally or deliberately be stored there,
- Possibility to employ **time locks**to ensure that the system can only be activated at a fixed time, e.g. during the poll,
- System **integrity, availabilityand authenticity tests**,
- **Ballots are not stored electronically on the ballot generators**,
- Ballots are **decrypted by a quorum** after the polls are closed, and the decryption keys are created only by the quorum after the election,
- Systems (e.g. holograms etc.) **prevent ballots from being copied, submitted, and/or counted multiple times,**
- Security against **electromagnetic eavesdropping,**
- **Tampering and malfunction alarms,** which either go off with a loud sound in the voting booth or are communicated more discreetly to the polling supervisor via a headset,
- **Entrances in ballot generators are secured** with physical keys and strips/seals,
- **Mathematical proofs** of decryption and counting are run after the elections to make sure that the ballots have not been tampered with and that the system has functioned correctly,
- **Hardware is standalone**during polling hours,
- **Ballots are shuffled** before they are decrypted to protect privacy and secrecy of the vote,
- Storage of **images of every ballot,**

- **Cameras** survey data centres,

- **Restriction of access** to core services differentiated according to user identity or user role& requirement of **user authentication,**

- **Splitting of security keys and passwords** between two or more trusted polling supervisors or members of the election committee, so no official can start or close the system and/or procedure the results alone.

Despite all these and more security provisions, some of the economic operators contended that a significant number of threats can and should rather be mitigated by ensuring that the right protocols and procedures are in place. Security should be looked at as involving a combination of people, process and product that all have to work together.

Audit and certification

Most economic operators presented a wide range of certificates and credentials achieved from their work with election systems for other customers around the globe.[ix] Many of the systems provided by the economic operators that participated in the technical dialogue have been audited by 'the big four' auditing economic operators (PwC, Ernst & Young, Deloitte and KPMG) as well as by academics employed by the customers etc. The economic operators are thus accustomed to having to comply with different standards and undergo different certification and audit procedures and prepared to do so also in a Danish context.

Open source

Assessment that an e-voting systemfunctions correctly and that security ismaintained is very essential to validate the results of an election and retain the publics' trust in the electoral process.[x] This assessment can be done by the independent evaluation or as mentioned above certificationof the system as a whole or of its components, which requires disclosureof the critical system elements. The assessment can be carried out through,for example, disclosure of the system design, inspection of detailed documentation,source code disclosure, inspection of component evaluation and certificationreports, in-depth penetration testing, etc. The actual level of disclosure ofthe system elements needed to achieve appropriate assurance depends on thespecific features of the system, its components and the services provided. In this context, one of the questions that need to be addressed is whether the system provided should be "open source".[xi]

All economic operators declared themselves ready to hand over the system software for independent review, while retaining property of the solution. Many of the solutions use Linux based operating systems. Some economic operators sell the software to the customer to do with it as the customer seems fit, including having other economic operators or in-house capacities develop the software, others provide the software on a license basis.

7.5. Accessibility for the disabled

All solutions demonstrated to the Ministry during the technical dialogue have different accessibility features that allow one or more specific groups of disabled voters to vote without forfeiting the anonymity of their vote, i.e. by enabling them to vote without assistance by a third party, e.g. a family member or election official.The solutions have all been developed and tested in cooperation with different local associations for the disabled and live up to different national and international standards.

All solutions include a feature for blind and visually impaired that incorporates some kind of audio 'read aloud' functionality. The Ministry discussed with the economic operators ways to ensure that a blind or visually impaired voter would know which way to fold the ballot to fold it correctly, so the human readable text is not shown to anyone else before or during the insertion of the ballot into the ballot urn.

Other functionalities presented allow for the use of sip-and-puff devices, joy sticks, buttons, pedals, head-and-mouth pointers, enlarged fonts on screens, and key boards. The solutions that employ smartcards to initiate the ballot generator machine all have the possibility to have information added to the smartcard indicating that the voter is blind/visually impaired or otherwise disabled, thus instructing the ballot generator to either turn off the screen or allow the use of a special feature.

All economic operators of ballot generators emphasized that the different disability functionalities as default are added to *all* ballot generator machines, so voters needing these functionalities can choose any voting booth containing the machine instead of being assigned to a particular voting booth, with the exception of the optical scanner solution.

A common fact for all systems for the disabled to take into account according to the economic operators is that voting for the disabled using any of the described functionalities will invariably take longer compared to a non-disabled voter.

7.6. Economic implications

Preconditions
As previously mentioned, the economic operators have demonstrated several technical solutions essentially spanning from optical scanning and e-counting of hand-filled paper ballotsto ballot generating systems with optional e-counting functionalities. The different systems demonstrated during the technical dialogue are built up from different technical solutions of varying complexity and with different choices of components (dedicated/non-dedicated hardware etc.), which is reflected in the tentative pricing quoted by the economic operators.

The tentative level of expenditure stated below has been calculated on the basis of an isolated e-voting pilot and therefore also encompasses non-recurrent expenses for procurement of ballot generators and/or e-counting equipment etc. The equipment can be reused as a starting point if the evaluation of the pilot is positive and permission is given for more pilots or e-voting is permitted on a more general basis. The hardware has an estimated life span of at least 7-9 elections. Furthermore, the Ministry estimates that expenses for training, project management and voter information (see the listing of expenses below) will be relatively high for the first pilots and then gradually decrease.

The calculations have been made on the basis of a turn-out of 88 %, which is rather high and corresponds to the turn-out at parliamentary elections. If the calculation is based on a lower turn-out, e.g. corresponding to the usual turn-out at local or European Parliament elections, the number of hardware units required for e-voting and/or e-counting will probably be somewhat lower.

An average of the prices indicated by the economic operators for comparable equipment has been employed for the calculation of the following *tentative, overall cost estimates*. It has furthermore been presupposed re. the prices for ballot generating systems that all voters in attendance at the polling station will cast an electronic vote and that "intelligent" ballot boxes are employed for the recording, counting, and tallying of the electronically generated ballots.

The price estimates below are as previously mentioned based on information imparted by the economic operators during the technical dialogue and are meant to give an indication of a *possible* price range. However, it is not possible at this given time to say how the market will react in a real competition situation when the Ministry initiates a tender process to enable limited pilots, including whether a lower pricing could be expected.

Price estimates
The total price estimates below include expenses for:

- Hardware (depending on whether the chosen solution includes optical ballot scanners or ballot generators, digital ballot boxes with e-counting functionality, tokens and other hardware),
- Software
- Technical support before and on election day
- Training of election officials
- Project management and implementation
- Voter information
- Independent control of equipment and audit
- Evaluation

Expenses for technical support, training, project management and implementation, voter information, control and audit, and evaluation are estimated.

A. Polling station with 2,500 voters

The total expenses including the elements listed above will, depending on the chosen solution and the technological setup etc., roughly estimated amount to **250,000 – 450,000 DKK** for an e-voting pilot on a polling station with 2,500 voters.

B. Polling station with 5,000 voters

The total expenses including the elements listed above will, depending on the chosen solution and the technological setup etc., roughly estimated amount to **350,000 – 750,000 DKK** for an e-voting pilot on a polling station with 5,000 voters.

C. Polling station with 10,000 voters

The total expenses including the elements listed above will, depending on the chosen solution and the technological setup etc., roughly estimated amount to **550,000 – 1.1 mill. DKK** for an e-voting pilot on a polling station with 10,000 voters.

Potential reductions in expenditure
The number of election officials needed at the polling station is estimated to be unchanged on election day and during the counting and recounting during the first e-voting pilot.

In the event that a number of elections is subsequently carried out employing optical ballot scanners or ballot generators combined with an e-counting functionality, the electronic counting and tallying might in time partly or completely replace the manual count of the ballots at polling stations and eventually also the recount, resulting in reductions of administrative expenditure.

7.7. Innovation, agile methodology and possibilities for further development (transferability)

All economic operators stated that their systems are continuously being updated and developed and that they employ an agile methodology, including new technological

possibilities as they arise. New versions always leverage market improvements, and there is independent evolution of each component. Some of the economic operators shared some future plans for development of their systems.

Training and services

All economic operators offer training and services as part of their solution. Training can be designed to meet the customer's need. Many economic operators provide e-learning tools as a supplement to on-site training. Most economic operators employ a train-the-trainer methodology, as it *inter alia* is viewed as most cost-effective. Some international economic operators usually choose to work with a local partner to provide support and other services. All manuals can as a rule be provided in the customer's local language (i.e. in Danish), and calling centres will be staffed with native speakers.

7.8. Scalability and separation of functionalities

All economic operators informed the Ministry that their solutions could easily be scaled and cited a number of past experiences where it had been necessary to upscale the solution rapidly. The solutions are all built according to a modular approach, which means as previously mentioned that the solutions can be customised in a number of ways to meet the demands of the customer.

The ballot generator-solutions can be progressively introduced, so that initially the machine only marks the ballot, and the e-counting functionality is added at a later stage when voters have grown comfortable with e-voting. However, one economic operator argued that the ballot counting functionality is the least costly when it comes to an ballot generator-solution and concurrently one of the most beneficial. The economic operator therefore recommended that the Ministry and municipalities opt for the full end2end solution from the beginning. The voter verification station could also be added at a later stage, but one economic operator argued that this functionality is important to implement in the beginning, where voters most likely will be more sceptical and eager to verify the bar code on their ballot to make sure that the machine has worked as intended.

Implementation

Most economic operators stated a lead time of between 6-18 months from contract signing to election day. This period will however depend on the scale of the procurement; if the solution is being procured only for a limited pilot of 10-30 polling stations, the implementation time of the system will naturally be shorter than if the solution is being procured for the whole country. Stages to be considered when drawing up the project plan include blue print stage (for definition of inter alia the requirements), voter engagement and information campaign (should be initiated as soon as possible and in good time before the election), adaptation of solution to Danish legislation and standards and approving of design, independent review/certification of HW, SW, and procedures, manufacture of machines, tests and mock election(s), sealing, training of election staff and finally roll-out of solution, delivery tests etc. However, all economic operators that the Ministry has met with have vast experience in adapting and customising their solutions to meet the specific needs of the customer, and can also offer some flexibility re. implementation.

8. Advantages and risks/disadvantages of electronic voting and counting

Advantages

In the opinion of the economic operators participating in the technical dialogue, the following main advantages can be derived from employing a digital voting and/or counting system:

A. More accurate tallying

Electronic counting can offer more accurate tallying and as good as eliminate human errors in the counting process.

Some of the economic operators recommended that when manual counts are to be conducted for audit purposes after the electronic tallying (either as a complete recount or random checks), a proper procedure should be implemented to minimize human error. E.g. counts should be undertaken by independent auditors or officials that have not been participating in the election all day, where the risk of them not being capable of conducting a recount under optimal conditions is significantly enhanced compared to if you bring in a "fresh" team. Also, the recount should be undertaken in teams of 2 or 3, where all individuals must agree on the result before it is compared with the electronic tally.

B. Voter verifiability

All the demonstrated electronic counting systems offer the voter the possibility to scan his/her ballot before inserting it in the ballot box either manually or by transitional operation. Hence, the voter is enabled to verify him/herself that the vote is actually counted, which is not possible in the traditional paper based and manually counted elections.

C. Provides the disabled with the opportunity to vote without assistance

All the systems demonstrated during the technical dialogue include features that are designed to enable voters with disabilities to cast their vote without assistance. The range of disabilities covered by the different solutions and their usability vary, but all do to some extent make it possible for some groups of disabled voters to cast their vote unsupervised (cf. section 7.5. below).

D. Eliminates involuntarily spoiled ballots while keeping the option to cast a blank vote

All the demonstrated solutions can prevent the casting of involuntarily spoiled votes, while still retaining the option to cast a blank vote, as the voter only has the option to mark the ballot electronically with one choice (either a vote for a particular candidate, a particular party or a blank vote.[xii]

E. Additional 'back-up' storage of ballots

According to the economic operators, the e-voting solutions contain an extra security provided by the electronic storage of the ballots and results in parallel with the physical storage of the paper ballots. This offers redundancy, as the result of the poll can be reproduced if for some reason the paper ballots should be damaged, destroyed or lost, thus avoiding a second ballot as the ultimate consequence if a significant number of ballots cannot be produced for the count or recount for one of the reasons previously mentioned.

F. Faster count and results & reduction of administrative resources for manual count

E-counting *ipso facto* enables a much faster tally and result. The economic operators informed the Ministry that a faster and more accurate count and tally also offers significant advantages from the administrative point of view of the municipalities, in that it can lead to a reduction of resources allocated to the manual count and particularly to the recount (which could on the long run become redundant). However, this advantage would only manifest itself over time, and should be weighed against the increased economic implications of procuring and maintaining e-voting equipment and the additional staff that will be required to set up, run and pack the equipment after the election.

On basis of the information received by the economic operators on the different potential benefits of e-voting, the Ministry finds that the municipal councils which are considering to engage in e-voting pilots should have a thorough discussion of the enlisted and other possible potential benefits of e-voting and e-counting, and ultimately decide which of these should be guiding for the municipalities' overall strategy for conducting e-voting and/or e-counting pilots.

Risks and disadvantages

The greatest risks or disadvantages of introducing and employing e-voting and/or (to a lesser extent) electronic counting is in the opinion of the consulted economic operators not so much a question of technology flaws or security issues, but more of *perception* and *trust*.

For this reason, some economic operators recommend introducing e-voting by a step-by-step approach, starting out slowly and giving the voters sufficient time to familiarise themselves with the changes and get to trust the system by seeing it work in a satisfactory way in numerous elections. Some economic operators also pointed out that in their experience voters are generally receptive and positive towards the introduction of technology in the election realm, while scepticism is often mainly expressed by candidates and political parties. Therefore, it is important to conduct independent audits after the elections that can prove beyond any reasonable doubt that the election has not been tampered with and that the results have been correctly counted and tallied.

Notwithstanding, the economic operators also pointed out that the issues of *security against malfunction and manipulation* of an e-voting system as well as the matter of preserving the voter's privacy and the secrecy of the ballot are equally very important issues to consider and protect when drawing up the requirement specifications for a future e-voting/e-counting solution and during the procurement process.

9. Conclusion: Choices have to be made

Most economic operators can provide customized solutions and employ a modular methodology. The economic operators all operate in several different countries with a large variety of election systems, where the lesson learned and imparted to the Ministry during the technical dialogue is that no two election systems are the same, sometimes not even within the same country (e.g. USA).

Therefore, if Denmark proceeds with the plans to make its own experiences with e-voting, a number of **choices** will have to be made, *inter alia*:

- What are the main benefits that the municipalities expect to obtain from an e-voting system, and which kind of solution does best fit these needs taking into account the economical aspects?
- Should e-voting in Denmark be introduced in the form of a ballot generator that marks a ballot paper electronically, or should we opt for an optical ballot scanning and counting device that scans and counts hand-filled ballots?
- If the first option of an electronic voting machine that marks the vote electronically is chosen, should the votes then be recorded on the e-voting machine, or should they only be recorded when a paper ballot or similar is introduced into a scanning device?
- Should the solution be based on dedicated hardware or commodity hardware?
- Should the voters be offered the opportunity to verify not only the human readable imprint of the vote, but also any electronic record (bar code or similar)?
- What kind of accessibility functionalities should be offered to disabled voters?

- Should there be a requirement that the system has to be open source? And to which extent?

- Is the system primarily being considered for voting on election day at the polling stations, or should it also be able to handle advance voting, and if so should it only be used at fixed locations (town halls etc.) or also in mobile environments (e.g. for advance voting at hospitals, the voter's own home, homes for the elderly etc.)?

[i] KL is the interest group and member authority of Danish municipalities.
[ii] http://evalg.teknoprojekt.dk/
[iii] http://www.demtech.dk/#
[iv] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2004:134:0114:0240:EN:PDF
[v] http://ted.europa.eu/udl?uri=TED:NOTICE:201846-2012:TEXT:EN:HTML
[vi] https://www.retsinformation.dk/Forms/R0710.aspx?id=137281
[vii] The electronic 'double envelope' systems are similar to the system employed for advance voting today, where the advance ballot until election day is stored in an envelope that is sealed and placed in a new envelope with a covering letter containing inter alia the name and address of the voter. The covering letter and sealed envelope containing the advance vote are separated the day before election day, when the polling supervisors examine the advance votes and decide whether all formalities have been met and the vote qualifies for consideration.
[viii] A voter-verified paper audit trail (VVPAT) or verified paper record (VPR) is a method of providing feedback to voters using an electronic voting system, as itallows voters the possibility to verify that their votes are cast as intended and can serve as an additional barrier to changing or destroying votes. A paper VVPAT is by definition readable by the human eye, and offers the voters the opportunity to directly interpret their vote. The VVPAT may be added a bar code or other electronic readable feature for rapid electronic recording of the votes by scanners etc., and will make it more difficult for voting machines to corrupt records without human intervention.
[ix] According to the Council of Europe's Recommendations on legal, operational and technical standards for e-voting (2004) (standards 111-112), an e-voting system should be subjected to a certification process introduced by the public authority responsible for procuring or defining the necessary requirements of an e-voting system. The certification process should allow for any ICT (Information and Communication Technology) component in the chosen e-voting solution to be tested and certified as being in conformity with the technical requirements set up by the same authorities. In addition, end-to-end auditing including recording, providing monitoring facilities and providing verification facilities should also be undertaken (standards no. 100-110). See Recommendation Rec(20045)11 of the Council of Europe on legal, operation and technical standards for e-voting. Available at: http://www.coe.int/t/dgap/democracy/activities/GGIS/E-voting/Key_Documents/Rec(2004)11_Eng_Evoting_and_Expl_Memo_en.pdf
[x] According to the Council of Europe's "Legal, operation and technical standards for e-voting", standard no. 24, the components of an e-voting system should always be disclosed, at least to the competent electoral authorities, for verification and certification purposes.
[xi] Open source is a philosophy, or pragmatic methodology in production and development that promotes free redistribution and access to an end product's design and implementation details, typically employed for software solutions. There is an international discussion whether such a critical system that touches upon the core of democracy should be validated according to the methodology of open source, the argument for this being that open source entails greater transparency, perceived as the hallmark of democratic elections.
[xii] In the experience of the Ministry, the large majority of the spoiled votes have not been purposefully spoiled by the voters; the majority of the voters having cast a spoiled vote other than a blank vote are thus under the wrong impression that their vote has been correctly cast and counted and forms part of the overall result.