The Project work in this course includes the following:

2 students/group.

A communication application/technical problem/problem area, relevant for the course, is investigated.
The choice of project is mainly done by the project group.

Articles and conference papers from IEEE´s database ”IEEE Xplore”
http://ieeexplore.ieee.org/Xplore/DynWel.jsp
is recommended to get additional technical information.

Written report, oral presentation and opponent to another group (both the written report and the oral presentation).

Digital Communications – Advanced Course (ETT055)

The Project

1. Each project group consists of two students.
2. Each project group should write a report, and 2 copies should be handed in on Wednesday 17 February (study week 5 in VT1), 2010, 15.00, at the latest (Email with .pdf format is also OK).
3. The report should be written in English *with your own words, tables and figures*, and contain at least 8 pages.

   Observe copyright rules, "copy & paste" is in general strictly forbidden!
4. Each project group should also present the project work in an oral presentation (15 – 20 min). Directly after the oral presentation the written report and the presentation will be discussed.
5. Each group should read and comment the written report and the oral presentation of another group.

Project start-up procedure:

Monday 23 November (study week 5 in HT2):

A list of project examples is available at the homepage of this course.

Project info and examples are presented at the lecture.

Start-up project meeting in study weeks 5-6 in HT2:

A start-up project group meeting (30 min) will be held as soon as you have found a project partner, and decided which two projects you find most interesting as project candidates.

The project groups should contact Göran Lindell as soon as possible!

Follow-up project meeting in study weeks 6-7 in HT2:

The purpose of this meeting (30-45 min) is to answer any questions related to your project, and to discuss how to structure your project work.

Additional follow-up project meeting in study weeks 1-2 in VT1:

The purpose of this meeting (30 min) is to make sure that your project work has started and that you are on the right track. We will also discuss how your written report should be structured.

List of examples of projects.

Project 1: Adaptive coding and modulation.

In this project systems that use adaptive coding and modulation is investigated and explained, and also the gains obtained (xDSL, WLAN, EDGE, 3G,…). An interesting sub-problem should also be studied.

Project 2: Choice of pulse shapes in advanced applications.

In this project different advanced pulse shapes that are designed to resist intersymbol interference is investigated and explained. An interesting sub-problem should also be studied.

Project 3: Signal power distribution over the frequency axis to obtain high bit rates.

In this project systems that use this kind of technique is investigated and explained, and also the gains obtained (xDSL, WLAN, EDGE, 3G,…). An interesting sub-problem should also be studied.

Project 4: MIMO system.

In this project MIMO systems, and possible applications, are investigated and explained. An interesting sub-problem should also be studied.

Project 5: OFDM system.

In this project the techniques used in OFDM systems, and an application, are investigated and explained. An interesting sub-problem should also be studied.

Project 6: The importance of diversity to improve performance.

In this project the concept of diversity is investigated and explained. An interesting sub-problem should also be studied.

Project 7: Bluetooth.

In this project the technique used in Bluetooth, and an application, are investigated and explained. An interesting sub-problem should also be studied.

Project 8: Digital TV.

In this project the techniques used in Digital TV is investigated and explained. An interesting sub-problem should also be studied.

Project 9: Wimax.

In this project the technique used in Wimax systems, and possible applications, are investigated and explained. An interesting sub-problem should also be studied.

Project 10: The multipath channel.

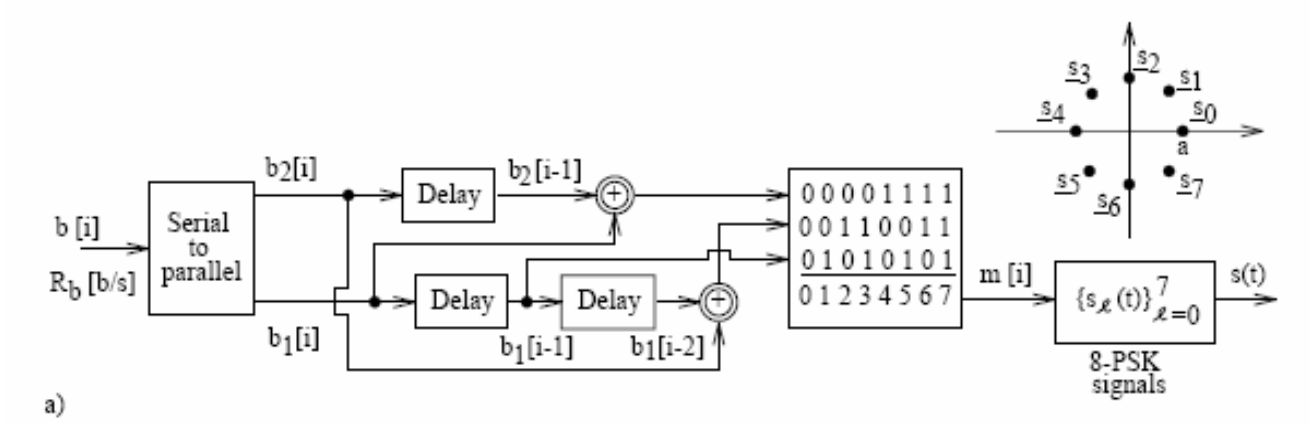
In this project some consequences of the multipath channel is investigated. What kind of signals should be used, receiver design and error probability are here considered.

Project 11: Communication over power lines.

In this project possible techniques for communication over power lines, and possible applications, are investigated and explained. An interesting sub-problem should also be studied.

Project 12: Signal design to simplify synchronization.

In this project we investigate how signals can be designed to simplify synchronisation in the receiver. An interesting sub-problem should also be studied.

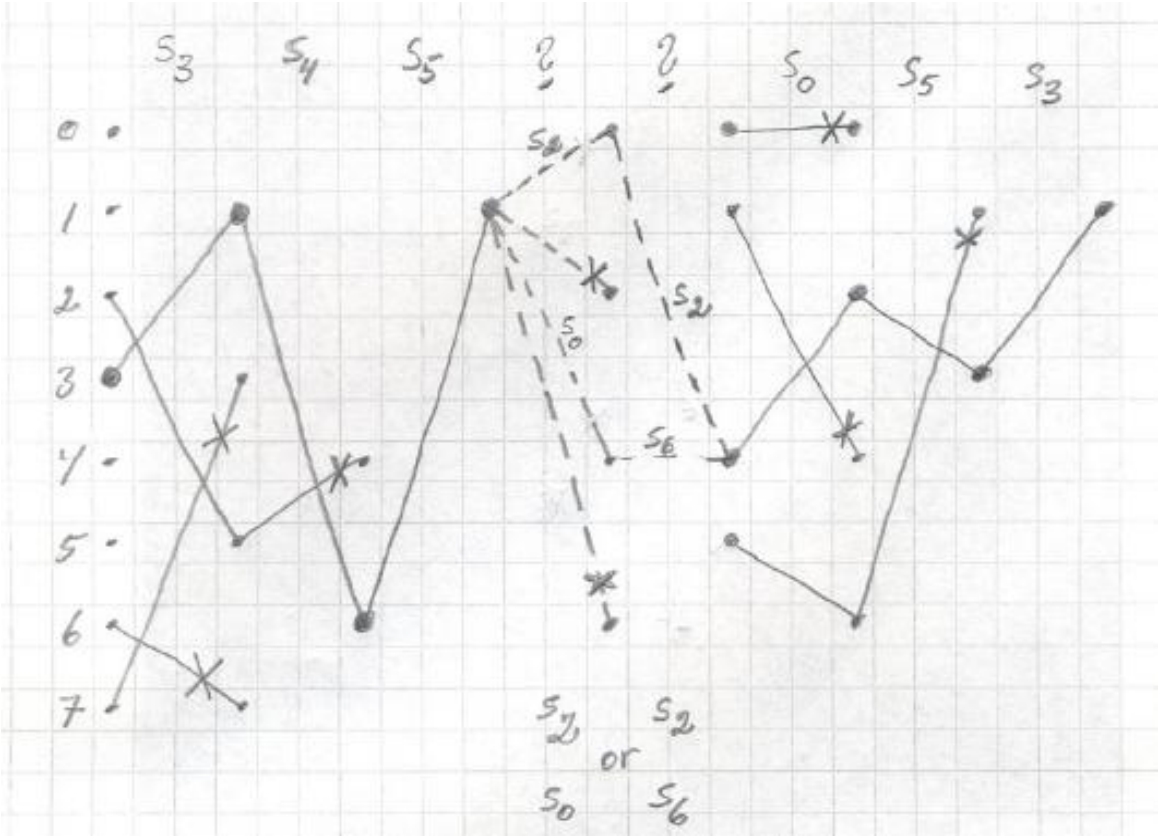


Given: ……..s3, s4, s5, s?, s?, s0, s5, s3

Find: s?, s?

INPUT $\begin{pmatrix} b_2[i] \\ b_1[i] \end{pmatrix}$	Current state σ [i] (000) 0	(001) 1	(010) 2	(011) 3	(100) 4	(101) 5	(110) 6	(111) 7
$\begin{pmatrix} 0 \\ 0 \end{pmatrix}$	0/0	0/2	1/1	1/3	0/4	0/6	1/5	1/7
$\begin{pmatrix} 0 \\ 1 \end{pmatrix}$	2/4	2/6	3/5	3/7	2/0	2/2	3/1	3/3
$\begin{pmatrix} 1 \\ 0 \end{pmatrix}$	4/2	4/0	5/3	5/1	4/6	4/4	5/7	5/5
$\begin{pmatrix} 1 \\ 1 \end{pmatrix}$	6/6	6/4	7/7	7/5	6/2	6/0	7/3	7/1

σ [i+1] / m [i]



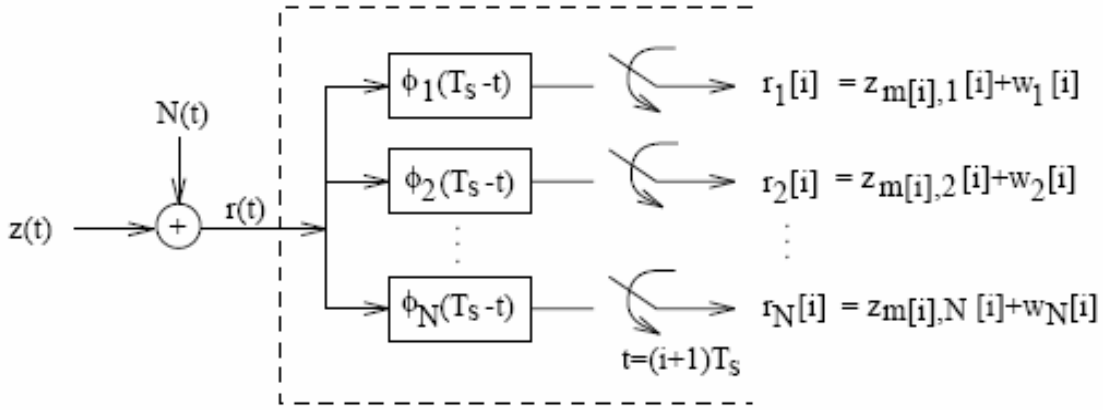


Figure 8.10: The first stage of the ML receiver.

$$\boldsymbol{r}[i] = \begin{pmatrix} r_1[i] \\ r_2[i] \\ \vdots \\ r_N[i] \end{pmatrix} = \begin{pmatrix} z_{m[i],1}[i] \\ z_{m[i],2}[i] \\ \vdots \\ z_{m[i],N}[i] \end{pmatrix} + \begin{pmatrix} w_1[i] \\ w_2[i] \\ \vdots \\ w_N[i] \end{pmatrix} = \boldsymbol{z}_{m[i]}[i] + \boldsymbol{w}[i] \quad (8.44)$$

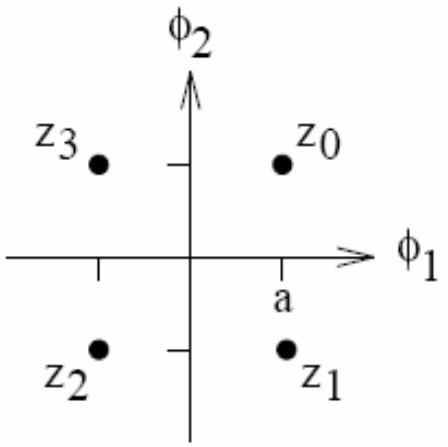
$$\ldots, \boldsymbol{r}[i-1], \boldsymbol{r}[i], \boldsymbol{r}[i+1], \ldots \quad (8.45)$$

$$\ldots, \boldsymbol{r}[i-1], \boldsymbol{r}[i], \boldsymbol{r}[i+1], \ldots \tag{8.45}$$

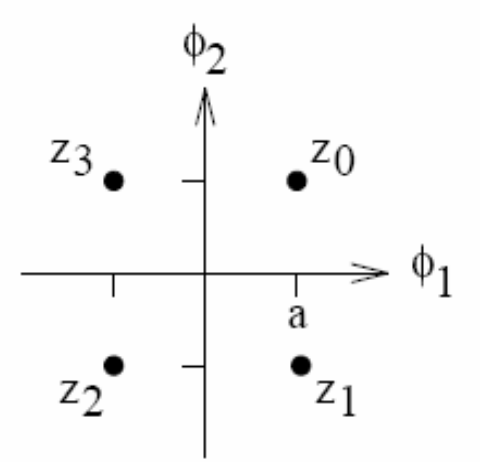
$$\ldots, \boldsymbol{z}_{m[i-1]}[i-1], \boldsymbol{z}_{m[i]}[i], \boldsymbol{z}_{m[i+1]}[i+1], \ldots \tag{8.46}$$

$$\boxed{D^2_{\boldsymbol{r},\,\boldsymbol{z}}[i] = D^2_{\boldsymbol{r},\,\boldsymbol{z}}[i-1] + D^2_{inc}[i]} \tag{8.50}$$

$$D^2_{inc}[i] = \left(\boldsymbol{r}[i] - \boldsymbol{z}_{m[i]}[i]\right)^{tr} \left(\boldsymbol{r}[i] - \boldsymbol{z}_{m[i]}[i]\right) = \sum_{\ell=1}^{N} \left(r_\ell[i] - z_{m[i],\ell}[i]\right)^2 \tag{8.49}$$



EXAMPLE 8.14



$$\boldsymbol{r}[i-2] = \begin{pmatrix} a/2 \\ -a/4 \end{pmatrix} \ , \boldsymbol{r}[i-1] = \begin{pmatrix} -a/2 \\ -3a/4 \end{pmatrix} \ , \boldsymbol{r}[i] = \begin{pmatrix} 3a/2 \\ a/4 \end{pmatrix}$$

Calculate the squared Euclidean distance increments associated with the candidate sequence $\boldsymbol{z}_0[i-2]$, $\boldsymbol{z}_3[i-1]$, $\boldsymbol{z}_2[i]$.

$$\begin{aligned} D^2_{inc}[i-2] &= \sum_{\ell=1}^{2} \left(r_\ell[i-2] - z_{0,\ell}[i-2]\right)^2 = \\ &= \left(\frac{a}{2} - a\right)^2 + \left(-\frac{a}{4} - a\right)^2 = \frac{29}{16}\ a^2 \end{aligned}$$

The Viterbi Algorithm:

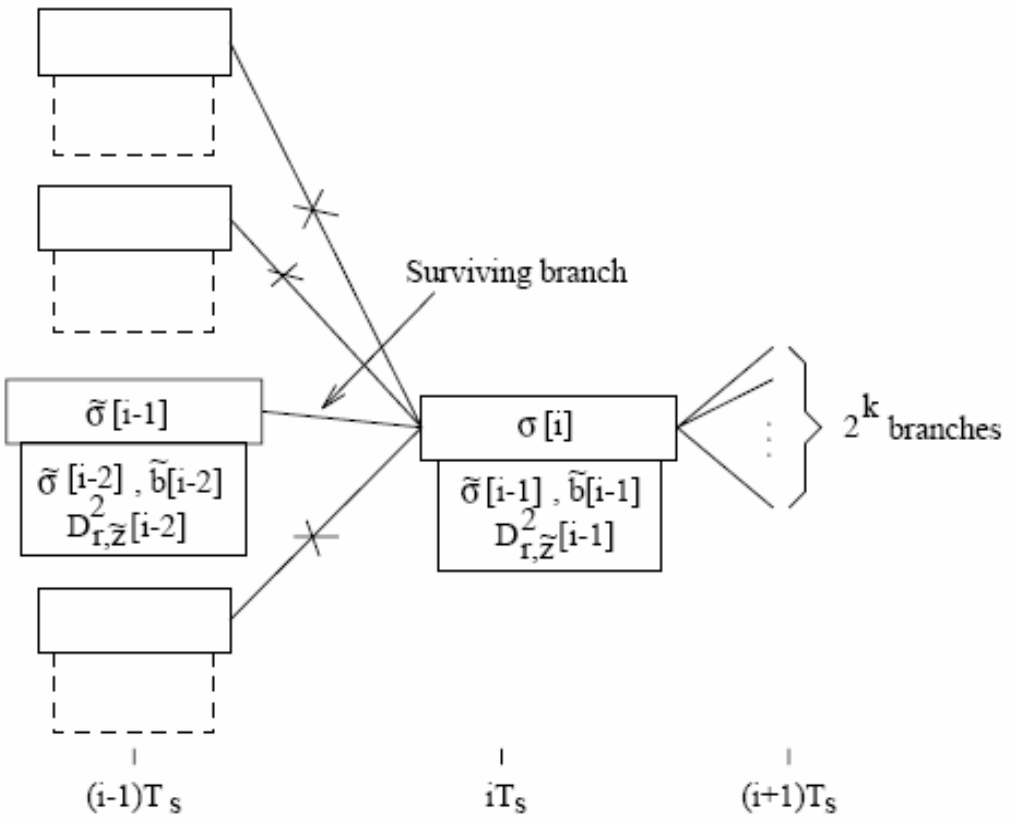


Figure 8.11: Illustrating how branches in the trellis are deleted (x) by the Viterbi algorithm.

The result of the Viterbi algorithm, at time $t = iT_s$, is exactly $\mathcal{S}$ surviving **candidate sequences**, one for each state $\sigma[i]$. These sequences can be found, i.e., traced back in the trellis by using the saved information at each state. *Note that the most likely sequence, up to time $t = iT_s$, must be one of these $\mathcal{S}$ candidate sequences!*

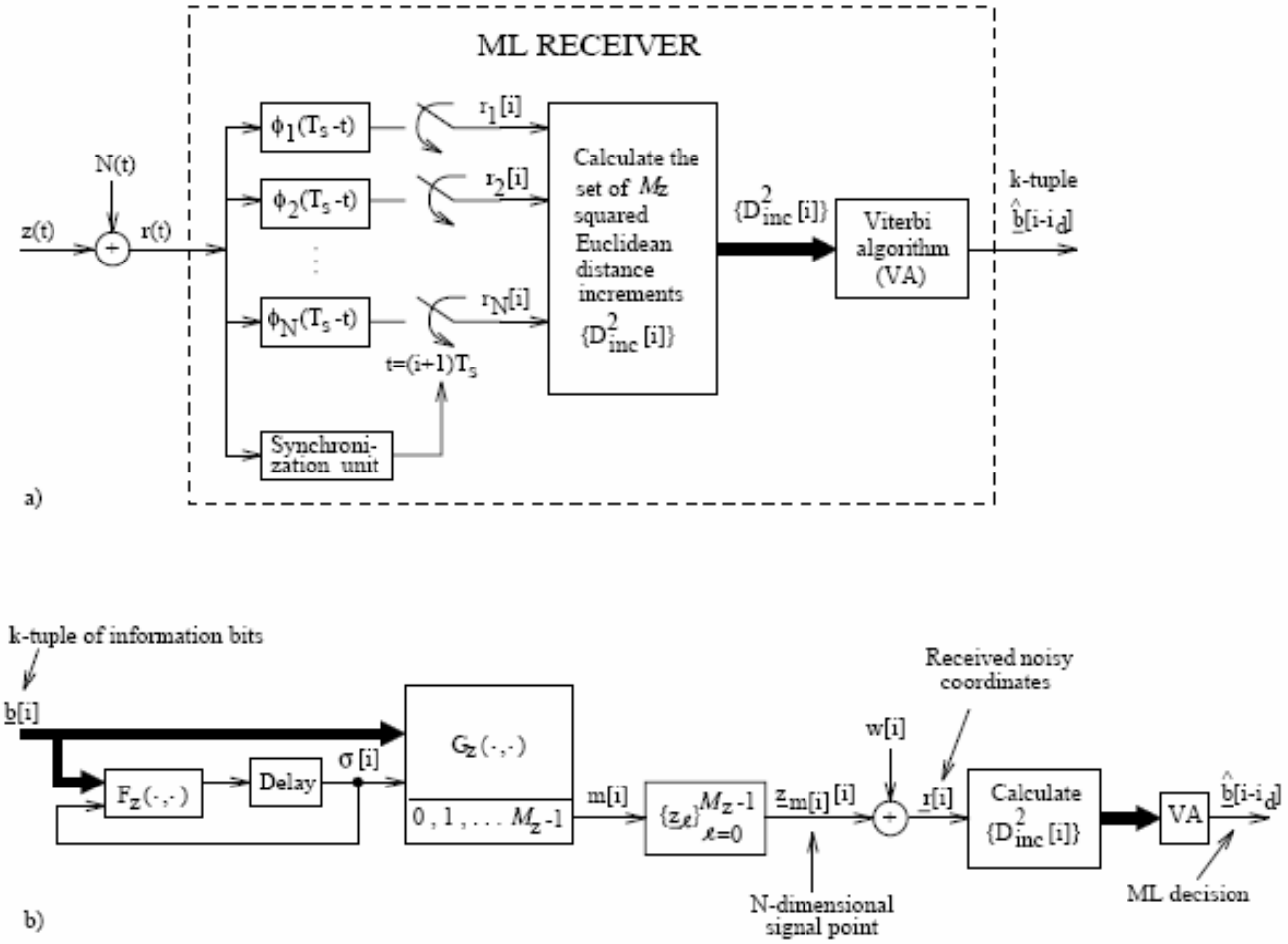
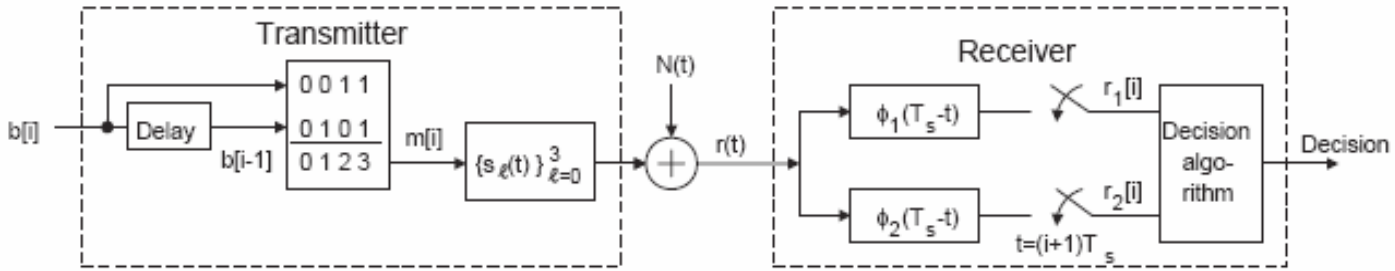
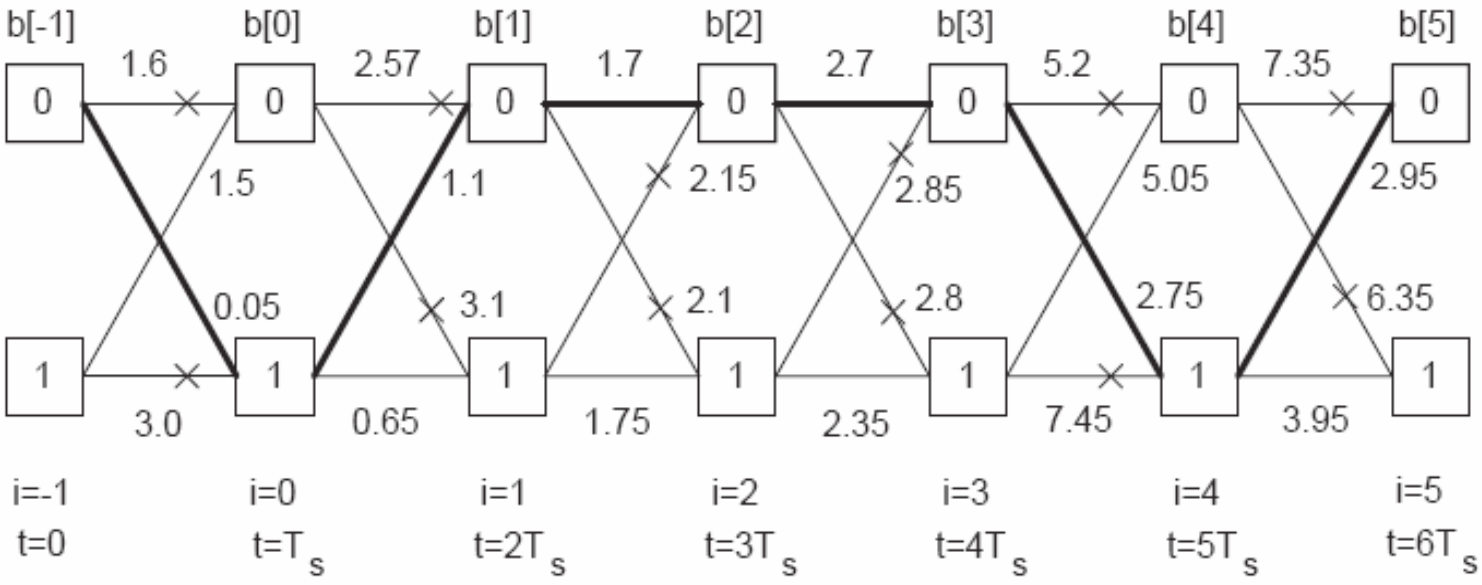


Figure 8.12: a) The coherent ML (sequence) receiver for trellis-coded signals in AWGN; b) A discrete-time model in signal space of the overall digital communication system.

EXAMPLE 8.16

Study the communication system below.





8.3.1 The ML Receiver - An Alternative Approach □

In this subsection, an alternative implementation of the coherent ML receiver for trellis coded signals in AWGN is derived. With this implementation the number of matched filters in the receiver is significantly reduced compared with Figure 8.12a, making it particularly interesting in many applications.