TÉCNICO LISBOA

Trustful Action Suggestion in Human Agent Interaction

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Acknowledgments

I would like to thank my parents for their friendship, encouragement and caring over all these years, for always being there for me through thick and thin and without whom this project would not be possible. I would also like to thank my grandparents, aunts, uncles and cousins for their understanding and support throughout all these years.

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I would also like to acknowledge my dissertation supervisors Prof. Some Name and Prof. Some Other Name for their insight, support and sharing of knowledge that has made this Thesis possible.

Last but not least, to all my friends and colleagues that helped me grow as a person and were always there for me during the good and bad times in my life. Thank you.

To each and every one of you – Thank you.

Abstract

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Keywords

Maecenas tempus dictum libero; Donec non tortor in arcu mollis feugiat;Cras rutrum pulvinar tellus.

Resumo

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Palavras Chave

Colaborativo; Codificaçãoo; Conteúdo Multimédia; Comunicação;

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Acronyms

CC	Cloud Computing
CDN	Content Distribution Network
DASH	Dynamic Adaptive Streaming over HTTP
GPRS	General Packet Radio Service
HTTP	Hypertext Transfer Protocol
LAN	Local Area Network
LTE	Long Term Evolution
SVC	Scalable Video Coding
UMTS	Universal Mobile Telecommunication System

1

Introduction

2

This is the Second Chapter

Contents

2.1 Traditional Streaming Technologies 5
2.2 Cras lobortis tempor velit 5

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2.1 Traditional Streaming Technologies

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Sed pulvinar, felis id consectetuer malesuada, enim nisl mattis elit, a facilisis tortor nibh quis leo Table 2.1.

Table 2.1: Streaming Technologies Comparison

	Dynamic Streaming	Smooth Streaming	HLS
Streaming Protocol	RTMP	HTTP	HTTP
Video Codec	H.264, VP6	H.264	H.264
Audio Codec	AAC, MP3	WMA, AAC	AAC, MP3
Container Format	MP4, FLV,	MP4	MPEG2-TS
iOS	NO	YES	YES
Android	NO	YES	YES

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2.2 Cras lobortis tempor velit

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3.1 Architecture Design Requirements

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Web-streaming: The client application should support streaming media using Hypertext Transfer Protocol (HTTP) protocols.

Multi-source streaming: The client application should support multi-source streaming media, i.e., "simultaneous" streaming of media content components from a network, supported/complemented by Content Distribution Network (CDN)/Cloud Computing (CC) services.

Support content Metadata Description: The client application should support content metadata description in a format similar or compliant with MPEG Dynamic Adaptive Streaming over HTTP (DASH) [11].

Scalable and Adaptive Media Contents: The system should support on-demand streaming of scalable and adaptive contents based on Scalable Video Coding (SVC).

Heterogenous End-User Devices: The client application should be compatible with current and future generations of end-user devices form factors, irrespective of their performance, screen size and resolution.

Access Network independency: The solution should provide the expected service over different types of access networks supported by the end-user devices, such as Wireless Local Area Networks

(LANs) (IEEE 802.11) or cellular data networks such as General Packet Radio Service (GPRS), Universal Mobile Telecommunication System (UMTS), Long Term Evolution (LTE), etc.

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3.2 Architecture Design Requirements

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Listing 3.1: Example of a MPD file.

```
<?xml version="1.0" encoding="UTF-8"?>
<StreamInfo version="2.0">
    <Clip duration="PT01M0.00S">
        <BaseURL>videos/</BaseURL>
        <Description>svc_1</Description>
        <Representation mimeType="video/SVC" codecs="svc" frameRate="30.00" bandwidth="401.90"
            width="176" height="144" id="L0">
            <BaseURL>svc_1/</BaseURL>
            <SegmentInfo from="0" to="11" duration="PT5.00S">
                <BaseURL>svc_1-L0-</BaseURL>
            </SegmentInfo>
        </Representation>
        <Representation mimeType="video/SVC" codecs="svc" frameRate="30.00"
            bandwidth="1322.60"
            width="352" height="288" id="L1">
            <BaseURL>svc_1/</BaseURL>
            <SegmentInfo from="0" to="11" duration="PT5.00S">
                <BaseURL>svc_1-L1-</BaseURL>
            </SegmentInfo>
        </Representation>
    </Clip>
</StreamInfo>
```

Nam malesuada ornare dolor. Cras gravida, diam sit amet rhoncus ornare, erat elit consectetuer erat, id egestas pede nibh eget odio. Proin tincidunt, velit vel porta elementum, magna diam molestie sapien, non aliquet massa pede eu diam.

4

Trust Model

Contents

We sought out to develop a trust model definition that would be easily implementable, but generic enough to be able to adapt to various testing scenarios. To do this we took inspiration from the work by Sabater et al. [**?**] described in Section **??** by taking a similar approach to architecture where a central memory component holds the model's current state, getting updated by perceptions received from the environment. But while Repage describes a third module that suggests actions to resolve belief conflicts in the model, we instead defined such module to assume the point of view of one of the agents in the scenario and, if participating in a social interaction, it suggests actions to improve the trust relationship with a trustor. In fact, most of the design of the model was made with the intent that it would be used by one of the agent's in the scenario, and the model created would be his own trust model of the world environment. And so, the model can be described by 3 main components:

- **Memory**, which defines and stores the main model structure;
- **Perceptions**, a series of environment perceptions mapped to changes in the Memory;
- **Action Suggestion**, a module that outputs different actions depending on current perceptions and the state of the model.

4.0.1 Memory

One of the main concerns while designing the model was how trust would be calculated, as we wanted to use Castlefranchi and Falcone's conceptualization of trust [**?**] as a basis for trust definition, focusing specially on it being dependent on the task entrusted, and the transferability of trust between different tasks. But starting from the five-part definition of trust, as seen in Equation **??**, we decided that inserting context (**C**) and the trustor's goal (g_x) into the model would bring in too much complexity for the scope of this thesis, as it would require for a world state model to be kept, as well as some way to predict the trustor's goal. So we simplified, defining trust through a simpler three-part relation, involving just the trustor (**X**), the trustee (**Y**) and the task (τ), represented in Equation 4.1.

$$TRUST(X\ Y\ \tau) \tag{4.1}$$

So we designed the structure with the concepts and relations represented in Figure 4.1, and we can describe them as follows:

- **Agent**: a simple representation of the known entities in the scenario world space, serving mostly as an identifier;
- **Trustee**: each agent contains a collection of other agents he has information about, either by reputation, or by interaction, which we represent as their Trustees;

- **Trust Feature**: a piece of information a trustor has on a trustee is represented in a Trust Feature, which contains the Belief Sources of said information. The Feature Model defines and uniquely identifies what feature is represented.

- **Feature Model**: the possible set of trust features from which a trustee can be assigned is defined in a collection of Feature Models where each one represents a possible piece of trust related information relevant to the model scenario (e.g. The trustee's ability to cook, or the willingness to drive);

- **Category**: a Feature Model must belong to a Category, making it easier to present the different type of Trust Features;

- **Belief Source**: this represents a source of information on the corresponding feature, belonging to one of the 3 sub-classes depending on the origin of the information, Reputation for when reported from other agents (whether directly (e.g. talking) or indirectly (e.g. report on newspaper)), Bias for pre-existing beliefs on the feature, and Direct Contact for direct observations of the trustee, 3 values are provided to determine the associated feature's belief value:

  - Belief Value, a number between 0.0 and 1.0 describing the trustor evaluation;
  - Certainty describes how well the trustee was evaluated, in Reputation for instance, this might represent how well we trust in the reporter, and in Direct Contact how well the trustor observed the trustee performing said feature;
  - Time is just a record of when was this belief source recorded, as older records might have a lower impact in the overall belief value score, compared to newer records.

- **Task**: a representation of the possible delegation tasks in the scenario, containing the Feature Models associated with the performance of this task (e.g. The ability to serve drinks if the task is bartending). A weight is given to each Feature corresponding to its importance in the task. The various weights are normalized so that their sum is 1.0.

4.0.1.A Trust Calculation

Taking a Trustor X, a Trustee Y and a delegated task τ, Trust can then be calculated by taking the Trustee's Trust Features F_y, the Task's Feature Models F_τ and checking which they have in common, which we can represent as $F_{y\cap\tau}$. Remember that Trust Features are uniquely identified by a Feature Model. So after getting $F_{y\cap\tau}$ we can apply a linear function to each of the features in $F_{y\cap\tau}$, where for each element F_i we multiply the trustee's feature's belief value $B(F_i)$ with the weight of the feature for

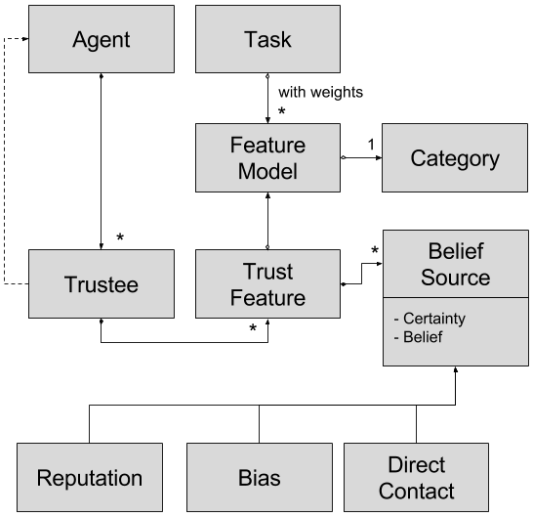

Figure 4.1: Memory Architecture (represented in UML)

the task $W(F_i)$, as represented in Equation 4.2.

$$Trust_{X,Y,\tau} = \sum_{i=0}^{n} W(F_i)B(F_i) \tag{4.2}$$

The belief value of the feature itself, $B(F_i)$, is also calculated through a sum of parameters pertaining to each of the n belief sources $B^j_{F_i}$ composing the feature, as represented in Equation 4.3, with each parameter described as follows:

$$B(F_i) = \sum_{j=0}^{n} D^j_{F_i} C^j_{F_i} B_j \tag{4.3}$$

- $D^j_{F_i}$, a value from 0.0 to 1.0 that represents how far ago in time was this belief source received compared to the last one, being 0.0 a long time ago, and 1.0 the most recent belief. We wished to represent the rapid decay of value of old beliefs when compared to new ones, but also making sure recent memories would not fall quickly in value, so we chose to describe this parameter with a Gaussian Function, as represented in Equation 4.4, where $T^{Last}_{F_i}$ is the most recent belief value's time stamp, $T^j_{F_i}$ is $B^j_{F_i}$ belief value's time stamp, and L is the difference between the oldest and newest belief value's time stamps. $\frac{L}{4}$ defines the mid drop-off point of the function.

- $C^j_{F_i}$, the certainty value stored in the Belief Source;

- $B^j_{F_i}$, the belief value stored in the Belief Source;

$$D^j_{F_i} = e^{-\frac{T^{Last}_{F_i} - T^j_{F_i}}{2(\frac{L}{4})^2}} \tag{4.4}$$

4.0.2 Perception

In this module, a collection of relevant environment perceptions is inserted into the model, in order to translate perceived changes in the environment, into changes in the model. This is done through a Perception object, representing some possible environment input, and containing a map of what target features should have belief sources added, what kind of belief sources they are, and how to translate the values received from the environment to belief value and certainty, as exemplified in Figure 4.2.

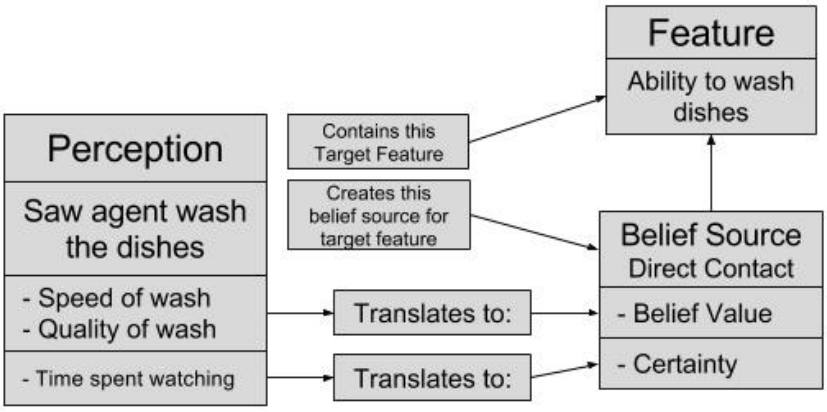

Figure 4.2: Perception Example

4.0.3 Action Suggestion

This component contains a collection of

5

This is the Fifth Chapter

Contents

5.1 Maecenas vitae nulla consequat 19
5.2 Proin ornare dignissim lacus 20

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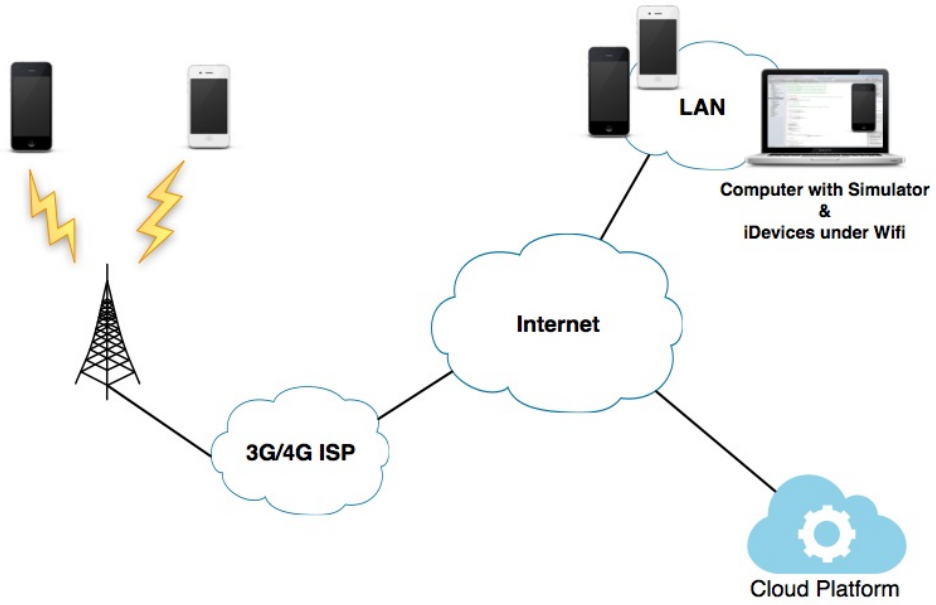

Figure 5.1: Test Environment

Aliquam aliquet, est a ullamcorper condimentum, tellus nulla fringilla elit, a iaculis nulla turpis sed wisi. Fusce volutpat. Etiam sodales ante id nunc. Proin ornare dignissim lacus. Nunc porttitor nunc a sem. Sed sollicitudin velit eu magna. Aliquam erat volutpat. Vivamus egestas. Nunc tempor diam vehicula mauris. Nullam sapien eros, facilisis vel, eleifend non, auctor dapibus, pede Table 5.1 used in the tests. The Network Link Conditioner allows to force/simulate fluctuations in fixed network segments.

Table 5.1: Network Link Conditioner Profiles

Network Profile	Bandwidth	Packets Droped	Delay
Wifi	40 mbps	0%	1 ms
3G	780 kbps	0%	100 ms
Edge	240 kbps	0%	400 ms

Aliquam aliquet, est a ullamcorper condimentum, tellus nulla fringilla elit, a iaculis nulla turpis sed wisi. Fusce volutpat. Etiam sodales ante id nunc. Proin ornare dignissim lacus. Nunc porttitor nunc a sem. Sed sollicitudin velit eu magna. Aliquam erat volutpat. Vivamus ornare est non wisi. Proin vel quam. Vivamus egestas. Nunc tempor diam vehicula mauris. Nullam sapien eros, facilisis vel, eleifend non, auctor dapibus, pede.

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N_j Is the number of times peer j has been optimistically unchoked.

n_j Among the N_j unchokes, the number of times that peer j responded with unchoke or supplied segments to peer p.

$C_{r[j]}$ The cooperation ratio of peer j. If peer j never supplied peer p, the information of $C_{r[j]}$ may not be available.

$C_{r(max)}$ The maximum cooperation ratio of peer p's neighbors, i.e., $C_{r(max)} = max(C_r)$.

$$G_j = \begin{cases} \dfrac{n_j C_{r[j]}}{N_j} & \text{if } n_j > 0 \\ \dfrac{C_{r(max)}}{N_j + 1} & \text{if } n_j = 0 \end{cases} \tag{5.1}$$

Cursus $C_{r(max)}$ conubia nostra, per inceptos hymenaeos j gadipiscing mollis massa $N_j = 0$, unc ut dui eget nulla venenatis aliquet $G_j = C_{r(max)}$.

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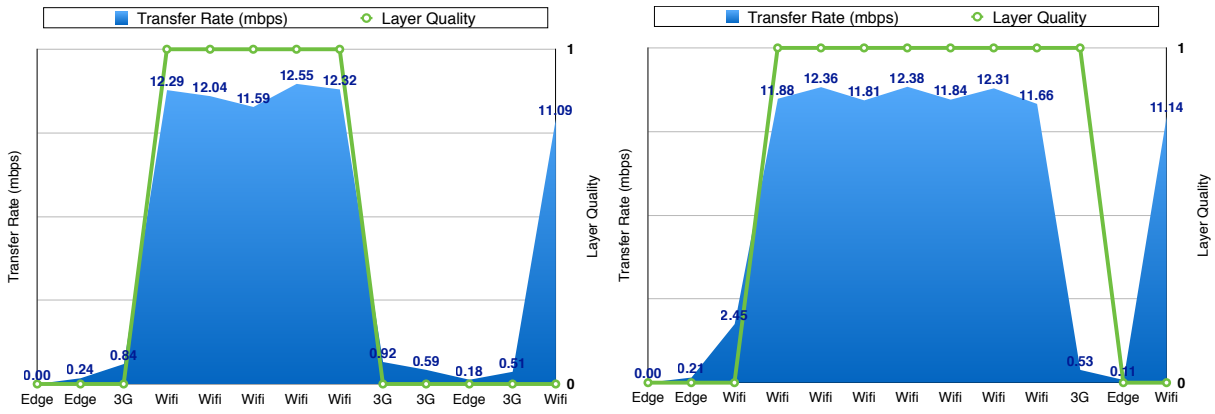
Both Fig. 5.2(a) et Fig. 5.2(b) Phasellus eget nisl ut elit porta “perfect” tincidunt. Class aptent taciti sociosqu ad litora torquent per conubia nostra.



(a) Adaptation System Test 4

(b) Adaptation System Test 5

Figure 5.2: Adaptation System Behavior Test

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6

Conclusion

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6.1 Conclusions

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6.2 System Limitations and Future Work

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Bibliography

[1] Apple, *HTTP Live Streaming Overview*, Apple Inc., 1 Infinite Loop, Cupertino, CA 95014, 408-996-1010 U.S., 2011. [Online]. Available: https://developer.apple.com/library/ios/documentation/networkinginternet/conceptual/streamingmediaguide/StreamingMediaGuide.pdf

[2] Adobe HTTP Dynamic Streaming. [Online]. Available: http://www.adobe.com/products/hds-dynamic-streaming.html

[3] Z. Alex. ISS Smooth Streaming Technical Overview. [Online]. Available: http://download.microsoft.com/download/4/2/4/4247C3AA-7105-4764-A8F9-321CB6C765EB/IIS_Smooth_Streaming_Technical_Overview.pdf

[4] Fraunhofer Heinrich-Hertz-Institute, "SVC: Scalable Extension of H.264/AVC," 2013. [Online]. Available: http://www.hhi.fraunhofer.de/de/kompetenzfelder/image-processing/research-groups/image-video-coding/scalable-video-coding/svc-scalable-extension-of-h264avc.html

[5] ISO/IEC, "Information technology – Coding of audio-visual objects – Part 10: Advanced Video Coding," International Organization for Standardization/International Electrotechnical Commission, International Standard ISO/IEC 14496-10:2012, Oct. 2012.

[6] B. MacAulay, A. Felts and Y. Fisher, "IP Streaming of MPEG-4 Native RTP vs MPEG-2 Transport Stream," WHITEPAPER, October 2005. [Online]. Available: http://www.envivio.com/files/white-papers/RTPvsTS-v4.pdf

[7] H. Schwarz, D. Marpe, and T. Wiegand, "Overview of the Scalable Video Coding Extension of the H.264/AVC Standard," *Circuits and Systems for Video Technology, IEEE Transactions on*, vol. 17, no. 9, pp. 1103–1120, 2007.

[8] J. Bankoski, J. Salonen, P. Wilins, and Y. Xu, "VP8 Data Format and Decoding Guide," RFC 6386, IETF, RFC 6386, November 2011. [Online]. Available: http://tools.ietf.org/html/rfc6386

[9] Y.-H. Chiang, P. Huang, and H. Chen, "SVC or MDC? That's the question," in *Embedded Systems for Real-Time Multimedia (ESTIMedia), 2011 9th IEEE Symposium on*, 2011, pp. 76–82.

[10] P. Moscoso, “Interactive Internet TV Architecture Based on Scalable Video Coding,” Master’s thesis, Instituto Superior Técnico, May 2011.

[11] ISO/IEC, “Information technology – Dynamic adaptive streaming over HTTP (DASH) – Part 1: Media presentation description and segment formats,” International Organization for Standardization/International Electrotechnical Commission, International Standard ISO/IEC FCD 23009-1:2012, Apr. 2012.

A

Code of Project

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Listing A.1: Example of a XML file.

```
1 <?xml version="1.0" encoding="UTF-8"?>
2 <StreamInfo version="2.0">
3     <Clip duration="PT01M0.00S">
4         <BaseURL>videos/</BaseURL>
5         <Description>svc_1</Description>
6         <Representation mimeType="video/SVC" codecs="svc" frameRate="30.00" bandwidth="401.90"
7             width="176" height="144" id="L0">
8             <BaseURL>svc_1/</BaseURL>
9             <SegmentInfo from="0" to="11" duration="PT5.00S">
```

```
10              <BaseURL>svc_1-L0-</BaseURL>
11          </SegmentInfo>
12      </Representation>
13      <Representation mimeType="video/SVC" codecs="svc" frameRate="30.00" bandwidth="1322.60"
14          width="352" height="288" id="L1">
15          <BaseURL>svc_1/</BaseURL>
16          <SegmentInfo from="0" to="11" duration="PT5.00S">
17              <BaseURL>svc_1-L1-</BaseURL>
18          </SegmentInfo>
19      </Representation>
20  </Clip>
21 </StreamInfo>
```

Etiam imperdiet turpis. Praesent nec augue. Curabitur ligula quam, rutrum id, tempor sed, consequat ac, dui. Maecenas tincidunt velit quis orci. Sed in dui. Nullam ut mauris eu mi mollis luctus. Class aptent taciti sociosqu ad litora torquent per conubia nostra, per inceptos hymenaeos. Sed cursus cursus velit. Sed a massa. Duis dignissim euismod quam.

Listing A.2: Assembler Main Code.

```
; ********************************************************************
; * Constantes
; ********************************************************************

ON     EQU 1 ; contagem ligada
OFF    EQU 0 ; contagem desligada
INPUT  EQU 8000H ; endereço do porto de entrada
           ;(bit 0 = RTC; bit 1 = botão)
OUTPUT  EQU 8000H ; endereço do porto de saída.


; ********************************************************************
; * Stack
; ********************************************************************

PLACE   1000H
pilha:    TABLE 100H  ; espaço reservado para a pilha
fim_pilha:

; ********************************************************************

PLACE   2000H

; Tabela de vectores de interrupção

tab:    WORD  rot0

; ********************************************************************
; * Programa Principal
; ********************************************************************

PLACE   0

inicio:
  MOV BTE, tab     ; incializa BTE
  MOV R9, INPUT    ; endereço do porto de entrada
  MOV R10, OUTPUT    ; endereço do porto de Ìsada
  MOV SP, fim_pilha
  MOV R5, 1      ; inicializa estado do processo P1
  MOV R6, 1      ; inicializa estado do processo P2
  MOV R4, OFF      ; inicializa controle de RTC
  MOV R8, 0      ; inicializa contador
  MOV R7, OFF      ; inicialmente não permite contagem
  EI0           ; permite interrupções tipo 0
```

```
45    EI            ; activa interrupções
46
47  ciclo:
48    CALL  P1      ; invoca processo P1
49    CALL  P2      ; invoca processo P2
50    JMP   ciclo   ; repete ciclo
51
52  ; ********************************************************************
53  ;* ROTINAS
54  ; ********************************************************************
55
56  P1:
57    CMP R5, 1     ; se estado = 1
58    JZ  P1_1
59    CMP R5, 2     ; se estado = 2
60    JZ  P1_2
61  sai_P1:
62    RET         ; sai do processo.
63
64
65  P1_1:
66    MOVB  R0, [R9]  ; lê porto de entrada
67    BIT R0, 1
68    JZ  sai_P1    ; se botão não carregado, sai do processo
69    MOV R7, ON    ; permite contagem do display
70    MOV R5, 2   ; passa ao estado 2 do P1
71    JMP sai_P1
72
73  P1_2:
74    MOVB  R0, [R9]  ; lê porto de entrada
75    BIT R0, 1
76    JNZ sai_P1    ; se botão continua carregado, sai do processo
77    MOV R7, OFF   ; caso contrário, desliga contagem do display
78    MOV R5, 1   ; passa ao estado 1 do P1
79    JMP sai_P1
```

Class aptent taciti sociosqu ad litora torquent per conubia nostra, per inceptos hymenaeos. Phasellus eget nisl ut elit porta ullamcorper. Maecenas tincidunt velit quis orci. Sed in dui. Nullam ut mauris eu mi mollis luctus. Class aptent taciti sociosqu ad litora torquent per conubia nostra, per inceptos hymenaeos.

This inline MATLAB code `for i=1:3, disp('cool'); end;` uses the `\mcode{}` command.[1]

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Listing A.3: `Matlab Function`

```
for i = 1:3
    if i >= 5 && a ~= b       % literate programming replacement
        disp('cool');         % comment with some LaTeXin it:  πx^2
    end
    [:,ind] = max(vec);
    x_last = x(1,end) - 1;
    v(end);
    ylabel('Voltage (μV)');
end
```

[1] MATLAB Works also in footnotes: `for i=1:3, disp('cool'); end;`

Nullam ut mauris eu mi mollis luctus. Class aptent taciti sociosqu ad litora torquent per conubia nostra, per inceptos hymenaeos. Sed cursus cursus velit. Sed a massa. Duis dignissim euismod quam. Nullam euismod metus ut orci.

Listing A.4: `function.m`

```
%   Copyright 2010 The MathWorks, Inc.
function ObjTrack(position)
% #codegen
% First, setup the figure
numPts = 300;              % Process and plot 300 samples
figure;hold;grid;          % Prepare plot window
% Main loop
for idx = 1: numPts
    z = position(:,idx);   % Get the input data
    y = kalmanfilter(z);   % Call Kalman filter to estimate the position
    plot_trajectory(z,y);  % Plot the results
end
hold;
end   % of the function
```

Class aptent taciti sociosqu ad litora torquent per conubia nostra, per inceptos hymenaeos. Phasellus eget nisl ut elit porta ullamcorper. Maecenas tincidunt velit quis orci. Sed in dui. Nullam ut mauris eu mi mollis luctus. Class aptent taciti sociosqu ad litora torquent per conubia nostra, per inceptos hymenaeos. Sed cursus cursus velit. Sed a massa. Duis dignissim euismod quam. Nullam euismod metus ut orci. Vestibulum erat libero, scelerisque et, porttitor et, varius a, leo.

Listing A.5: HTML with CSS Code

```
<!DOCTYPE html>
<html>
  <head>
    <title>Listings Style Test</title>
    <meta charset="UTF-8">
    <style>
      /* CSS Test */
      * {
        padding: 0;
        border: 0;
```

```
        margin: 0;
      }
    </style>
    <link rel="stylesheet" href="css/style.css" />
  </head>
  <header> hey </header>
  <article> this is a article </article>
  <body>
    <!-- Paragraphs are fine -->
    <div id="box">
      <p>
        Hello World
      </p>
      <p>Hello World</p>
      <p id="test">Hello World</p>
      <p></p>
    </div>
    <div>Test</div>
    <!-- HTML script is not consistent -->
    <script src="js/benchmark.js"></script>
    <script>
      function createSquare(x, y) {
        // This is a comment.
        var square = document.createElement('div');
        square.style.width = square.style.height = '50px';
        square.style.backgroundColor = 'blue';

        /*
         * This is another comment.
         */
        square.style.position = 'absolute';
        square.style.left = x + 'px';
        square.style.top = y + 'px';

        var body = document.getElementsByTagName('body')[0];
        body.appendChild(square);
      };

```

```
      // Please take a look at +=
      window.addEventListener('mousedown', function(event) {
        // German umlaut test: Berührungspunkt ermitteln
        var x = event.touches[0].pageX;
        var y = event.touches[0].pageY;
        var lookAtThis += 1;
      });
    </script>
  </body>
</html>
```

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Listing A.6: HTML CSS Javascript Code

```

@media only screen and (min-width: 768px) and (max-width: 991px) {

  #main {
    width: 712px;
    padding: 100px 28px 120px;
  }

  /* .mono {
    font-size: 90%;
  } */

  .cssbtn a {
    margin-top: 10px;
    margin-bottom: 10px;
    width: 60px;
    height: 60px;
    font-size: 28px;
    line-height: 62px;
  }
```

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Listing A.7: PYTHON Code

```
class TelgramRequestHandler(object):
    def handle(self):
        addr = self.client_address[0]          # Client IP-adress
        telgram = self.request.recv(1024)      # Recieve telgram
        print "From: %s, Received: %s" % (addr, telgram)
        return
```

B

A Large Table

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As Table B.1 shows, the results were very satisfactory considering the characteristics of the radio link.

Table B.1: Example table

Benchmark: ANN	**#Layers** (1)	**#Nets** (2)	#Nodes* $(3) = 8 \cdot (1) \cdot (2)$	Critical path $(4) = 4 \cdot (1)$	**Latency (T_{iter})** (5)
A1	**3–1501**	1	**24–12008**	**12–6004**	4
A2	501	1	4008	2004	**2–2000**
A3	10	**2–1024**	**160–81920**	40	60†
A4	10	50	4000	40	**80–1200**

Benchmark: FFT	**FFT size**‡ (1)	*#Inputs* $(2) = 2^{(1)}$	*#Nodes** $(3) = 10 \cdot (1) \cdot (2)$	*Critical path* $(4) = 4 \cdot (1)$	**Latency (T_{iter})** (5)
F1	**1–10**	2–1024	**20–102400**	4–40	6–60†
F2	**5**	32	1600	20	**40 – 1500**

Benchmark: Random networks	**#Types** (1)	**#Nodes** (2)	*#Networks* (3)	*Critical path* (4)	**Latency (T_{iter})** (5)
R1	3	10–2000	500	*variable*	(4)
R2	3	50	500	*variable*	$(4) \times [1; \cdots; 20]$

* *Excluding constant nodes.*
† *Value kept proportional to the critical path:* $(5) = (4) * 1.5$.
‡ *A size of* x *corresponds to a* 2^x *point FFT.*
Values in bold indicate the parameter being varied.

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