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SeeGate

Container Code Recognition System

System Technical Information

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1.Purpose & Scope

This document provides and overview and technical information on SeeGate, a vision-based Container Code Recognition system.

2.Referenced Documents

2.1 SeeLane - Vehicle License plate Identification system

2.2 Freight Containers - Coding, Identification and Marking [ISO 6346 1995(E)]

3.Overview

3.1.   Product description

SeeGate is a stand-alone system that is used to automatically track and read Shipping Containers identification number **together** with the license plate of the carrying Truck. This sophisticated image processing system can be placed at various port locations: at gates, at the docks, or in any other location that requires fully automatic identification.

   The identified number strings and images are displayed on the system's main display, and logged in its local database. This data is transferred to other Windows applications via DDE messages. The application can be used in conjunction with a pre-stored list of Container and truck numbers.

   Each unit controls several video cameras and handles them simultaneously while the truck and containers are in *motion*. The system uses these multiple cameras in order to look at various sides of the containers and to capture and analyze the Truck license plate. Additionally, as additional options, the wagon/chassis ID can be recognized.

3.2.   *Typical installation at Port gates*

The system can be located at the gates of the port, and records the entry or exit of the truck **together** with its container. An optional Chassis/Wagon ID can also be recognized. The identifications can also be transmitted to the port's computer and are used for data collection.
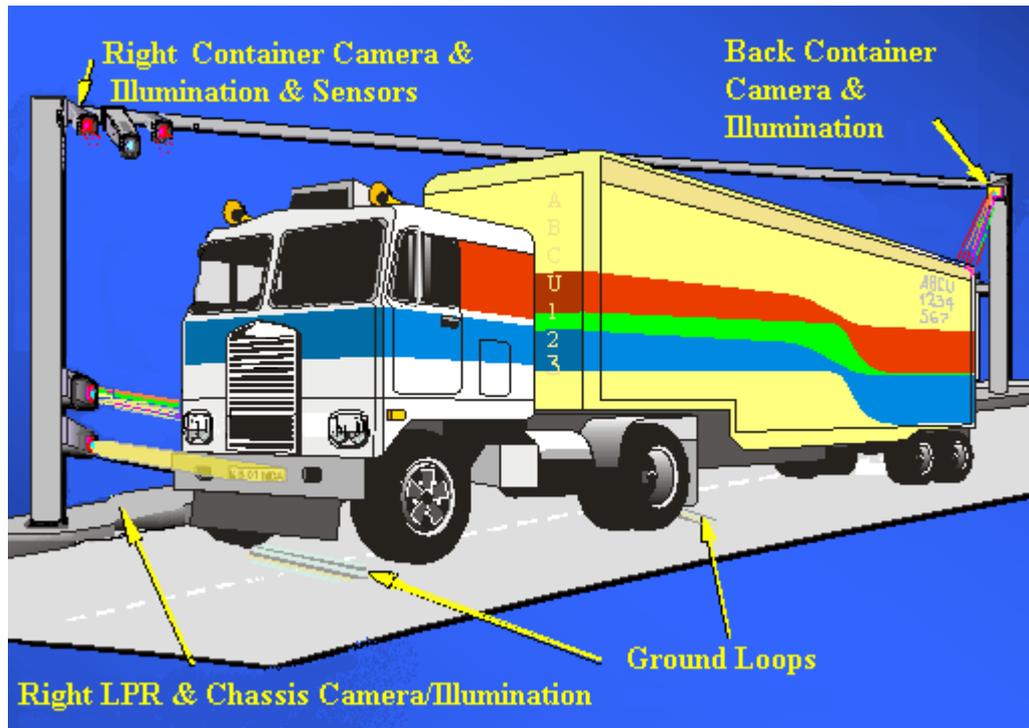

Figure 3.2: Port gate installation *(simplified)*

The following photo shows one of the cameras (at the right side) and its pair of illumination units.

The following photo shows the front view, where a double set of camera/illumination units are used to capture the truck plate:

Photo 3.2.2 : Truck plate camera/illumination units

An additional optional back Container camera can also be installed for improved recognition. Optional Chassis/Wagon ID cameras can also be installed for covering additional recognitions.

The system's PC is installed near the monitored lane. The main display is shown in the following photo, which shows a case of a single Container.

Photo 3.2.3: Main system display *(sample case of single container)*

3.3.SeeGate System advantages

The system has the following advantages over existing manual recorded sites:
- fully automatic process (no man-in-the-loop)
- increases the processing of the container/truck traffic at the congested gates
- the system data collects the traffic history
- handles simultaneously container & truck identification
- provides live view of the gate traffic

The system has the following advantages over other automated solutions:
- simple configuration (few cameras)
- covers all types of containers (20,40,20/20feet and combinations)
- performs recognition while at motion (the container does not stop)
- simple integration into the existing computer resources at the port
- has a high recognition rate (has 2-3 views redundancy on each container)
- has a user friendly display and operation
- a reliable system, 24 hour operation
- fast response (output in seconds)

SeeGate systems are leading the number of Worldwide installations. One of these installations is shown in the photo below:

Photo 3.3: Sample Installation - Pier 400 (Los Angeles, California)

3.4. Overview of Container ID

The major purpose of the SeeGate Container Recognition software is to take pictures of the Containers, extract the **alpha numeric** digits out from the picture (by image processing software), verify its correctness (using the Container Code check digit as a final verification test), and transmit the identification string and optionally the image files.

An example of a container code ID shown in figure 3.4. Note that this is one of the several container ID formats that the international standard (ref. #2.2) defines. Other horizontal and vertical markings are possible as well and are recognized by the system.
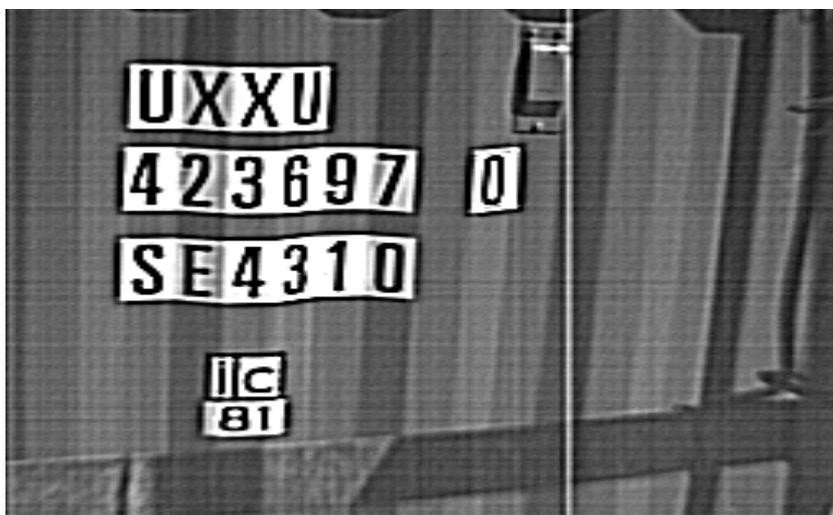
Figure 3.4: Example of container ID

The container ID is composed of several fields, including the following fields:

1. the shipping company (e.g., "UXX")
2. the equipment category (always "U" for freight containers, "Z" or "C" for chassis)
3. the serial number of the container (e.g., "423697").
4. the check digit of the first 3 fields (e.g.,"0")
5. the container type (e.g.,"SE4310")

Only the first 3 fields are relevant to the identification of the container, and represent a unique identification number for each shipping container. In the above case, this ID is "UXXU 423687".

The shipping company field ("UXX"in the example) is verified against a pre-defined list of known companies. Additionally, the second field ("U") is always verified.

The check digit is used in order to verify the entire 10-fonts identification number. If the check digit is not identified, only the 10 fonts are compared and reported. If it is

recognizied and tested for correctness, it will also be reported (a "0" in the above case).

The container type (in the above example,"SE4310") is not part of the ID and is not identified or transmitted.

3.5.Reduction factor

The SeeGate Container recognition software actually performs a huge reduction in the amount of information. It converts a 512 x 512 pixel picture (for example) to a {6+4} digit ASCII string transmission (the first two fields, a total of 10 bytes, excluding the check digit). The **total** reduction factor from the raw image to the extracted string is 1:262,144 ! Thus, the system saves a great deal of transmission and post processing when it merely sends the string rather than the entire picture.

Additionally, the system sends the identified string *only* when it detects that it faces the container, thus further reducing the need to send multiple images of different positions of the markings. This increases the savings of the transmission and storage of the raw images, an incredibly high number. This is the essence of the system.

Combined with a similar recognition package for the carrying truck license plate (SeeCar) and the Chassis number (SeeChassis), the system performs a large reduction and automates the traffic recording process which is usually performed manually, thus increasing the processing speed at the gate.

4.Architecture

This section describes the architecture of the SeeGate system which identifies both the Shipping Container markings and the Truck License Plate.

4.1.Overview

The system is based on a stand-alone hardware system that includes the following:

- **PC** running Windows NT (to run the system's software)
- SeeContainer, SeeCar and SeeChassis 32-bit **DLLs** (Dynamic Link Libraries, that recognize the Container/license plate/Chassis from an input image)
- 3-5 **cameras** with special illumination (to view the container and truck license plate)
- 1-2 camera/illumination units for optional Chassis/Wagon ID
- **2 6-video-input frame grabbers** (to capture the images in fast real time)
- **I/O board and terminal block** (for sensor and gate input and output)
- **Serial Communication** (for outputting the result)
- **TCP/IP link** (to be used with SeeData product)

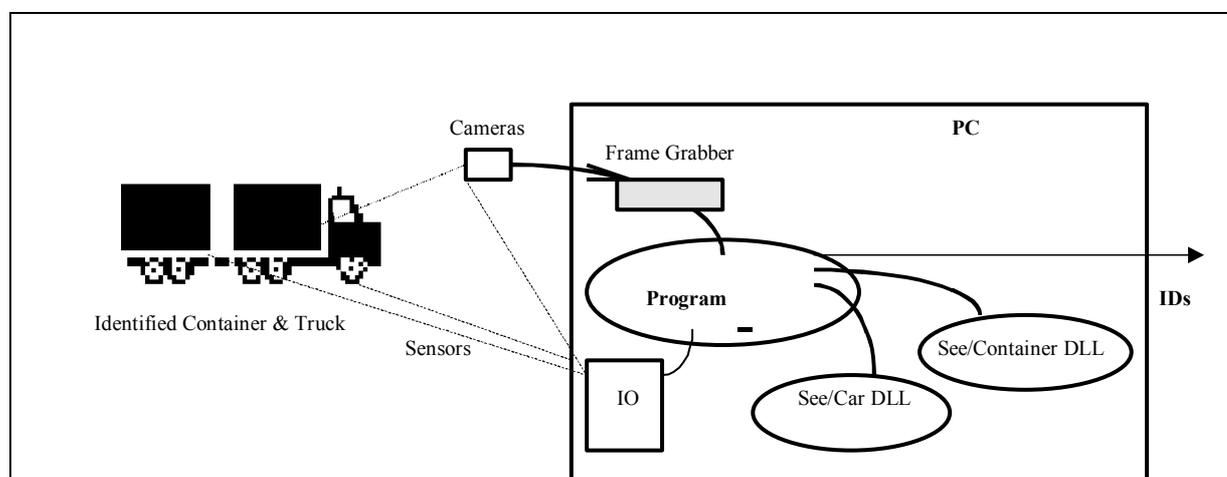The following simplified illustration shows this configuration.

Figure 4.1: SeeGate System configuration

The operation of the system is as follows: when the moving truck and the containers that it carries enter the detection zone, the sensors are activated and signal to the program (via the IO card) that the container is present. The program now starts the recognition process: a sequence of images in different illumination levels are captured according to the container types. After this, the images are sent to the SeeContainer and SeeCar DLLs for container and license plate identification.

After receiving the results and applying certain logic and validation/verification, the program outputs the combined Container & Truck ID results to the display, as a message and to the communication line.

A Client application also takes the message data and writes it to a text log file. Additional Client applications could also use the message information for other purposes. A specially designed network product (SeeData) can also spread the message through the network to remote Central processors and databases.

4.2. The Image processing DLLs

The system calls the following image processing DLLs that analyze the captured images of the container and the carrying truck:

- **SeeContainer DLL** - an ISO 6346 Container Marking recognition software
- **SeeCar DLL** - a license plate recognition (LPR) package specifically adapted to the country where the system is installed
- **SeeChassis** - a recognition package for the wagon/chassis number (optional on the SeeGate system)

These 32-bit Windows DLLs perform the following image processing functions:

- Image Enhancement - improves the quality of the captured image
- ID numbers finding - locates the marking (Container) or truck license plate (Truck) within the image
- Characters detection - locates each of the marking's characters
- Characters identification - identifies each of the detected characters
- Validation - compares the resulting string to the standard formats, and calculates and verifies check digits (for the container ID only)

The program analyzes the results of the recognition across the series of the captured images (in different illumination levels and in several capture positions), and combines them into a final recognition of the Truck and its containers, and displays/files/sends their results.

4.3. Camera & Sensors Configuration

The cameras (with built-in or additional illumination) are installed in a typical configuration as follows: Truck license plate (#1), side cameras (#2,#3) and an optional back camera (#4). Additional cameras read the Chassis/Wagon ID.

The sensors are configured as: Truck sensors (a magnetic loop sensor on the lane), front and rear Container sensors (optical sensors mounted at the sides of the lane).

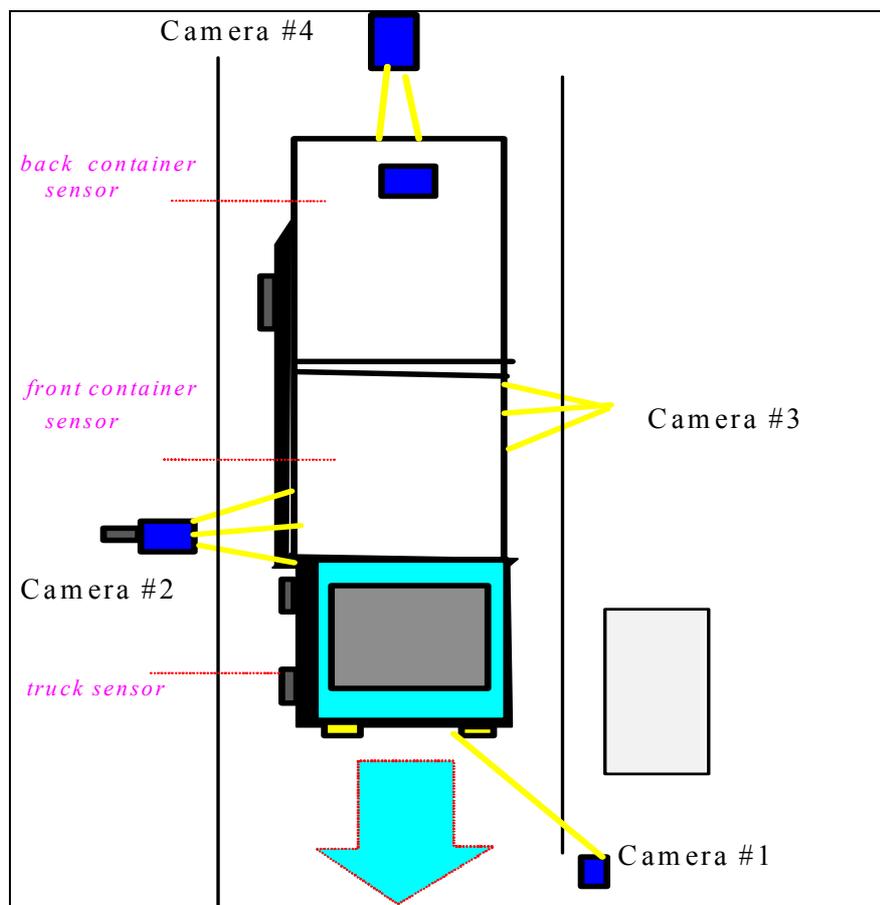The following illustration shows this arrangement (simplified):

Figure 4.3: Cameras & Sensor configuration

 The recognition process starts from the truck sensor event (a truck entering the detection area) and completes when the truck and container leaves the detection area.

4.3.1. Illumination units

The illumination units are based on pulsed solid-state LED arrays.

 Some of the illumination arrays are integrated within the camera enclosure (such as the Truck plate units, the Container back camera/illumination unit, and the Chassis

unit) and others are packaged in separate illumination units (such as the side container units).

The LED arrays are activated at predefined timings (when the container and truck is moving through the installation) and at different illumination levels (low, medium and high). They are energy efficient (operating in pulse mode) and are turned <u>off</u> most of the time.

4.3.2.Light Safety Notations - Note on Compliance with International Standards:

The illumination units comply with International Standard IEC 60825-1, for Class 1 LED (light emitting diodes) product containing Class 1 LED's. Class 1 LED product poses **no hazard** to the user or to any other person present near the illumination unit. The use with the illumination unit is totally safe and needs no specific precautions.

4.4.Main Display

The main display is a window with a predefined arrangement that is displayed on the screen and operates like a console. The user does not need to select any sub-windows (only in installation mode) and thus can see what the system is doing, its status and the recognition results and history.

The system main display is composed of several sub-windows:
- System Menu - contains several options that allow the user to select
- Images display - shows the camera images of the containers, truck and wagon/chassis
- Identifications Window - shows a graphical presentation of the recognitions and the type of containers
- History Log window - shows the recent history of identifications
- Status - shows the system status

A display example is shown in the following illustration. In this example the side image of the containers and the truck ID is seen in the main window, the container types are shown graphically above the images, the history of containers/trucks are shown in the bottom list, and the system status is shown in the right side.
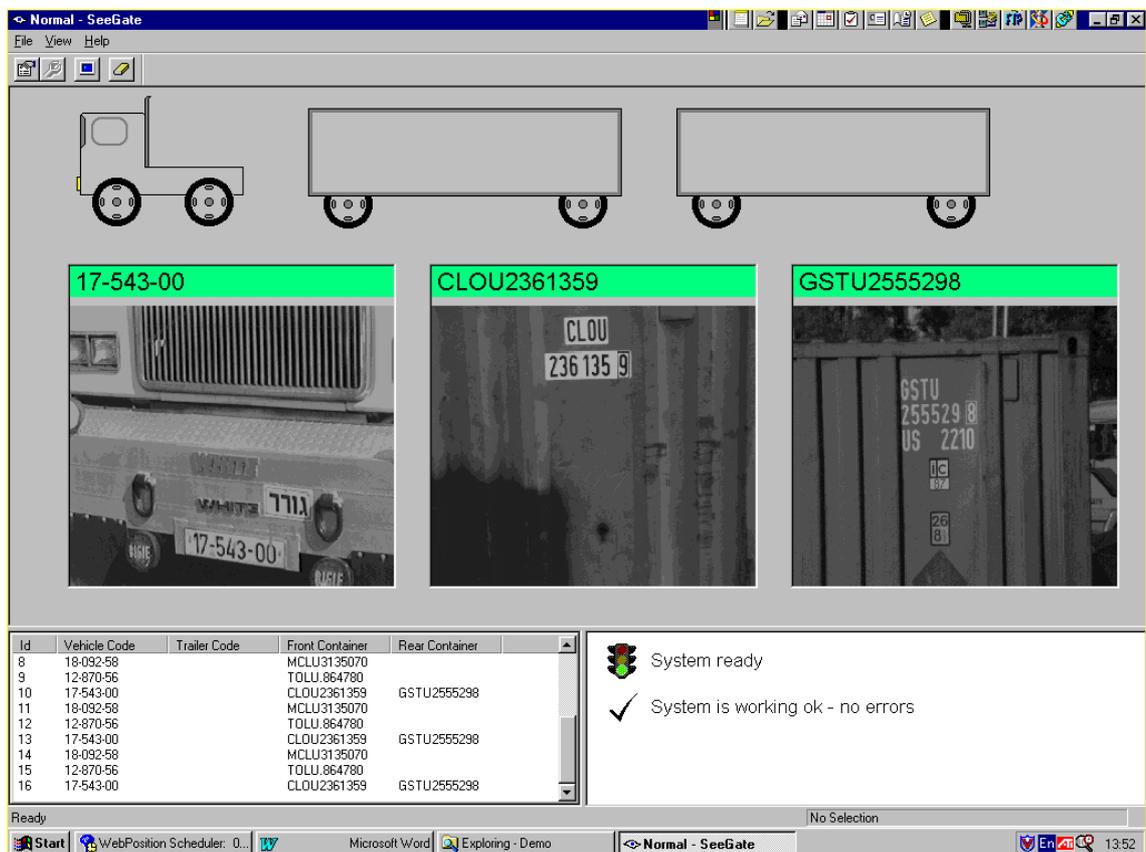

Figure 4.4: Main display (example of two 20 feet containers)

4.5. Inter-application Messages

SeeGate is designed to share the container/truck identifications with other processes. This can be done either by external communication (RS232) or by application-to-application messages. The latter method is implemented by DDE messages that are sent after each identification cycle.

One or more Client applications can intercept the DDE messages. The client process receives the messages and uses the information for various purposes. For example, if the client process is a database interface, it will insert each message data into the database.

4.6. SeeData - Networking option

An optional product adds networking capabilities to SeeGate system. The product, SeeData, collects the local DDE messages and transmits them over TCP/IP network. One or more Central nodes retrieve the messages (using TCP/IP) and allow a "Central" Client application to process them. *The messages are similar to the local computer messages, with an additional server ID offset number added to the lane number.*

4.7. SeeMonitor and SeeService

The SeeGate system has additional networking and operational utilities, that simplify the operation of multiple units and ensure that the entire site is running smoothly:

- **SeeMonitor** – this utility allows to see the status of an array of SeeGate units, and get histograms and other graphs on each of the lanes and each of the cameras. This is useful both at the installation time and in the operation phase.
- **SeeService** – this watch-dog utility keeps the SeeGate application running at all times and optionally updates new versions from a server
- **SeeCleaner** – this utility performs housekeeping operations in the working directory

5.Detailed Functional Description

This section describes the functions of the container identification system which identifies both the Shipping Container markings and the Truck License Plate.

Note that Hi-Tech Solutions may change these functions on future system releases, and additional functions may be tailored for specific customer requirements.

5.1.General Requirements

A.   Intended system use: stand-alone Container ID and Truck Number (and optional Chassis/Wagon ID Number) automatic identification system.

B.   Single Lane - supports one container lane only

C.   Container Types - All standard cases: 40 feet, 20 feet front, 20 feet rear, double 20 feet, 45 feet.

D.   Moving containers - the system will handle the recognition while the container is moving, from 5KM/H up to 40KM/H.

5.2.GUI (Graphical User Interface)

A.   Camera View Display- cameras video display (see: image handling)

B.   Event Log - list of identifications (one row for each car/front/rear container)

C.   Sensors status - on/off status

D.   System status - state: installation/Idle/capturing/identifying

E.   Graphic result display - show picture of car/container with current Ids

1.   Display Symbols of Containers/Trucks/Chassis

2.   Show recognition results

F.   Options setting -

1.   TAB Sheets - using tabs sheets to select different catagories

2.   Security - have 2 levels of users to prevent simple operator ability to make changes

G.   About Dialog - upon request

5.3.Operation Logic

A.   Identification

1.   SeeContainer DLL- extracts container marking string

2.   SeeCar DLL - analyzes the image and returns a
recognized truck and Optional chassis number

B.   Recognition bank - looks on the recent history of all valid or partial
identifications in order to maximize the output based on the multiple recognitions

5.4.Image Handling

A.   Display camera
Dynamic Display - display the container or truck image after the sensor is
activated. The image that is displayed is the one that was identified on
each active camera.

B.   Configuration

1.   Configure # of captures per application

2.   Configure SeeCar or SeeGate per camera

5.5.Installation Mode

A.   Live Video - select one of the cameras

B.   Image capture - (see "FILE" section); used for off-line debug and development.

5.6.Sensor Control

A.   Sensor types : Car, Front, Rear

B.   Display Status of sensor

C.   Sensor Configuration

1.   NC/NO (normally-connected or normally-open state)

2.   Pin # on Parallel connector

3.   Active Rise or Fall

5.7.File

A. LOG File (with Client Application)

B. Images File Save

a) Image on all active cameras

   b) identified cameras only

c) daily/wwekly/monthly or single directory

C. Configuration - Save after changing

5.8.Communication

A. DDE Messages - send recognition results to other applications.

B. Network message transmission – the recognition results can be reported to other PCs using SeeData or NetDDE

6.Support and more Information

You can contact us for more information and assistance at:

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Visit our Home page (http://www.htsol.com) and download demo recognition applications.

You can also download a simulation of the SeeGate system and a sample Client application.