COMMUNICATIONS IN BRISA'S CENTRE FOR OPERATIONS COORDINATION (CCO)

Abstract:

Brisa is one of the largest European private motorway concessionaires and endorses the planning, design, financing, construction, operation and maintenance of motorways. Since 2003, the company is involved in a technological initiative aimed at replacing most of its decentralized operations' coordination by a centralized one in the Centre for Operations Coordination, based near its corporate headquarters.

One of the most challenging tasks in this process is the integration and processing of communication channels.

Communication channels being integrated span a wide range of different sources and systems. These can be divided into two major components with direct relevance for operation: human-to-human (H2h) communications and machine-to-human (M2h) communications.

Among the different sources we can name the telephony inbound channels, a heterogeneous national emergency network of Call boxes (S.O.S.), assistance vehicles (mechanics and in-vehicle systems) and all sorts of telematics equipment.

To provide a solution to integrate such heterogeneous mediums, Brisa has adopted two major policies: to integrate the H2h communications into telephony as far as possible and to use a web based client for the information system used in M2h communications.

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Background

Brisa Auto-estradas de Portugal, shortly Brisa, was founded in 1972 with the aim of constructing, maintaining and operating motorways as their respective service areas under a concessions scheme of motorways via toll system. With 28 years of experience, Brisa is the **largest Portuguese operator** and the fourth in Europe (in terms of area), controlling 1,056 Km of motorways, linking Portugal from the North to the South, from West to East, through 11 motorways under operation.

To manage this network Brisa supplies 24 hours services which include: **on-road surveillance**, with assistance vehicles, an **emergency call centre** number and **operations control centre**. The control centre plays a key role interacting directly with on-road surveillance and call centre along with all other resources and elements available through communications, telematics and information services.

Prior to the creation of the **centre for operations coordination** (**CCO**), sections of each motorway were operated by **local control centres** (**COs**). Only with the centralization of operations to the CCO was it possible to implement a uniform and standardized model of operation, capitalize on technological endeavours towards a state of the art motorway operation system and optimize the results of a 24x7 specialized operations team.

The centralization was only possible with the creation of custom management systems, inter-twinned into a platform named *iBrisa*. The way each piece is inter-twinned into the *iBrisa* platform is the key to our success.

Brisa's control centre

The Brisa CCO has a 10x3 (14m x 3m) **video-wall** and 15 seats equipped with **tri-monitor** PC workstations, **two telephones**, an **IP Radio console**, a lamp and quite some free space (no more cluttered PCs, complex hardware or legacy front-ends).

Figure 1. *Layout of the CCO seats.*

For these seats we implement a **"hot-seat"** operation model. Each seat can operate any group of logic areas (directly inherited from the CO jurisdiction model), just like a contact centre operator can be working in a group of campaigns. When shifts change new operators do a re-login to inherit the working state of the previous operator. Any changes to the logic area distribution can be made dynamically (with one click) at any point during operation.

The transparency required for this model of operation is obtained through the integration of all communication channels.

Transparent integration of heterogeneous communication channels

Communication channels being integrated span a wide range of different sources and systems. These can be divided into two major components with direct relevance for operation: **human-to-human** (**H2h**) communications and **machine-to-human** (**M2h**) communications.

Among the different communication sources we can name:

1. Telephony inbound and outbound channels
    a. Call centre transferred calls, filtered from a motorway emergency and assistance number
    b. Internal calls, from toll cabins, National Guard (GNR – which works tightly with Brisa), etc.
    c. Outbound calls to third party entities (police, fire squads, insurance companies, etc.)
2. An heterogeneous national S.O.S. system (mostly copper wire based)
3. Assistance vans (mechanics personnel – H2h and in-vehicle systems – M2h)
4. All sorts of telematics equipment (M2h):
    a. CCTV cameras
    b. Variable message panels (VMPs)
    c. Weather stations (WSs)
    d. Specific tunnel equipment
    e. Etc.

As can be noticed most of the **H2h communications** channels are inbound while some are also outbound; examples are the outbound telephone calls or VHF radio used to communicate with the assistance vehicles. As for **M2h communications**, most of the volume is made up of alarm information, but also includes control information and operations (panel messages, CCTV operation, tunnel control in manual mode, etc.). M2h communications are naturally very different from H2h communications, providing complementary information (and meta-information, as locating the source of an H2h communication through an M2h channel).

To provide a solution to integrate such **heterogeneous** mediums BRISA has adopted two major policies: to **integrate the H2h communications into telephony** as far as possible and to use an **information system** (web-based) – part of the ***iBrisa platform*** *for information systems and communications integration* - to **drive the M2h communications**.

Overall *iBrisa* architecture

The *iBrisa* platform is composed of several **layers**:

- **On-road** equipment and vehicles
- **Local systems** at each CO for radio and S.O.S. integration
- **Telephony** resources (telephone central, call centres)
- **Servers** for:
    - SIC (a web-based incidence management system)
    - HORUS (a SIG system that integrates telematics data sources)
    - *iBrisa* Portal (a portal where access is provided to operations and analysis)

Figure 2 presents the **communication architecture** as it spans these layers.

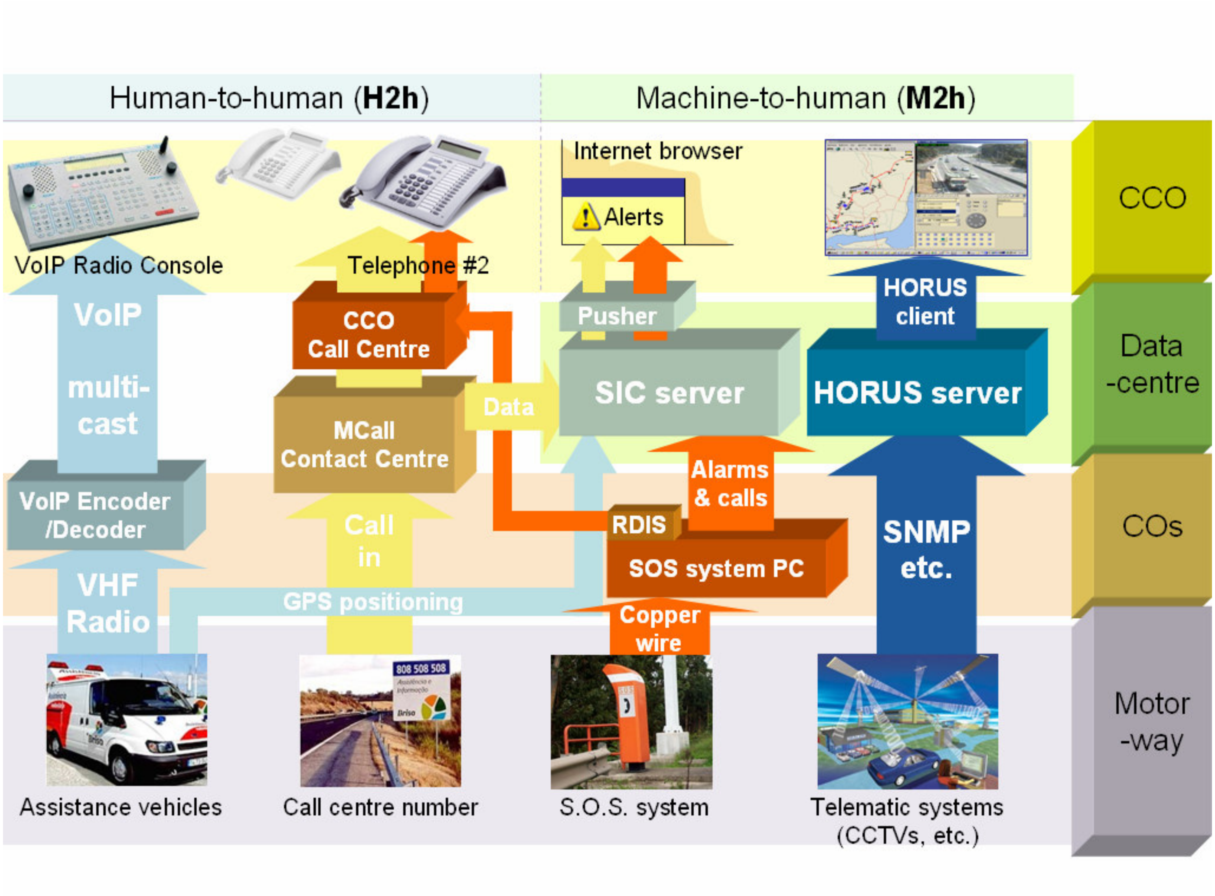

Figure 2. *Logical model for the iBrisa communication architecture.*

While most of the interactions represented for each system are discussed in this article, the focus of this section is the **information systems** and the technical issues related with how these integrate **M2h communications**.

Industry tends to associate web applications with back-office processes or final user front-ends. Our web application approach is different and thus satisfies **real-time operation needs** with simple but effective technology.

Our web application approach is based on heavy usage of **dynamic web interfaces** (using DHTML) and some **very dynamic web interfaces** (1) (using XMLHTTP and a Pusher ActiveX), providing an interface which interacts with the operators with real-time, context relevant information and functionality.

Pushing events from the **server** to the **client** is already our key to **real-time delivery** of alarms and inbound call information (like S.O.S. location or data collected by the call centre agents for transferred calls). The **implementation** is straightforward: the server has a permanent connection (socket) to each client (using the client ActiveX), which it uses to send alerts for new events that are relevant to each operator.

Some communication systems (like S.O.S.) also benefit from the fact of being native to SIC, being managed, operated, troubleshot and analysed from within the same client platform.

Additionally, **GIS information** used for operation is not **geography oriented** but **cognition oriented**, using what is commonly know as **cognitive maps** (2) – think of the typical underground maps applied to a motorway network, but fully interactive.

The (geography) GIS based system (HORUS) is used for telematics, namely **CCTVs control**, **variable message panel operation** and processing of weather station information, to generate

weather alerts. For the rest of the systems the **web-based solution** is proving itself more **adaptable** and **integrated** into the operators work.

Integration of "legacy" systems with full power

When operating locally, many channels of a communication area are bound to the localization of operation by hardware requirements, namely VHF radio or S.O.S. call boxes, each has a limited radius of operation (radio) or is limited to specific operation localization (S.O.S. central PC).

It has been our goal to integrate such legacy systems with their full power (control, alarms, etc.). The best examples of this kind of integration in Brisa CCO are:

1. The integration of **S.O.S. call boxes**, which are locally implanted over a copper-wire serial bus.
2. The **VHF radio system** used to communicate with assistance vehicles, which uses local analogue frequencies.

For both systems there is a gateway system implemented locally at the CO.

The S.O.S. system gateway (which interacts with the complex copper wire electronics) integrates with a **RDIS interface** to generate phone calls from **virtual extensions** (one for each S.O.S. call box) when communication from a call box is demanded. The virtual extensions are also used to enable connecting to the call box, this functionality is mainly used for daily tests.

The analogue VHF radio system has a receptor antenna at each CO where the broadcast signal is digitally captured into a **VoIP** stream sent to the CCO consoles through a **multicast stream** (to optimize bandwidth usage). The inverse is done with the CCO responses digitally captured into a VoIP stream at the CCO, decoded and emitted into VHF at the CO.

At the lower level, both mediums are sent to the CCO through IP (simply because our telephony structure uses IP, as only the VHF radio system uses VoIP directly). The VHF radio system is sent through IP into remote consoles in the CCO because it had to be independent from the telephony system; otherwise fault tolerance (that is a must for the assistance vehicles) would be lost to any mobile telephony system hazards.

Extra functionality of the legacy systems is implemented as services (in particular **Web services**).

In the case of the S.O.S. system the Web service offers alarms, event delivery (to identify call boxes being used or new alarms of major importance) and other state information regarding the local gateway. It also provides for the execution of commands for special operation, maintenance, troubleshooting and testing.

Even though there are two different S.O.S. system providers in the Brisa's motorways, the same Web service interface is used due to early **WSDL standardization**.

When it comes to the VHF radio system Web service, functionality is somewhat more limited (there are no alarms or commands) but the service was designed to enable automation of the console configuration which enables our "one click" CO affectation policy, much the same way it is implemented for telephony.

Each legacy system is integrated using **standard and open technologies** and managed using a **service oriented architecture** (SOA).

Inbound telephony management using basic call centre software

In the CCO operations room telephones work within a **call centre environment** for **queue management**, providing seat **mobility** (the call centre routing entries are dynamically changed when the logic area affectation changes) and providing a scalable **overflow** mechanism.

To each **motorway section** being operated (logic area) correspond two **call centre agent skills** (a normal one and an emergency one). Each operator in turn has two **call centre agents**, one for each phone, which are logged on for operation. When an operator receives a certain logic area to operate, its two skills are bound to the operator's agents (telephones).

This is achieved by having a **unified tool** that is used to **manage the operation of logic areas**. This tool interacts directly with ***iBrisa*** **authentication**, with the **call centre**, through a server-side **ActiveX** and with the **radio consoles**, through a **Web service**.

Basically the **call centre** is used to **aggregate all telephony channels** (originating ANI and DNIS) for each logic area and enable **logic area management** to **aggregate communication channels** at a higher level (emergency inbound, normal inbound, radio and information systems).

Although it's possible to implement **prioritization** within the queue there hasn't been need for it yet (from our experience call priority is more context dependent than media dependent). Even though, the queue is also not managed manually, that is, operators receive calls from the queue in **FIFO order**, can see a **list of queued calling parties** but cannot interact with it.

Emergency calls (like S.O.S.) have a small **overflow time** to grant the call is always answered by an operator in less than 1 minute. If the operator in charge of the section where the emergency call originates is **busy** with another emergency phone call, after 1 minute ringing (waiting in queue), the call will overflow to **another operator**, who, despite being operating other motorway sections, is free.

Additionally, call centre **reporting features** can be used to provide analysis data for operations management (response times for each channel or logic area) and human resource management (statistics by operator).

Outbound telephony using 1^{rst} party CTI

The solution adopted for outbound telephony uses a context (logic area) sensitive **contact base** implemented in the SIC component of *iBrisa*. When outbound calls are relevant there is always a **"click-to-dial"** icon to enable calling the number (the mobile number of an assistance vehicle, the contact for an insurance company, the extension to wake-up an S.O.S. call box, etc.).

It is implemented using **first party CTI** integration (using TAPI3) that enables "click-to-dial" for each contact (whatever the context). The operator clicks on a contact link in the web-browser, triggering an ActiveX method that integrates with the telephone through an USB connection and, "outbound-wise", directly with the telephone central.

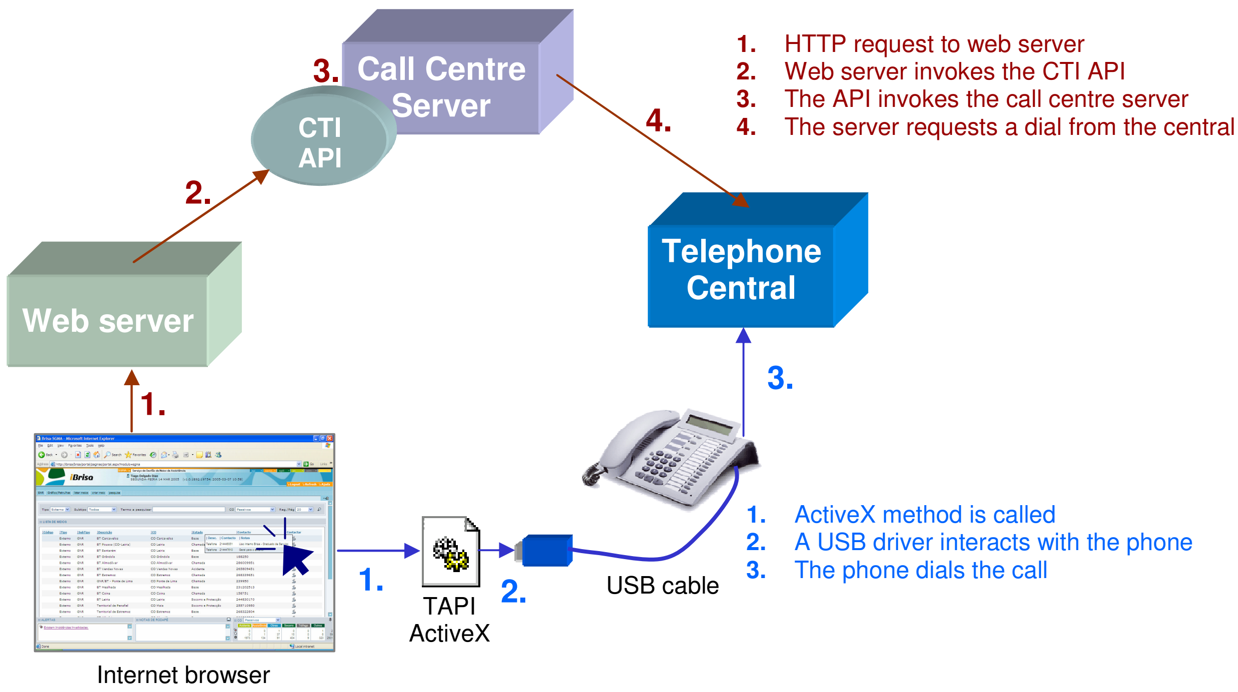

Figure 3. *1[rst] party CTI vs. typical centralized CTI architecture.*

The **key benefits** of using first party CTI over server-side integration are:

1. **Bypassing** several **server tiers**, namely communications from the web-browser to the web-server, then to the call-centre server and, finally, to the telephone central.

2. A **performance increase** of almost 10 times: the difference from a 2-3 sec. dial time for server-side CTI (used in most contact-centre applications) and a few hundred milliseconds with first party CTI.

3. Very **fast implementation** (took less than one week from start to deployment) and **easy maintenance** (mostly related with USB driver problems), due to the dependency on fewer software components.

Locating the assistance fleet

In addition to the **radio transceiver** installed in each assistance vehicle, there is also a **mobile phone** to provide H2h communications **redundancy**. Obviously this medium will be **worthless** in some **emergency situations** when **GSM cells** along the motorway are all occupied by mobile phones, something which can easily happen in emergency situations.
Emergency situations and operation under extreme conditions reinforces the importance of **fault tolerance of the radio system** and of the **availability** of the medium for **mission critical** situations.

One problem with the usage of the radio system is the amount of band required for sending **position information** (enough to allow tracking the assistance fleet), fortunately this information can be sent by a **location system** (machines are better than humans at providing discrete information in very little time).

In order to send positioning automatically a **custom GPS location system** has been implemented (an in-vehicle M2h communication channel). We intended to innovate while at the same time optimize the use of terminal resources, so each assistance vehicle has a **GSM enabled POS** (point-of-sale), also used for assistance billing, which is connected to a **GPS antenna**.

Positioning is based on a list of **critical positions** (**GPS coordinates** for control points, like access nodes, tolls, service stations, etc.; and a **tolerance radius**) for each motorway section where vehicles operate. These positions are mapped in both the **GIS system** and the **web based information system**, as will also be available all the way into the back-office and analysis phases (for efficiency analysis, legal issues, among other interesting purposes).
To provide positioning for **stopped vehicles** (usually giving assistance) a **timeout** (15 min) is used if vehicles do not pass critical positions to force sending the current position. **On demand positioning** is also available for specific critical situations.
These methods **minimize** the amount of **transferred data** for positioning (compared with simple timeout or distance threshold methods), **maximizing** the **usefulness** of the transferred data.
A **GPRS** connection is used to transmit positioning from vehicles (**lower cost** compared with GSM, SMS or MMS and a **simpler server-side**: a TCP server).

This way GPS positioning replaces the communication of vehicle positions through radio, freeing both the channel and the human resources. The POS is also used for shift and staff activity control.

Example: affecting a logic area "CO Carcavelos" to a seat (Seat 1)

An example of what happens behind the scenes when a logic area is affected to a seat comes in place, in order to consolidate the distinct operations happening for each medium.

Imagine the operator in charge of the current shift has just affected the logic area "CO Carcavelos" to Seat 1:

1. Custom integration with the call-centre server changes the ACD routing for telephony, bringing inbound channels relative to Carcavelos to the telephones in Seat 1.
2. The seat radio console is automatically configured with the Carcavelos CO channel (multicast IP) set into the group of operating channels.
3. The *iBrisa* software components (SIC and HORUS) use the affectation to provide CO specific media and operations:
    a. Alarms are filtered for the specific CO (alarm sources are: on-road telematics equipment – CCTVs, VMPs and WSs; the S.O.S. and tunnel systems).
    b. Access control for the main information system (where incidences are created, fed for real-time consumption, and managed further along the way, through back-office, into analysis and data-mining).
    c. Access control for on-road telematics equipment (CCTVs, VMPs, WSs) and video-wall management.
4. Access control to other custom applications integrated with the *iBrisa* platform, namely tunnel supervision.

Conclusions

The main **technical advantages** that power our solutions for the CCO project are:

- Usage of **open protocols** and **inter-communicating** systems (all working over IP).
- Usage of **APIs** as **ActiveX automation** and **Web services** for exposing functionality between components.
- Usage of **event channels** for alarms (across several mediums, and finally to client applications, for operation, and notifications, for other scenarios).
- Usage of a **common platform** (***iBrisa***) for all operation, **mostly web-based**, complemented by the HORUS system (which is the most visible fat client used).
- **Re-usability** of the same web platform for all other operation, exploration and road security areas (among others) by content customization via the ***iBrisa* portal**.
- **Fault tolerance** and support for **degraded operations mode** (namely resuming operations at a backup site or locally at the COs).

Software developed for us by third parties is closely accompanied through our own **issue tracking system** (based on an open-source solution). We also apply test models like **stress and load testing**, along with the typical **functional testing**.

This collection of technical advantages has enabled the integration of communications and, along with it, enables a common interaction channel for operation. This was the key to change from a scenario where information systems were scattered, closed and sometimes simply weren't used, into a unified information and communications system. This was also the key in Brisa's move from a locally operated structure into a centralized control room, accomplished in less than 1 year.

References

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