

eDevice

White Paper

M2M Project Management

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WHITE PAPER

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M2M

The expansion of traditional cellular communication networks like GSM and CDMA and their evolution to faster and more robust data transfer solutions (GPRS, EDGE, 3G) is resulting in a growing number of companies and organizations thinking about connecting their products to such data networks to provide new services or to enhance existing ones.

The M2M abbreviation, that stands for Machine To Machine, encompasses all equipment (hardware), software, and processes that enable machine management related communication between different machines and between machines and people.

The range of possibilities offered by GPRS, EDGE, and 3G make these networks the most attractive information transportation media for M2M solutions even though M2M encompasses equipment connected through PSTN (analogue phone modem), Ethernet, DSL/Cables networks, and WiFi.

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Roll-out Environment

The environment in which the M2M project will take place is the first issue requiring consideration, allowing to disregard technical solutions that do not fit the geographical, economic, and social constraints identified. This chapter includes a non-exhaustive list of the main external characteristics that may directly impact definition, installation, and roll-out of every M2M project.



Geographical Environment

Coverage Area

The telecommunication operators' (GPRS, ADSL, Cable...) national coverage areas must cover the sites that form part of the M2M project.

International Roll-Out

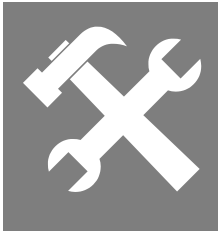
For an international roll-out, it is necessary to assess the resources required to negotiate separate agreements with each and every Telco in all relevant countries. If the company does not have competent negotiation capabilities in the concerned countries, it is more efficient and cheaper to use access services supplied by a Virtual Network Operator (VNO). The company then benefits from discounted high volume rates negotiated by the VNO directly with several national or international Telcos in each country..

Indoor Installation

For wireless implementations such as GPRS, the antenna must suit the environment, especially if the product is located in a secure area. In some cases, it is necessary for the product to be compatible with two different networks (such as for instance GPRS and PSTN) to guarantee successful installations in all the targeted locations.

Outdoor Installation

For an outdoor installation, it is necessary to take into account the physical and mechanical constraints: temperature, humidity, robustness against vandalism, etc.



Installation

End-User Installation

To reduce installation costs by eliminating the need to have a specially trained technician present for installation, the M2M units should be designed to allow installation by a consumer (for mass market products) or by a member of the technical department of the client company (for business implementations). By doing so, no direct costs will be incurred for the installation stage but the unit must be completely Plug & Play with a user-friendly end-user guide, which is multilingual (for international installations) and backed up with telephone / email hot-line support.

The availability of a configuration wizard (software) running on a PDA or a PC will further enhance the user-friendliness of the installation and will decrease the volume of phone calls to the support department.

In-House Installation

If the installation stage is performed by the manufacturing company itself, the installation process may be less user-friendly. A training session for the installation team is thus required.

Environment

When M2M products are designed to be installed in office communication rooms, the connection to PBX systems or to secure power sources is simpler and thus reduces the installation cost.

Procedure

To ensure a complete and successful installation in one shot, the installer should have at the time of installation of the M2M unit, access to network resources, the correct phone cabling and other accessories, and in some cases deep knowledge of all network configuration issues (outside prefix number, line restrictions, DHCP server availability, etc.). A check list ensuring all of this is available to the installer prior to scheduling a new installation will reduce the potential cost of having to return to the installation site a second time.



Economic Environment

ROI

In most cases, a key aim of the project should be to create new sources of revenue linked to the enhancement of already existing processes and/or to the creation of additional services. For most projects, M2M connectivity will allow to generate productivity profits on both existing and new services.

These new revenue sources that validate the financial viability of an M2M project may come in a multitude of formats and are very much dependant on the company's area of activity. Nonetheless, it is possible to list some of the most common ways that M2M will increase the productivity and profitability of a company's processes:

- Remote maintenance: the remote monitoring of equipment allows predictive maintenance to increase service availability for end-users;
- Remote alarming: the immediate transfer of problems detected by the M2M unit ensures a quick and reactive response and thus increases the overall quality of service;
- Automatic data reading: automated transfer of data generated and stored in the equipment allows to reduce transportation and field support costs and to provide the end-user with an invoice based on real consumption.

Finally an enhanced branding, linked to innovative services and to more ecological processes, will also generate medium to long term return on investment.

Network

The choice of communication network is driven by geographical constraints and then by the cost. PSTN and LAN M2M modules are still lower cost than GPRS modules. If a PSTN plug or an Ethernet router (DSL, Cable or leased-line) are easily accessible at the M2M installation site, the communication cost becomes marginal. However the use of existing networks may cause difficulties in terms of billing (PSTN without toll free access) and security (firewall restriction on local area network).

Network Access Rates

The specific nature of M2M data traffic may allow to obtain special rates, especially for GSM/GPRS networks that are often overloaded during peak usage hours. The transfer of M2M data can in many cases be scheduled during the night, off-peak, or with a lower guaranteed quality of service (in accordance with functional requirements) so as to decrease communication costs.

Billing

If M2M communication sessions can not be billed to the site owner, it is necessary to set up a toll free number when using regular phone lines. The use of GPRS networks, with M2M-dedicated subscriptions solves the billing issue related to the installation of M2M products.



Social Environment

Tracability

The set up of a M2M project may make visible way of uses that were hidden before especially when speaking about stock management. Taxes or regulation concerns may then create hurdles for adoption by the end-user. For some mass market projects, privacy protection is a possible brake and the company must guarantee that all privacy regulations are respected.

Staff

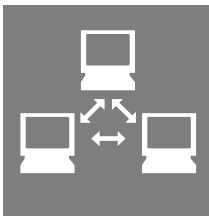
Automated meter reading (AMR), remote diagnostics, and remote maintenance M2M services aim notably at optimising the frequency and total number of field trips. The set up of such services is thus likely to have a direct impact on the human resources aspects of client companies.

Ecology

M2M services has a positive “green” side effect since reducing the number of field visits contributes directly to a reduction in pollution. In the same spirit, M2M products should be RoHS compliant to avoid the use of hazardous substances in production of electronics.

Functional Analysis

Analysis of the volume and specific format of the data transferred in the course of an M2M application operation will define the most appropriate network infrastructure to guarantee required level for quality of service, data confidentiality, and performance...



Network Connection

Permanent Link

If the M2M products require an almost permanent link or a link available during long periods of time, GPRS or Ethernet are necessary. A permanent attachment to GPRS networks can however have an impact on the fees paid to the telecommunications operator, albeit of a lesser concern than in GSM or PSTN networks.

If the machine may receive and process incoming calls on PSTN, it is necessary to activate a caller number identification feature (CallerID) to allow efficient sharing of the telephone line between several machines and/or people susceptible to processing incoming calls.

Throughput Required

Except for real-time video (Streaming) products, bandwidth requirements for most M2M projects are not generally a great constraint. On PSTN, the maximum throughput is 33kbit/s in both directions for V34 modulation, and the download link can reach up to 56kbit/s with V90 modulation. On GPRS networks, 115kbit/s is the theoretical value but it is rarely more than 57kbit/s on a real network. EDGE networks provide a higher throughput but are not yet widely available and require more expensive modules. Only an Ethernet network will theoretically provide a high throughput, which is generally not guaranteed in terms of quality of service as numerous computers, potentially requiring high bandwidth, share the same local network.

Response Time

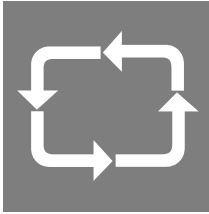
The integration of voice communication on IP networks, for instance to enable an M2M product's end-user to contact a call-centre directly (elevators, eHealth) implies a communication network that complies with real-time constraints and that offers a sufficient quality of service. However both GSM and PSTN networks intrinsically support classic voice services (non VoIP).

Connection Direction

In AMR applications, the M2M product establishes an outgoing applicative connection (FTP, TCP, SOAP) towards a remote server. To be reachable on the Internet, this server must use a public IP address like any standard public web server. For operations of punctual maintenance, for instance follow up to an end-user call signalling a problem, the support operator may need to establish an applicative connection from his administration console to the M2M product. In this scenario conversely, the M2M product must have a fixed public IP address or must use Web services (e.g. middleware, dynamic DNS server, etc.) designed to allow the M2M product to be contacted despite it not having a public IP address.

High Availability

If the M2M project provides a highly critical alarm-service (security systems, eHealth), it is necessary to ensure that the selected network is capable of providing the required level of reliability. Such reliability is generally difficult to guarantee on LAN networks due to the number of components building the local communication network itself (hubs, routers, firewalls, ADSL modems, Network providers). If the M2M product must be functional in case of power outage, batteries will have to be adapted to the consumption requirements of the product (higher with GPRS products than PSTN and LAN products.) In a lot of countries the reliability of PSTN is usually guaranteed due to the obligation for telecommunication operators and PBX manufacturers to permanently route emergency calls. In the United States for example 911 regulations require PSTN (POTS) lines to be available even in a power outage for several hours.



Data Flow

Transactional Traffic

During remote maintenance processes, the query of several values or statuses related to the equipment can be performed in a command/response mode similar to the one used by VT100 consoles and client/server systems. In that case applications are more tolerant to possible network failure but are less efficient in retrieving large blocks of data.

File Download

If the M2M product works as a Data logger by transferring to a remote server a log file of values stored by the equipment, mechanisms must be established to ensure file transfers are independent of network problems. For relatively large files, hot recovery transfer solutions allow, following a network breakdown, to continue the transfer from the point it was dropped. Methods inspired by "commit" command used in database transactions allow to ensure completion of the data transfers.

Confidentiality

Security of data being transferred, especially financial or personal data is guaranteed when using secure standard Internet protocols (SSL, IPSec), protocols used for running today's large-scale e-commerce operations. However, CPU-requirements (more powerful) of the associated encryption algorithms (AES, DES, 3DES) translate into additional costs on every M2M product. To avoid this cost increase, encrypting the data to be transmitted at the application layer allows use lower cost processors, while still ensuring a high level of security. The communication network itself can also secure data transactions, through VPN type solutions, without increasing the processing burden on the M2M product.

Piracy, Hacking

For cost optimisation, M2M network processors have been designed to use minimal memory and CPU power as possible. Consequently these network processors are generally very specialized in term of functionality and do not process unneeded tasks that may reduce overall performance. They are thus distinctly less permissive than PC operating systems which are designed to support a large number of applications.

Redundancy

To reduce as much as possible customisation work required on the network processor, the data sent by the host equipment may be transferred by the M2M product without interpretation. In this case the product's time-to-market is reduced but redundant data may be carried over the network which could lead to increased communication costs (especially on GPRS).



Volume

User Interface

If each M2M product must be driven or managed by a different end-user, a web interface directly embedded on the product itself or on intermediary middleware allows to provide a user-friendly and universal interface. Contrariwise, if the supervision of a large fleet of M2M equipment is made from one or a few administration consoles, the installation of a more complete solution with middleware and back office is mandatory.

Fleet Size

The number of installed products has a direct impact on the back-office server infrastructure including the network itself and server hardware. The initial solution should be scalable to allow it to cope with a more or less progressive ramp-up. This progression is often difficult to forecast, as it is often dependent on unknown sales cycles related to commercialisation of new M2M products. However, the related investment should not constitute an overbearing recurring cost (Back office network, hosting and hardware cost) but more of a one-off forward planning.

Size of Data

The average volume of data generated by an M2M product multiplied by the size of the M2M fleet defines the bandwidth of the communication link required for connecting the servers responsible for processing the information. The storage capacity of these servers will also have to be matched to the volume of data generated by the whole fleet.

Components Selection

The analysis of both technical requirements and available technical competences will govern the choice of all the components of the M2M connectivity solution from M2M modules to be installed on the equipment to M2M services allowing their management and the processing of the data transferred.



M2M Module

Analysis of current requirements

For legacy equipment, mechanical dimensions and power source constraints deeply impact the choice of M2M modules.

If the equipment hosts a socket modem type electrical interface for connection of a daughter board or a serial port connector in DB9 or DB24 format, it is possible to use standard solutions. The use of GPRS or WiFi M2M modules requires a power source comparatively higher than for PSTN or LAN modules. For such wired networks, it is possible to power the modules through the PSTN line or through the LAN cable of an IEEE802.3af compatible network (Power-over-Ethernet).

If the equipment is already in the field, the ease of implementation of the M2M modules is to be taken into account to minimize installation costs.

Fleet Size

The number of pieces of equipment to be connected as part of the M2M project impacts the hardware format used, with the aim of obtaining the lowest overall cost.

For a relatively low number of units or for stocking in small quantities, the use of standard products that avoid non-recurring expenses related to hardware adaptation is the most economical solution. A standard packaged box connected to the serial port of the equipment or a standard module plugged on the motherboard of the equipment on a socket type electrical interface are both viable options.

For intermediate volumes of more than a thousand units, a module type solution is usually better than an external packaged box. In fact, for such quantities, costs relating to connectors, external power supplies and casing of a packaged solution become too high in comparison with a more integrated hardware resolution.

For high volumes of several dozens of thousands of units and more, the use of a standard module or lightly customised modules remains economically competitive and allows to minimize expenses and time-to-market. However to highly optimise the cost of the equipment, the creation of a new hardware design is often the best option. This process lengthens time-to-market and requires critical internal know-how including capability to manage new hardware production.

Approvals

If the M2M project targets an international market, products will have to be compliant with all localised approvals in different territories. In addition to the approvals of electrical safety and electromagnetic conformance that are common in all electrical products, equipment communicating on a public network (GPRS or PSTN) must also comply with telecommunication approvals. Such approvals are often country-specific and in certain countries, specific to different network operators. Competences required to acquire approval are very specialized, in many cases leading to the preferred method of using pre-approved M2M modules. In many cases following the manufacturers' hardware recommendations for integration of approved modules, will extend the approval to the completed product.



M2M Middleware

M2M middleware is an intermediate component hosted on the Internet that manages connections with M2M modules in the field and the transfer of data to and from a back-office server.

Connections Management

In accordance with constraints of the data networks used in the M2M project, it is necessary to forecast sufficient network means to ensure timely and robust connections management. Direct connections to PSTN M2M modules will require for instance the use of one or several telephone lines by the middleware as well as appropriate billing processes. Maintaining permanent connections with LAN or GPRS M2M modules requires bandwidth and CPU power matched to the volume of generated data.

Data Transfer Management

Periodical retrieval of data stored in each M2M unit must be automated. Programming allows a staggering of connection times over the whole day, for reducing overloading or jamming the network link of the middleware. All transfers must be completed reliably and repeated successive failures should trigger automatic warnings to the administrator of the M2M fleet. Data retrieved by the middleware must then be sent to the back office in charge of performing business-specific logic processing.

Configuration Management

Remote management of the network configuration of a fleet of M2M equipment lengthens the fleet life cycle. Automation of remote network configuration allows to adapt to future environment evolution: alteration of connection frequency resulting from a roll-out ramp-up; switching network operators resulting in changes to access numbers and authentication parameters; updating embedded M2M software to enable access to new network services, etc. Remote configuration allows for instance to roll out equipment with a unique manufacturing configuration. Network parameters are then customised after physical dispersion during the first connection from the device to the middleware server.

A remote control and monitoring service for M2M modules, provided by the middleware server offers maximum reactivity in case of a detected failure.



Back-office

Already Exists

Existing software that performs the processing of data originating from the equipment typically either collects data manually in the field or directly retrieves the data over a serial port. In the latter case using software that transmits the IP stream into a virtual serial port allows quick and immediate adaptation of the application to remote M2M. No development is thus necessary to adapt the legacy software package to M2M connectivity but restrictions of use will exist, especially in term of simultaneity of connections.

Storage

All data originated by the M2M equipment and relayed by the middleware must be archived according to regulations and functional constraints relevant to the market and area of activity. The size of storage capacity must be adapted to the volume of data and provide safeguards and backup solutions. The hardware investment must anticipate ramping-up evolution to ensure quality of service without increasing related costs substantially.

Business Specific Processing

If the data originated by the equipment is processed by back office software that has to be replaced or if operations are currently manual, a new applicative component must be implemented for data processing. The architecture of this software component must be designed to comply with reliability, redundancy and security requirements.

Maintenance operations, such as installing bug fixes or new software versions, must be performed with no or minimal disruption to the service managing thousands of devices.

4

Planning

The topics reviewed in previous chapters allow us to forecast the life cycle of the whole M2M project for both budget and time-to-market purposes.



Budget Forecast

Module Cost

Typically the largest hardware investment of an M2M project is the cost of the connectivity modules. The cost of accessories such as power supplies, cables or antennae for connection to the network or to the equipment should also be considered.

Network Cost

The recurring network cost typically consists of monthly subscription fees plus usage (time – PSTN/GSM) or volume (data – GPRS, Ethernet) costs.

Back-office Cost

In addition to development costs of a specific back office component, there is the hardware investment related to the servers as well as the recurrent expenses for hosting and network access. The required quality of service (redundancy, reliability) for service availability directly impacts the cost of this item.

Development, Integration, Testing

Development is related to software and hardware integration of M2M modules within the original equipment, to adaptation or creation of a back office component and/or to the creation of a configuration wizard for easier installation.

An estimate of development costs can be obtained from an expert subcontractor or from the appropriate people within the organisation.

The testing program must notably include a stage of in-depth experimentation on pattern sites that should be as representative as possible of the different types of real installation sites. This experimentation should provide an opportunity to anticipate problems resulting from “field hazards” that will appear during the real rollout. A “field hazard” can be caused by specific network conditions (coverage, signal attenuation, legacy network equipment, etc.) or by a specific physical environment (power outage, electro-magnetic radiation, etc.).

Installation

Installation costs may include work by specialised technicians, the setup and running of a call-centre for support, and the shipment of the equipment to its site.

Maintenance, Support

Maintenance operations and updating of both configuration and embedded software related to the M2M modules or to the legacy equipment can be processed remotely by a middleware server. The cost thus corresponds directly to the cost of subscription to the middleware service plus the cost of communication between the M2M modules and the middleware server.

Otherwise, maintenance costs are related to the frequency of on-site visits needed for troubleshooting or for update of both configurations and embedded software that have reached obsolescence.

Remote control of both M2M modules and legacy equipment allows to substantially decrease support and maintenance costs while at the same time increasing reactivity, quality of service, and therefore customer loyalty.



Development Stage

Specifications

Technical specifications ought to describe all the mechanisms and processes required to perform all the functional features that form part of the M2M project. These documents concern potentially all the components responsible for transferring and processing the information: embedded software loaded into the equipment, M2M modules, network services, middleware, back office servers, etc.

This stage, critical for a smooth roll-out of the M2M project, can last several weeks, notably because it requires the validation of all competent people in different areas of expertise (electronics, networking, support, maintenance, finance, etc.). Use of standard components drastically diminishes the complexity of the specifications.

M2M Solution Validation

With technical specifications complete a Request For Proposal for each of the components of the M2M project can be issued.

Analysis of the different solutions provided by the selected M2M companies is a process that can take place over several weeks. This validation should notably check the presence of all communication protocols required as well as compatibility between the different M2M components (modules, middleware, back office). Further experimentation, using an evaluation kit, allows a more accurate estimation of the time required for future development.

Development/Integration

New hardware design and development will result in a unavoidable delay of the realisation, prototyping and approvals. In the context of the relationship with subcontractors, the technical specifications become the guideline for hardware and software development. Using standard integrated components distinctly reduces the cost and time of such development.

Test/Validation

This stage involves validation of the development performed and efficient integration of all the M2M components. When using off-the-shelf modules, the time required for this process is reduced as most of the features are guaranteed by the M2M supplier.

Experimentation

Experimentation generally requires availability of several almost industrialised prototypes or ideally a first production batch. This stage can quickly evolve through a progressive ramping-up to a real rollout stage.

Production

If production of the M2M device is managed internally, consideration should be given to delays due to components sourcing, manufacturing, testing and logistics. For a new hardware design, an additional delay is expected due to prototype validation.

eDevice

Resulting from its experience in M2M projects internationally, eDevice lists in this white paper several technical and financial issues that should be taken into account during the launch of an M2M project.



Corporate

Since its creation in 1999, eDevice has contributed to the proliferation of more than 1,000,000 M2M products connected on GSM/GPRS, PSTN, LAN, and Short-Range Radio networks. From the multitude of projects eDevice has been involved in, we have identified several key issues that should be considered in the roll-out of an M2M project to maximise the chances of a success project.



Boxes

eDconv

The eDconv range provides a complete software and hardware solution for adding M2M Plug&Play connectivity via Cellular (GPRS), analog telephone networks (PSTN/POTS), or Ethernet LAN, to equipment traditionally accessed locally via a serial port.

eDbox

The eDbox range consists of a series of programmable terminals with network connectors and one or two DB9 serial ports and is used for adding complete M2M connectivity via telephone networks, LAN or GPRS to legacy equipment.

eDindus

The eDindus range includes industrial terminals with DIN rail connectivity, network connectors, a DB9 serial port, RS485/422, integrated power supply and digital input/output, offering an industrial M2M connectivity product for communicating over telephone networks, LAN or GPRS. In addition to communication the eDindus doubles as a truly programmable platform.

eDgate

The eDgate range consists of terminals with network connectors and DB9 serial ports for adding M2M Plug&Play connectivity via telephone networks, LAN or GPRS through to a wireless Zigbee or 868/915MHz (ISM) network.



Modules

The eDmod range includes of modules in a socket modem format intended to be inserted on an electronic motherboard to add programmable M2M connectivity over telephone networks, LAN and GPRS.



Middleware

IDeMS is a group of middleware and back office services securely accessible over the Internet enabling remote management, data transfer, data processing, and publishing of data retrieved from M2M eDevice boxes and modules.



Software

A PC configuration wizard as well as a customisable emulator of a virtual serial port greatly simplified the installation process and the use of eDevice hardware.



Evaluation

The eDkit range provides a complete evaluation solution of all eDevice components relating to M2M connectivity via telephone networks, LAN or GPRS: eDmod, eDbox, PC software, temporary access to the middleware.



M2M Operator

In partnership with major worldwide and national telecommunication operators, eDevice provides an M2M adapted Internet access service for PSTN (ISP) and GPRS networks. Such Internet access is especially designed to easily connect thousands of M2M products.