

Machine-to-Machine (M2M) Communication Over GPRS Networks Setrix AG

Wireless Packet Data networks, such as GPRS, hold great promise for applications that rely on machine to machine (M2M) communication. Widespread availability and low price per Kilobyte are two key benefits of GPRS networks that make it an attractive technology to replace existing equipment or to deploy new wireless solutions. GPRS technology does, however, carry certain challenges when implementing M2M communication that has marred wireless developers in the past.

The Setrix Internet-Ready Gateway (SIRG) is a companion product to the Setrix GPRS-enabled S-372X-series embedded systems. Together, they provide a complete end-to-end solution for your M2M connectivity needs over GPRS networks. Using Setrix solutions, development of your wireless application requires little or no expertise in GPRS technology in order to enjoy reliable GPRS communication. Setrix offers you a field proven, world tested, reliable communication platform to deploy your wireless application.

1. M2M Usage scenarios

M2M application requirements differ from those of typical GSM/GPRS mobilphone customers. For example, GPRS-enabled mobilphones and PDAs are typically used as clients devices, accessing the Internet for viewing Web/WAP pages and reading e-mail. In contrast, in M2M communication, wireless devices may be acting as servers, delivering data on-demand to clients residing on the Internet. These special requirements of M2M applications running on networks from operators whose revenue still primarily comes from mobilphone customers, are the cause for common technical challenges that are encountered by wireless developers.

Wireless Client: Accessing Internet from wireless device

- scheduled transactions
- events and alarms

Wireless Server: Accessing wireless device from the Internet

- unscheduled transactions
- maintenance

2. Benefits of GPRS technology for M2M

- **Consumer technology**
Widely available through retail and corporate channels, from small to large quantities. Little or no contractual commitments. Choice from multiple providers.
- **Low connection delay**
Wireless devices may transmit information immediately into the Network, without the need of a lengthy connection establishment procedure.
- **Integration with IP networks**
no special infrastructure necessary for the application provider besides an Internet connection.
- **Cost based on amount of data transferred, not online time**
appropriate for M2M applications that transfer small amounts of information on a scheduled or unscheduled basis.
- **Higher data rates**
GPRS delivers two to five times higher data rates, compared to circuit-switched GSM, depending on the direction.
- **Very competitive pricing**
GPRS technology makes efficient use of air bandwidth, thereby providing an incentive for Operators to migrate their customers to it.

3. Challenges of GPRS technology for M2M

- **No dial-in**
GPRS Networks do not provide a means to contact a wireless device using a fixed, pre-established number or address.
Note: GSM circuit-switched data service and SMS, both of which are supported by Setrix systems, do allow to contact a wireless device using a fixed address. These services, however, need to be subscribed to in addition to GPRS service, and require dedicated infrastructure (e.g. dial-out lines) at the application provider.

- **Frequent disconnections**

It is common, and frequently observed on Operators networks, for the GPRS link to become disconnected, sometimes due to Operator policy, or due to technical constraints at the Operator (e.g. shortage of IP addresses). Such disconnection is not always detectable by the wireless device.

- **Varying network infrastructures across providers**

GPRS technology is largely specified and standardized by the ETSI (European Telecommunications Standards Institute). However, a number of Network design decisions in the area of IP routing, addressing and firewalling are left for each Operator to make. This has led to important differences in the way Operators have implemented their own Networks.

- **Public vs private addressing**

This is one of the most important difference between various Operator implementations of GPRS technology.

For example, German operator T-Mobile uses public IP addresses (reachable from the Internet) whereas German operator Mannesmann uses private IP addresses (not reachable from the Internet).

- **Firewalls and network address translation (NAT)**

Various GPRS operators have made different design decisions for the gateway between their Networks and the Internet.

For example, German operator T-Mobile does not implement a Firewall, whereas German operator Mannesmann includes a NAT Firewall.

Since both incoming and outgoing GPRS data packets contribute to the usage count, it is generally desirable for a firewall to be present at the Internet Gateway. This firewall protects wireless devices against attacks and scans originating from the Internet that would increase the usage count, prevent legitimate use (denial of service attack), and threaten security. Introduction of a firewall does, however, complicate the use of Wireless devices as M2M servers i.e. they may not be reachable from the Internet.

- **High end-to-end latency**

Network latency is the amount of time a data packet takes to traverse the network (latency is different than bandwidth or throughput). GPRS Network often exhibit very high latency, in the order of several seconds. Such high latency makes it difficult to reliably operate applications that were originally designed for circuit-switched networks. For examples, it is generally difficult to reliably tunnel a serial protocol across GPRS networks.

4. An Integrated solution from Setrix AG

Setrix AG has recognized the aforementioned challenges of deploying M2M applications on GPRS networks and has developed an integrated solution for wireless developers.

- Solution platform solves all known limitations of using GPRS technology for M2M
- Shortens time to market by allowing wireless developer to focus on value-add application.
- Tested and proven
- Operator neutral in the sense that it does not rely on any operator-specific feature or service provisioning.
- Retail GPRS service may be used without additional contracts or configuration changes.
- It is not required to operate a pool of devices all with GPRS service from the same provider. Wireless devices on different GPRS networks are all integrated into the solution framework.

The two main components of the integrated solution are the wireless device and Internet-Ready gateway, both described below.

A. S-372X series of Linux-based GPRS-enabled embedded systems

For the wireless developer, a Setrix S-372X system is the gateway between the application and the Internet. A S-372X consist of an embedded Linux computer, with a built-in GSM/GPRS modem and has the following features:

- Embedded Linux computer: multi-tasking, memory protected OS. Crash-resistant flash file system. Pre-configured for GPRS operation. Built-in configurable firewall. IPSec-based virtual private network. CompactFlash expansion slots.
- Open platform: 32-bit processor available to run application software. Cross-compiler available.
- Wide-Area communication: simultaneous GSM/GPRS and SMS communication i.e. SMS messages can be sent or received at the same time as GPRS data packets.
- Local-Area communication: serial (RS-232, RS-422, RS-485); wireless LAN (802.11b, using compact-Flash card) in Ad-Hoc; Station or Base-Station mode; Ethernet (802.3, optional); USB 1.1 (optional), master and slave; TTL Digital I/O
- Built-in continuous monitoring of GSM/GPRS network status to ensure online availability

- Hooks for end-to-end application connectivity checks

Applications can be developed for the S-372X using the same high-level API (e.g. C library) as available on Desktop Linux environments. In particular, all network communication is performed using standard Linux sockets and IP addressing without any special consideration for GPRS communication issues.

The GPRS link is configured in one of several modes:

- **always-on:**
the system ensures that the GPRS link is always connected
- **on-demand:**
the system brings-up the GPRS link as needed by the application
- **scheduled connections:**
the systems brings-up the GPRS link based upon a pre-configured schedule.
- **Manual connection control:**
the GPRS link can be controlled directly by the application, using a simple API, by SMS messages, or by SIRG (see below).

The S-372X systems provide a general-purpose computing environment that can be used to perform data collection or equipment control directly. Serial-based protocols are typically implemented on the S-372X directly, translating commands and data to web-based protocols (HTTP, FTP etc) and/or caching them onto local flash storage. This approach alleviates the problems linked to the high latencies of GPRS networks.

B. Setrix Internet-Ready Gateway (SIRG)

SIRG is an Internet-based service from Setrix AG, available either on dedicated or shared servers, that together with S-372X systems provides an integrated solution for GPRS-based M2M applications.

- **Fixed URL for access to wireless servers from the Internet**
Wireless servers can be reached from the Internet using a fixed, pre-established Internet domain name of the form `alias.sirg.net` (application-specific domain and sub-domains may be used). This URL will not change over time, even if a different GPRS operator is used, or if the device is roaming in a foreign country.
- **Authenticated Protocol proxying**
SIRG acts as a proxy to wireless devices on the Internet. The following protocols are supported: HTTP, HTTPS, FTP, arbitrary TCP connections (using SOCKS v. 4), SMTP (e-mail).

Clients and applications on the Internet may access the wireless devices using any of these protocols, provided valid credentials are provided.

Wireless devices may send e-mail, through SIRG, to any recipient or distribution list on the Internet. These messages will appear to originate from server `sirg.net` by user `alias@sirg.net` and will not be black-listed, as could otherwise happen when sending e-mail directly from the wireless device.

- **GPRS “dial-in” (Callback)**

SIRG can, upon receipt of a client request (HTTP, TCP, etc) from the Internet, for a particular wireless device, bring a GPRS device online if it is not already, thereby simulating a dial-in.

- **IPSec-based end-to-end IPSec security between SIRG and Wireless device**

All data communication between SIRG and the wireless device are authenticated and encrypted using IPSec protocols. Security keys are re-negotiated on a regular basis.

- **Protocol tunneling through NAT firewalls to reach private IP addresses**

A VPN tunnel is established between SIRG and the wireless device that allows requests proxied by SIRG to reach the wireless device, even when private IP addresses and a firewall with network address translation are in use.

This feature allows the use of Wireless servers on GPRS networks that use private IP addressing.

- Standard-based security between SIRG and Internet clients or application servers: SSL, SSH, IPSec etc.

5. Custom services from Setrix AG

- Secure application hosting on SIRG
- Application Development
 - turn-key solutions
 - embedded software development
 - custom hardware extensions e.g. Analog I/O
 - Device Drivers
 - Consulting

6. GSM/GPRS Reference Projects of Setrix AG

Aviation

Wireless Aircraft-Engine Diagnostic Systems – Continuous Monitoring of Aircraft Engines

A leading manufacturer of aircraft engines is using Setrix communications systems to collect engine data worldwide so that it can perform diagnostics and improve its products and product maintenance. To this end a Setrix communications module is installed in the aircraft cabin and linked to the aircraft engines. This Setrix module collates diagnostic data during the flight and after landing the engine performance data is automatically transmitted to the engine manufacturer's headquarters. In this way the engine manufacturer always has instant access to all the performance data on its turbines through their entire operating lives. The Setrix diagnostic system embraces local data transmission, remote data transmission, data storage and data backup.

Engine performance analysis is used to improve engine safety, deliver product enhancements, obtain data on the attrition of selected components, extend maintenance intervals and minimize unscheduled maintenance. A key advantage of the Setrix solution is its multi-protocol capability which makes it easy to monitor different types of engines. Turbine maintenance firms can therefore use Setrix systems to service engines from various engine manufacturers. Setrix also uses the GSM data communications network, via which all aircraft linked to the system can communicate worldwide with the manufacturer's headquarters in a reliable, secure and cost-effective manner.

Setrix is focusing its initial sales effort on the business jet sector with a market volume of around 30,000 engines.

Buildings Technology

Communications Host for Energy Billing Data (Heating and Water) in Apartment Buildings

A major maker of radio-based heating and water meters uses the Setrix communications system to automatically transmit consumption data to billing systems. The usage data for the individual households is transmitted to transceivers on each floor. These transceivers are locally networked within the building via M-Bus. The Setrix system also lends this network a cost-effective communications gateway to the Internet or Intranet. Energy usage data is transmitted both securely and cost-effectively to the billing system in the preferred data format at any time without obtaining access to the apartment. The usage data can be stored for extended periods before transmission to the utility headquarters at pre-selected accounting times.

Advantage: No need for appointments with individual tenants or home owners. Multiple reading of usage data is possible as and when required. Billing firms can auto-

mate the charging process. In addition, new information services can be offered to home owners. Households can check their own usage data at any time and take individual measures to change their energy consumption if desired.

Major billing firms in Germany have concluded contracts for millions of homes. The market volume for Setrix Gateway applications is around 40,000 to 80,000 systems.

Household Appliances

Residential Service Gateway for Monitoring and Controlling of Household Appliances (connection of multiple household appliances [230 V] to a single gateway via the power line [PLC]).

A leading manufacturer of household appliances plans to market a new product line which is fully networkable. All appliances of this manufacturer networked in the home can communicate with each other and also externally with the service provider or householder via an Internet link. To this end a Setrix Gateway is installed in each apartment to handle the data transmission, data storage, data backup and data analysis. Communications between the household appliances and Gateway take place along the power line (PLC Powerline) and beyond Gateway via a GSM/GPRS connection to the Internet/ Intranet. Gateway also has a wireless port for local access via wireless-LAN. Users can communicate locally with their household appliances via PDA, Laptop or SimPad* (registered trademark of Siemens AG) and a wireless-LAN interface. From outside the home the owners can communicate with their household appliances via devices equipped with a GSM/GPRS interface. The user interface is the same in both cases.

Advantages: The advantages of Setrix Gateway can be summarized as follows: low capital investment, minimal (no) installation expense, safe and reliable continuous operation, open platform, low data rates, optional future expansion with new functions, and cost-effective billing of services.

The key functions are security (monitoring and control of connected appliances), maintenance (procedure for optimizing energy consumption and energy management as well as monitoring of equipment for proactive maintenance) and convenience (remote operation and remote inquiry functions).

The use of power lines and wireless communications ensures cost-effective networking. The open system architecture means that several service providers can use the infrastructure (WAN and LAN communication) simulta-

neously. The special functions of each appliance vendor or maintenance firm can be implemented independently and mutually secured. Thus competing appliance vendors can securely transmit the operating data of their installed appliances via the same Residential Service Gateway. New services can be connected remotely.

Air Conditioning Systems

Air-conditioning specialist Carrier uses Setrix technology so that users can monitor and control its products via the Internet.

Carrier Corporation, worldwide market leader in the fields of air conditioning, heating and refrigeration systems, uses Setrix technology to link its appliances to the Internet. With the MyAppliance.com® service, air-conditioning systems can be monitored and controlled via the Internet from a regular PC or WAP-capable mobile phone.

Setrix S-3720 systems are employed as remote monitoring components in Carrier air-conditioning systems. Carrier also plans to introduce new Internet-based services throughout Europe for hundreds of private and business customers as an integral element of its new "Night and Day" console device. This MyAppliance.com®* program could be extended to cover the whole of Europe and North America.

The compact Setrix S-3720 Gateway combines a Siemens GSM/GPRS module with a special embedded Linux computer system. The device is outstanding for its easy installation, reliable operation and low operating costs. Setrix S-3720 acts as a virtual 'gatekeeper', communicating with Carrier air-conditioning systems while also protecting private information from intruders. Setrix technology enables the following MyAppliance.com® functions: remote surveillance, control, diagnostics and forecasting. Installed Setrix devices can be expanded with new functions via remote downloading. Solutions can be expanded efficiently and flexibly at any time with new applications.

7. Contact Setrix AG

Jörg Mortsiefer, Setrix AG
Theresienstr. 6-8
D-80333 Munich
+49'89'2 88 90'200 tel
+49'89'2 88 90'505 fax