EXPANDING THE ROLE OF THE MOBILE NETWORK OPERATOR IN M2M

STRATEGIC WHITE PAPER

INTRODUCTION

Machine-to-machine (M2M) communications is on the rise. Most mobile network operators (MNOs) are turning to M2M for growth in revenues buoyed by the significant growth projections for number of connected devices. With voice revenue reaching saturation and significant margin pressure on consumer data services, MNOs are attracted by the high margins involved in M2M connections. Estimates for number of M2M devices in the future are in the billions of devices. An oft quoted figure is from Ericsson: 50 Billion connections by 2020 [1], which is roughly ten times the number of cellular connections today. MNOs are investing a significant amount of resources in infrastructure platforms, partnerships, and marketing and sales to grow their M2M business.

Are there really going to be 50 Billion cellular connections by 2020? Of course not. The majority of the 50 Billion is likely to be devices that are connected by short range technologies to gateways that in turn connect to wide area networks. In fact, the number of M2M cellular connections is only likely to be around 2 Billion [2] with majority of the remaining connections made of short range technologies such as Zigbee or 6LOWPAN and WiFi. It is instructive to focus on the projections by Harbor Research [3] on the number of devices by the type of device. As can be seen from figure 1 the majority of the connected devices are small embedded devices that may be connected through gateways while the majority of the cellular connected devices are mobile information devices such as smart phones, tablets and media and gaming devices.

Figure 1. Break up of connected devices

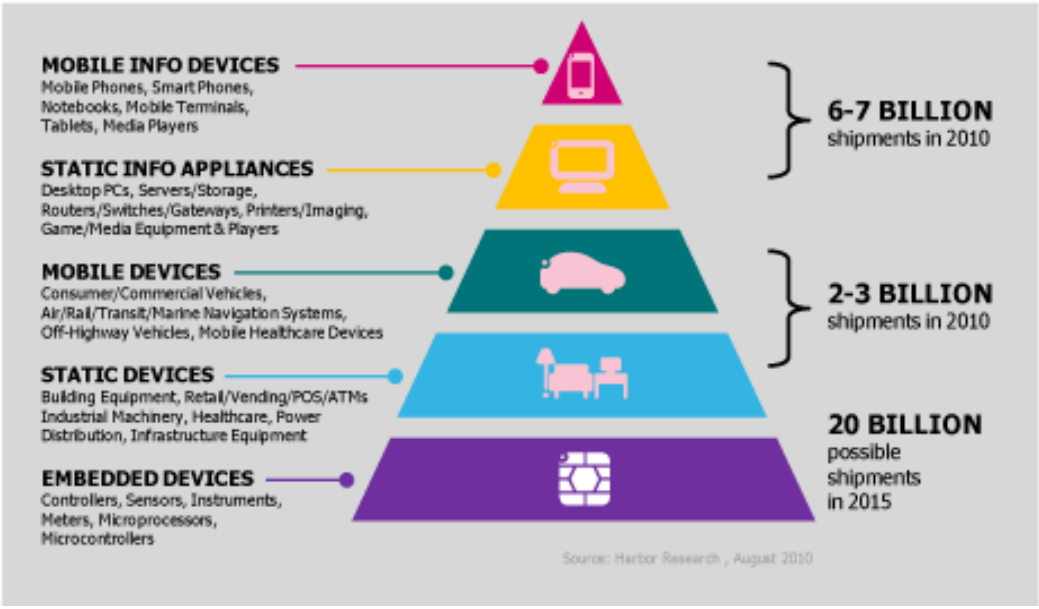
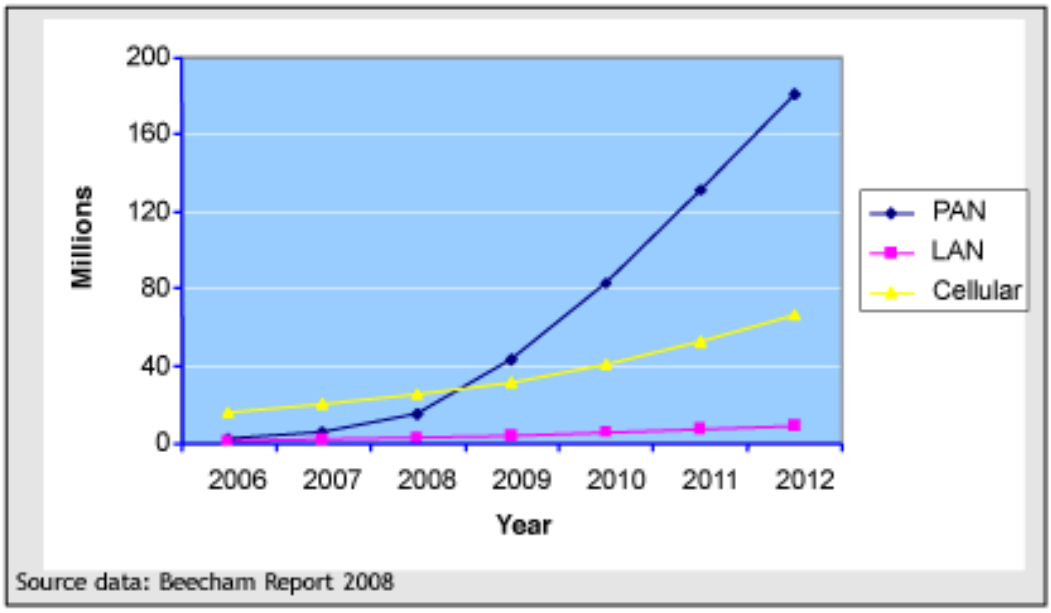


Figure 2 below shows the projections [4] for wireless devices that are personal area network (PAN) devices, local area network (LAN) devices, or cellular network devices. It is clear that the device category with largest number of devices expected to be deployed is the PAN devices, a portion of which would be connected to the wide area wireless network through gateways.

Figure 2 Devices growth projections showing much faster growth for PAN compared to cellular



In the light of the above, it is reasonable to focus the attention beyond directly connected cellular devices and ask how MNOs can exploit their network and M2M platform infrastructure to support the use of M2M devices that are not

directly connected to a cellular network, but are connected though a cellular gateway, one instance of which could be a smart phone connected to a number of sensors. In this document, we first highlight some applications that rely on non-cellular M2M devices and then discuss various capabilities that MNOs can offer for such devices and their applications, thus expanding their role to many more M2M devices than just cellular M2M devices.

INDIRECTLY CONNECTED M2M DEVICE APPLICATIONS

The term M2M is quite broad and refers to many different vertical markets, diverse communication technologies, and potentially a large geographical scope. The applications and devices of interest to the MNO from the point of view of providing value are sensor nodes that connect to a gateway which in turn is connected to a cellular network. Sensors connected to a wireline gateway are not of immediate interest. In this section we highlight some key applications that utilize this model for connectivity.

The mobile phone or tablet is emerging as a personal hub for a number of sensor devices that remain in the immediate proximity to the user of the phone. Or the phone itself is the sensor that collects a variety of information useful for M2M applications. Figure 3 below shows a modern smart phone and the variety of interfaces it typically supports. In addition to multiple cellular interfaces, the phone may have, one or more of interfaces such as WiFi, Bluetooth, near field communications (NFC), global positioning system (GPS), and Zigbee, and sensors such as camera, speed sensor, and gyroscope. The smart phone thus becomes an enabler for multiple vertical applications such as telehealth, ebooks, navigation, point of sale, or video surveillance as illustrated in Figure 3. The smart phone can essentially be treated as a personal hub.

Figure 3 Smart phone as a personal hub

Following are example applications for which the smart phone acts as a gateway or performs the M2M task.

- Medical devices such as heart monitors or blood glucose monitors connect via Bluetooth to the phone. An application client on the phone then transfers the information from the smart phone to a web based application.
- Wellness applications involve sensors such pedometers or shoes with connectivity to monitor activity levels of the user. These sensors can connect to a web server through the phone.
- For certain connected cars (e.g. Ford Sync) the phone acts as the hub for connecting the car and associated devices to the network
- The phone may be a tracking device, navigation device, e-reader, and a connected camera.

In principle, the above applications can all be offered by application and content providers (ACP) in a manner that is transparent to the network operator by simply using the data connection available to the phone. The question is how the MNO can help, beyond providing connectivity, enabling such application providers to make their applications better thereby taking a share of the value created.

Another class of applications is based on a cellular gateway device that connects sensors using short range communication technology based on IEEE 802.15.4, WiFi or Bluetooth to the cellular network. A number of wide area sensing applications could potentially use this approach. Some applications that are candidates for this approach are the ones based on outdoor sensors in close proximity to each other which can be networked to a gateway node. Examples include:

- Parking meters on individual parking spots
- Street lamp lighting control sensors
- Roadside traffic sensing devices for vehicle traffic monitoring or speed sensing Bridge/tunnel monitoring system of sensors
- Neighborhood smart meters connected to a concentrator with cellular backhaul

MNO SERVICES FOR INDIRECTLY CONNECTED M2M DEVICES

While the MNO provides connectivity to the cellular gateway or the phone, we

discuss some further capabilities that can be offered to ACPs, embedding the MNO in the M2M value chain more broadly.

Subscriber Data Management

When a new sensor device is connected to the network through the phone-gateway or a stand-alone cellular gateway, it is necessary to maintain a record of the device identity, who it belongs to, the location where the device is installed, security credentials associated with the device, device statu (e.g. active, asleep), dynamic network address of the device, and policies related to the device and the applications using that device. Such data is necessary for performing billing, access control, inventory management or other related tasks.

MNOs routinely maintain such data for cellular devices such as phones. It should be natural to extend the capabilities to devices that are behind a gateway. Maintaining a subscriber data base is critical for performing some of the other capabilities envisioned below.

With such information, MNOs can provide automatic association of all the devices belonging to the same consumer customer. For example, an association can be established between a smart phone with a home control application and the home sensors deployed in the home. Such an association is very useful to the MNO itself or can be offered to the application provider. Automatic association reduces the end users' burden through bundled billing across all devices or enhanced security, for example, only that consumer's particular associated smart phone is allowed to reach the sensors to perform control functions. Another advantage from establishing a link between various devices is the ability to perform sophisticated analytics based on correlations of information from multiple devices.

Remote Device Management

Device lifecycle management tasks such as parameter configuration, service activation, firmware upgrades, and device diagnostics need to be performed remotely for M2M devices whether they are directly connected or through a gateway. With standards such as the PD-174 extension to TR-069 [5] standard of the broadband forum and the OMA-DM Gateway protocol from the Open Mobile Alliance [6] forum emerging for managing devices behind gateways, MNOs can deploy device management platforms and offer the capability as a horizontal service to their enterprise customers and application providers who deploy the devices. This can significantly reduce the operations expense of application providers thereby generating a substantial value.

QoS, Traffic Monitoring and Charging/Billing Management

Multiple applications may be supported by the gateway device or the phone that is directly connecting to the MNO network. There may be a need to monitor or individually account for the traffic that each of the applications generates. For example, to determine if a particular application is misbehaving it will be necessary to separately track the amount of traffic from that application or sensor connected to the gateway.

Deep packet inspection (DPI) in the packet gateway can be leveraged to monitor and generate charging record information specific to each of these applications. DPI engines can identify the application or the sensor generating the IP flow based on the TCP port number used, protocol signature, or even a unique application name. Once the flow is identified as belonging to a specific application then various policies such as limit flow bandwidth, , generate flags based on volume or perform charging rules on the flow. An alternative to deep packet inspection in the packet gateway could be through separate flow monitoring and analysis tools such as the Alcatel-Lucent 9900 Wireless Network Guardian tool that gets access to the data going through the packet gateway by port mirroring.

In addition to the record generation, the MNO could offer integrated billing for various applications consumed by the end user. This allows the MNO to play a key role in monetization of the application.

Security and Access Control

The MNO controls the connectivity to the gateway which in turn connects to the sensors. Thus the MNO is well positioned to stop unauthorized users from sending packets to specific ports on the gateway used for these applications. This is particularly important in the case of battery operated gateways or phone-gateways since dropping packets from non-legitimate sources at the device implies that battery power is already consumed even though the packets are delivered to the sensor device.
If data from the application server goes through an MNO M2M service platform, then platform can ensure the desired level of security. All data from specific applications on the gateways could be routed to the service platform thereby preventing fraudulent use of the connectivity to access other web applications or portals.

Resource Optimization

MNOs can play a role in optimizing the resources consumed by a phone-gateway that can improve the customer experience and benefit the operator

through reduced churn. Customer experience can be improved by ensuring that the different applications relying on different sensors connected to the phone-gateway work in a coordinated fashion to minimize the amount of computing and communication resources used, and maximize battery life. This will require installation of a common client function on the phone-gateway to manage the communications from the different sensors each belonging to a different application. Some potential optimizations that can be done are

- Eliminate separate secure tunnels and keep alive messages from each device/application connected to the phone-gateway. Rather the common client function should provide the connection to the different sensors. MNOs can also offer push service to the different applications to wake up specific sensors behind the gateways.
- Save phone battery life by preventing different delay tolerant device/applications communicating asynchronously. Instead the common client function can aggregate data from the different sensors and transmit them to the MNO network side platform at the same time. The platform can then make the data available to the different applications.
- Reduce processing and software footprint on the phone by performing common functions across multiple sensors/applications within the common client.

Access

MNOs are actively considering deployment of small cells to complement the macro network deployment. Outdoor small cells are likely to be deployed in dense urban areas where there is a need to increase capacity of the network. Dense urban areas are also the locations where outdoor sensors are likely to be deployed. By deploying sensor gateways on small cell base stations and femto cells in the home, MNOs can provide access to sensor devices that communicate using a non cellular network protocol such as IEEE 802.15.4. This is viable given that the small cells will have ranges comparable to that of the sensor communication technology.

SUMMARY AND RECOMMENDATIONS

MNOs are seeing the potential for growth through M2M as revenues from voice saturate. Using the infrastructure being deployed to serve cellular M2M devices, MNOs can also provide services to non-cellular M2M devices that are connected to the cellular network through a gateway. While the revenue per device for such devices is likely to be smaller than that for cellular M2M devices, the significantly larger number of such devices makes it an interesting opportunity for MNOs.

Alcatel-Lucent provides mobile wireless network equipment including both the access and the core network. An M2M Service platform is also under development with plans to offer that to MNOs. The network and M2M service platform should thus include features that are capable of providing value to the devices connected through a gateway. This can be an important differentiator for ALU products in the future. We can specifically make the following recommendations to the access, core and service platforms.

Sensor access in small cells
The small cell roadmap, specifically femto and pico cells, and possibly metro cells, should include incorporation of sensor gateway functionality to provide access to low cost, low power sensors using short range communication technologies.
Incorporate appropriate software in the small cells to enable remote device and application lifecycle management of the devices connecting through short range technologies

Core network support for M2M devices behind gateways
Ensure that the DPI/application assurance capability of the packet gateway product meets the QoS, monitoring and charging needs of M2M applications.
Ensure M2M standardization in 3GPP/3GPP2 takes into account requirements of devices behind gateways

M2M Service Platform should support indirectly connected devices
The remote device management capability in the service platform should be capable of managing devices behind gateways.
Service platform should include subscription management services for indirectly connected M2M devices
OPTIMIZE AND SECURE ACCESS TO THE GATEWAYS SUPPORTING MULTIPLE APPLICATIONS

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