Device Connection Platform for M2M Communication

Vanesa Čačković, Željko Popović
Ericsson Nikola Tesla d.d., Croatia
e-mail: vanesa.cackovic@ericsson.com, zeljko.popovic@ericsson.com

Abstract: **For the last several years players in the telecom arena are talking about machine to machine (M2M) market and its huge potential. Most of the players agree that 50 billion connected devices vision will come true in the near future and that everything that can benefit from a network connection will be connected. At this moment we are at the turning point. Reason for that is in fact that in the past years machine to machine market was highly fragmented, different between verticals, enterprise and geography.**

Lately together with technological advancement much effort is being put into standardization and driving openness and simplicity. The result is that standards are being set and platforms are being built upon those standards.

This paper discusses the Ericsson Device Connection Platform which provides the operator with access to key functionalities to manage the connectivity of the M2M business, including device management, subscription management and self-service. Also, examples of different business models and applications with deployment scenarios are described.

1. INTRODUCTION

It has been foreseen that the M2M industry will be one of the industries with highest growth in the next decade. The M2M market is growing between 20-30% a year, with the number of connected devices forecasted to reach between 5-50 billion by 2020. Machine-to-machine industry refers to technologies that allow wireless and wired systems to communicate with other devices of the same ability. The prediction is that the M2M business will grow in few waves. First wave which is happening at this moment is the connected consumer electronics. Consumers want their products being connected to the net for consuming content everywhere but also producing and broadcasting their own content to their communities. Not only the consumers have a demand for this, the manufacturers see the value of having their devices connected too.

Second wave will be networked verticals and industries. Global networks cover many areas of activities, for instance networked research and innovation, networked production, e-business etc. Networked businesses are enhancing collaboration with connecting people through the use of social-media tools. It aims to help employees, customers and suppliers collaborate, share and organize information which results together with increased machine to machine communication with businesses that are gaining increased process efficiency and increased human effectiveness. The business can support in a cost efficient way new services like new software updates to industrial machinery, after sales services, remote service etc. In especially the consumer segment business can through networked devices move in and enter new value chains. Manufacturers of audio visual hardware can offer for example content through the networking capabilities as an over the top player.

The third wave will be networked society, networked everything where everything that benefits from a connection will have one.

M2M applications are today mainly driven from enterprise or government needs. The enterprise focus is on cost reduction and efficiency, and the government focus is on sustainability, safety and socio-economic impacts. The telecom industry is increasingly looking at M2M as a new source for revenue when on many markets revenue growth is stalling. Standardization bodies have the long term intent to drive the M2M domain towards a horizontal system and business orientation. The reason for belief in horizontalization is that it provides the most efficient structure for the involved industries.

There are activities ongoing such as ETSI M2M standardization that tries to create a common horizontal base for M2M services, which can be used by multiple industries, to reduce costs and drive economy of scale.

There are essentially three elements of the M2M value chain: the device, the network and the application. The device typically sends data through the network to reach an application.

Although only mobile network operators can provide the radio network to provide access, there are opportunities for other companies to provide the core network elements for device activation/deactivation, billing, support, security, provisioning, subscription/device management, and other aspects of the core network and support systems. These different value chain roles have been termed service management [15].

The network access, or airtime revenue, is the core service the mobile operators provide. This element of the value chain has been measured and forecast in terms of revenues. However, it provides only around 18% of the total connectivity revenue, and mobile operators are increasingly focusing on the service enablement aspect of connectivity to increase their revenue. Service Enablement is an opportunity to monetize on assets in the network, but perhaps more importantly to simplify for applications and developers to build & nurture the eco-system of M2M. Different capabilities and services in the network can be exposed and monetized on, e.g. location & SMS. Different composite services can also be created as a combination of different services and capabilities. Advanced device management functions such as remote SW management and evolving towards asset management is also an important area. The main goal of service enablement is to simplify communication between applications and devices, and to simplify the collection of data from devices. Different services and data from the devices can be exposed to the applications. Service creation and orchestration enables value added enablement, simplicity and openness. Going forward more advanced features for data collection, data aggregation, filtering, data mining etc can be provided.

This paper will provide an overview of the ETSI standardized end-to-end M2M architecture and Ericsson Device Connection platform that is built upon ETSI standard. It mainly provides an end-to-end perspective of M2M communications, integration of M2M devices and M2M service enablement. The importance of the service enablement is also explained on example of Software-as-a-Service Device Connection Platform model which enables operator to enter the M2M arena in scalable and cost efficient way. Integration into specific business applications and the relation to other key enablers required for M2M-oriented services is also introduced but is not the focus of this paper.

2. APPLICATIONS AND BUSINESS PROCESSES

M2M applications exist in a number of industry segments and are very diverse. Typical application domains include industrial automation, transport and logistics, asset management, utility and health care. In addition, the emergence of consumer electronics with embedded connectivity and bundled services represent yet an application domain of relevance with similarities to the existing more traditional M2M domains.

M2M capabilities are generally integrated into the business processes of an enterprise, and some of these capabilities are used in a stand-alone fashion (e.g. collecting a meter reading), whereas some are more tightly integrated in the overall business process. For instance, an alarm or event requiring the dispatch of field personnel supplied with adequate event information, thus requiring the establishment of a multimedia session between the field force worker and a central operations center using functionalities of core network like IP Multimedia Telephony Subsystem (IMS), and pushing out information using a messaging service like short message service (SMS) or e-mail.

The service requirements of M2M services can vary significantly. Connected consumer electronics will have similar (demanding) QoS requirements as mobile multimedia services for mobile broadband. On the contrary, sensors, meters and connected devices have low QoS requirements, but may have very stringent requirements on energy efficient operation and cost. Works to address these issues are addressed in 3GPP [12] [13]. In addition, a massive amount of connected devices can lead to an overload of signaling messages. This is also addressed in 3GPP [14]. Other M2M services may impose other requirements, like high reliability and low delay for industrial control applications and smart grid; high reliability, low delay and high mobility for automotive applications, etc. Long Term Evolution network (LTE) already provides support for diverse service requirements. If a significant demand in M2M use cases is foreseen it is likely that 3GPP will address according enhancements and optimizations in the 2016+ time frame.

The conclusion is that one size does not fit all. For an mobile network operator (MNO) to be competitive in the world of more than 50 billion devices a platform built on standards is needed. This platform needs to provide the means to create tailored subscriptions and offers the possibility to fine-tune and tailor subscriptions for specific devices and applications. Differentiated tariffs go hand in hand with tailored subscriptions, adding the requirement on such a platform to provide the functionality to rate a tailored subscription with a differentiated tariff.

In order to derive service capabilities and requirements for the overall M2M system architecture, the ETSI M2M technical committee has defined a number of application areas and a number of use cases for each application area. The actual application areas accounted for are eHealth [4], Connected Consumer [5], City Automation [6] and Automotive Applications [7]. The Smart Metering application, driven by the European Commission Standardization Mandate M/441, is of particular importance [8]. The general objective of the mandate - and consequently of the use case - is to create European standards that will enable interoperability of utility meters (water, gas, electricity, heat), which will be used to improve customers' awareness of the actual consumption. Thus, the consumers will be enabled to allow consumption adaptation to their demands, while improving the energy end-use efficiency.

The growth of the M2M communications industry has lead to the need for interoperability between M2M solutions. The all major standardization bodies have identified the need for a cooperative M2M community standards activity which leads to regularly enhanced releases of the M2M Service Layer specifications. This standards activity is known as "oneM2M".

The ETSI Technical Committee M2M is defining the end to end M2M service platform and the intermediate service layer that are key components of the horizontal M2M solution. This standards based platform is engineered to support multiple services, whilst remaining network agnostic.

3. ARCHITECTURE AND COMPONENTS OF M2M

The European Telecommunications Standards Institute (ETSI) has published the first release of its Machine to Machine (M2M) service standards, providing a standardized platform to manage the complexity of multiple M2M services and technologies.

ETSI M2M Release 1 is built upon proven and mature standards from ETSI and other bodies such as the IETF, 3GPP, the Open Mobile Alliance and the Broadband Forum. The business benefits are reduced complexity of M2M deployments, reduced deployment time for new M2M services, and ultimately reduced CAPEX and OPEX. The ETSI M2M standards specify architectural components including M2M devices, gateways with associated interfaces, applications, access technologies as well as the M2M Service Capabilities Layer. They also offer security, traffic scheduling, device discovery and lifecycle management features. The ETSI M2M Release 1 standards are published as a set of three specifications [1], [2], [3].

ETSI defines M2M functional architecture as illustrated on Figure 1. It consists of Device and gateway domain and a Network domain.

The Device and gateway domain consists of following elements:

1. M2M Device - that runs M2M application(s) using M2M Service capabilities.

M2M devices can connect to Network domain either directly or via M2M gateway. If the M2M device is connected to access network directly, the M2M device performs the procedures such as registration, authentication, authorization, management and provisioning with the Network domain. The M2M device may provide service to other devices (e.g. legacy) connected to it that is hidden from the Network domain. If the M2M device is connected via gateway, the gateway acts as a proxy for the Network domain towards the M2M devices that are connected to it. Examples of procedures that are proxied include authentication, authorization, management, and provisioning.

M2M Devices may be connected to the Networks Domain via multiple M2M Gateways.

2. M2M Area network - provides connectivity between M2M devices and M2M gateways. Examples of M2M Area networks include: personal area network technologies such as IEEE 802.15.1, Zigbee, Bluetooth, IETF ROLL, etc or local networks such as PLC, M-BUS, Wireless M-BUS and KNX.

3. M2M Gateway

M2M gateway is gateway that runs M2M application(s) using M2M Service capabilities. The gateway acts as a proxy between M2M devices and the Network domain. The M2M gateway may also provide service to other devices (e.g. legacy) connected to it that is hidden from the Network domain.

The Network Domain is composed of the following elements:

1. Access Network - allows the M2M device and gateway domain to communicate with the Core network. Access networks include (but are not limited to): xDSL, HFC, satellite, GERAN, UTRAN, eUTRAN, W-LAN and WiMAX.

2. Core Network - provides IP connectivity at a minimum and potentially other connectivity means, service and network control functions, interconnection (with other networks) and roaming.

Different Core networks offer different features sets. Core networks include (but are not limited to) 3GPP Core networks, ETSI TISPAN Core networks and 3GPP2 Core networks.

3. M2M Service capabilities - provide M2M functions that are to be shared by different applications by exposing functions through a set of open interfaces. Service capabilities use Core network functionalities and simplify and optimize application development and deployment through hiding of network specificities.

4. M2M applications - run the service logic and use M2M Service Capabilities accessible via an open interface.

ETSI high level functional architecture also defines common network management functions and M2M management functions. Network management functions which consists of all the functions required to manage the Access and Core networks. These include Provisioning, Supervision, Fault management, etc.

M2M management functions consist of all the functions required to manage M2M Service capabilities in the Network domain. The management of the M2M devices and gateways uses a specific M2M Service Capability.

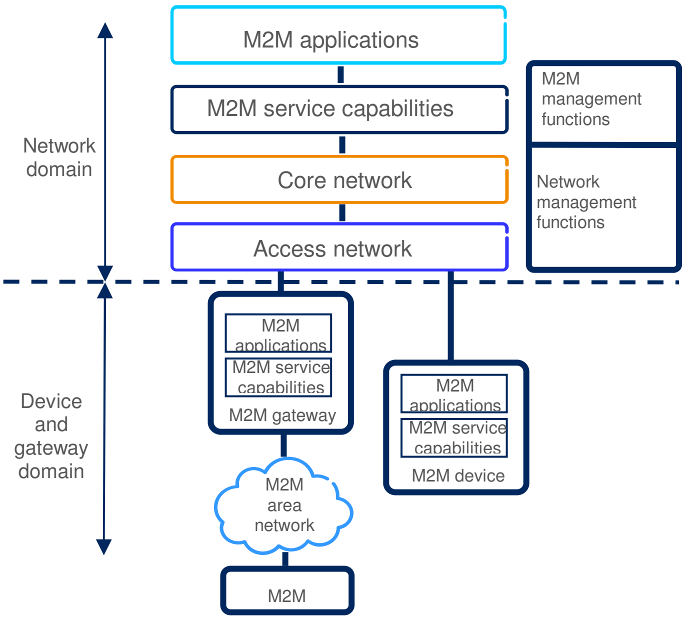

Figure 1. High level M2M architecture

The ability to share software components is particularly significant since it allows M2M applications to migrate from the current vertical stovepipe model and adopt the horizontal cloud-computing model of today's enterprise environment. In turn, this will facilitate the integration of M2M data with mainstream back-office applications.

4. DEVICE CONNECTION PLATFORM

The Ericsson Device Connection Platform (DCP) is a key component of the total M2M value chain and the 50 billion connected devices vision, offering a managed connectivity platform to mobile network operators and mobile virtual network operators owning their own network core.
DCP provides an optimized M2M service enablement system, supporting the new devices and applications covering the M2M verticals and newly emerging Connected Consumer Electronics segment.
The DCP as a Service is an optimized M2M service offering with functionality and capacity that enables communication between devices and applications covering the M2M verticals and the newly emerging connected consumer electronics segment.

4.1 Functional architecture

DCP is a full end-to-end connectivity solution and encompassing support for the main Business Support processes, Subscription Management, IP control and Application Enablement, including following main functional areas:

1. Device Connectivity:
• IP establishment and Policy Enforcement: Provides IP address allocation to devices, APN/VPN routing as well as subscription policy enforcement
• Device Access Enablement: Enables the device to be available on Internet over private and public IP addressing schemes

2. Policy control & charging:
• Rating & Policy Control: Enables differentiated pricing of subscriptions, configures the subscription policy and charging profile.

3. Management and provisioning of subscriptions & devices:

- Subscription Management: Selected HLR/AUC Functionality for M2M and connected consumer electronics devices handles subscriptions and detection of new devices.
- Connectivity monitoring: Supervises device connections and provides diagnostics data to operator and enterprises.
Portals, provisioning and order management: Operator portal for handling of customers and tailoring of subscriptions, and operator branded enterprise self-service portal for efficient provisioning and management of devices and subscriptions.
- Device Management & Diagnostics: Device configuration management, remote SW management and diagnostics features, to support management of devices.
Furthermore, the following functions are provided driven from end customer needs:
APIs, SCE, and Service Execution Environment: Provides exposure of API’s and device & network capabilities towards the applications & developers, and supports service creation & execution environments.

Figure 2 shows how the DCP solution interfaces with enterprises as well as mobile operators, providing functionality.

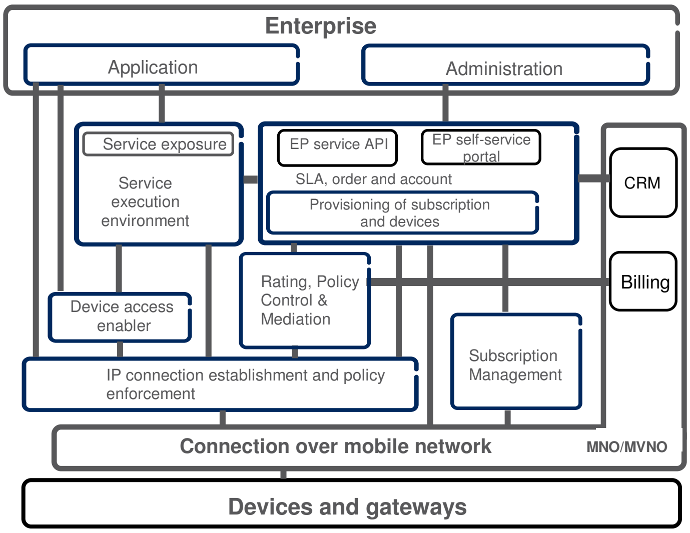

Figure 2. DCP Platform architecture

Devices are connected to enterprise applications through the DCP and via the operator's mobile network. For transparent IP connectivity, the Gateway GPRS Support Node (GGSN) supports private IP networks, while the device access enabler (DAE) grants access to devices on the internet. The platform includes a service execution environment, which provides support functionality to enterprise applications such as a subscribe/notify communication scheme and location services.

The policy and charging control block handles the various settings for tailored subscriptions, such as data capping and charging levels. Enforcement of the parameters takes place in the GGSN and online charging systems (OCSs). The latter components also pre-rate and sort charging information – Call Detail Records (CDRs) – for each enterprise and operator. CDRs are then transferred to the operator's billing system according to a desired control cycle.

For operator and enterprise users, dedicated portals provide access to the platform for service-level agreement (SLA), order and account management components. The operator can, for example, create enterprise specific subscriptions, set up portals and monitor SLA reports. Through the self-service portal the enterprise can purchase services, order subscriber identification module (SIM) cards, and monitor real-time/statistical data on devices. The self-service portal also includes provisioning of subscriptions into the DCP components as well as auto configuration of connectivity parameters into the devices. All devices supported by the DCP are provisioned in the subscription database.

The Operational Support System (OSS)/diagnostics component provides operational and maintenance functions, such as alarm handling, as well as statistics for SLA reporting. A subset of status information and alarms is provided to the operator's network operation center.

Not all of the more than 50 billion connected devices will be equipped with SIM cards. Figure 3 shows a probable scenario in which DCP interacts with M2M devices via a M2M gateway. The gateway, which can be connected to several different M2M devices, handles communication over the mobile network.

Communication protocols used may be of any type. This example shows HTTP being used between DCP and the gateway and the IETF-specified Constrained Application Protocol (CoAP) between the gateway and devices [9].

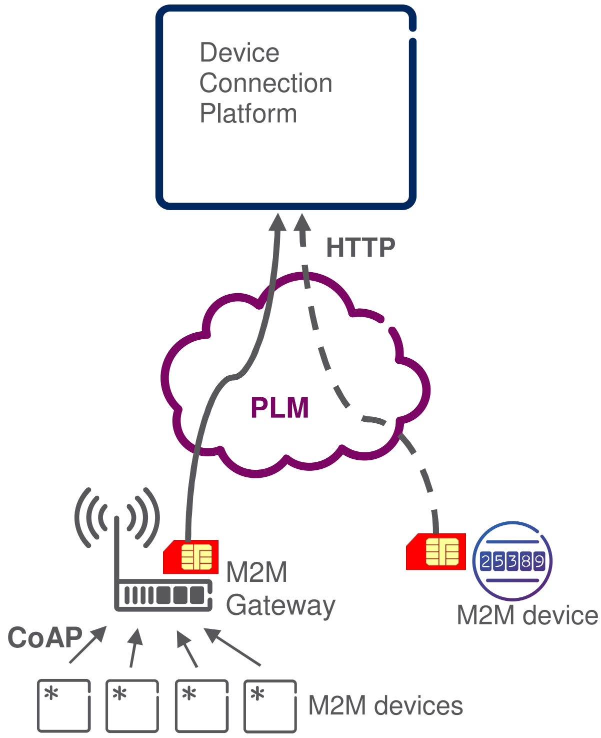

Figure 3. DCP interaction with M2M devices via a gateway

4.2 Ericsson Device Connection Platform deployment architecture

Device Connection Platform offered as Service SaaS in a cloud style is a convenient and cost-effective way to connect devices and applications. The cloud model features pay-as-you-grow characteristics, rapid elasticity of system resources and ease of use. As already mentioned, in the M2M arena there will be many different devices. Some will send and receive small amounts of data infrequently, some will send small amounts often and others will send and receive large

amounts of data often or rarely. What M2M devices have in common, however, is that they could all benefit from the convenience of re-using infrastructure nodes for M2M services, such as provisioning, connectivity, charging and policy.
The DCP deployed as a SaaS to supports this convenience and will interface to several nodes, as shown in Figure 4.

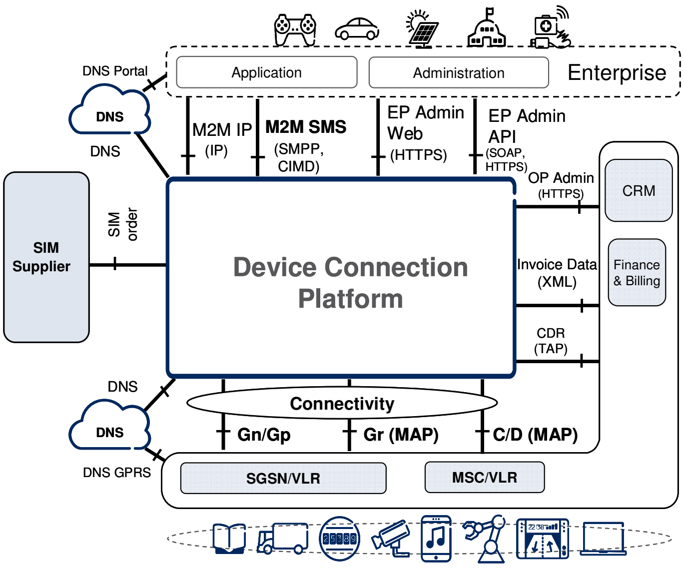

Figure 4. DCP general deployment

Below are short examples of how DCP will support multi-tenant services in areas such as provisioning; OSS; charging; and accessing devices from the internet.
To handle the use of the subscription database (HLR), which is shared among customers, for its own or MNO-owned IMSI series, the DCP will typically have its own HLR/AUC and interface to SGSN via the Gn/Gp/Gr interface. The different MNOs share the DCP but use their own radio and core networks for sending messages to the platform. When the M2M device is equipped with a DCP SIM card, 3GPP messages such as Attach and Authentication messages, which will be routed via the IMSI number to the DCP HLR and processed according to standard 3GPP methods.
When the M2M device issues a (Packet Data Protocol) PDP context activation message, that message will be routed to the DCP GGSN via the MNO-controlled SGSN by a Domain Name System (DNS) lookup of the Access Point Name (APN) derived from the M2M device plus the DCP IMSI number.
For MNO-owned IMSI series, the routing to DCP HLR will additionally be based on Mobile Station Identification Number MSIN (plus the ordinary usage of MCC and MNC). Operators will need to configure their networks to route messages to DCP HLR for specific ranges of IMSI.

Most utilities agree that using the existing mobile networks for smart metering connectivity would be a perfect solution in many ways. They are standards based, easy to use and there is already widespread coverage in most countries typically >95% population/dwellings. Based on that research, Ericsson built a model called Private Network Operator for smart metering connectivity purpose, which was award winning solution for improving utilities use of the existing and future public mobile network infrastructure.
The standard MVNO model is well understood technically and commercially and it is in widespread use globally. Often the full MVNO has its own HLR, SIM cards, customer management system, billing system and core network which allows it a large degree of service management and control.
The utility is in general not looking to provide mobile phone services to the public, rather it is looking for a cost effective connectivity solution for its own private use, typically to provide two way connectivity for smart metering, substation and distribution automation, asset management and field force communications. Since these are all 'private' utility applications and can be enabled by an MVNO type architecture the term Private Virtual Network Operator or PVNO is a more appropriate description than MVNO.
The PVNO concept solves concerns like SIM lock-in, cost, coverage, security, scalability, redundancy and reliability that have been raised by utility customers and in solving these issues it opens up the opportunity for utilities to maximize their use of the existing mobile operator networks potentially saving them hundreds of millions in costs.
While the technology and business models behind the PVNO and roaming are very mature, the concept of the PVNO is something new and it may take telecommunications regulators in particular countries some time to understand. Normal conditions on for an MVNO licensee around emergency call support or other legislative conditions may not be appropriate. Ericsson has discussed the model with a number of regulators, operators and the GSMA and has in general received broad support for the model.
The PVNO model can be implemented in a number of different ways:

- as a Utility owned and managed infrastructure
- as a utility owned but managed by Ericsson or another partner solution
- or as a complete service offering as described above in DCP as a Service model

5. CONCLUSION

Ericsson Device Connection Platform is an important step towards realizing the vision of more than 50 billion connected devices. It provides tools for actors, such as operators and enterprises, to handle provisioning in a self-service way. As part of the layered approach to device connectivity service provisioning, applications are treated separately from connectivity and management. This simplifies the solution and enables a greater number and variety of application developers to enter the market. It also speeds up development and enables reuse of functionality across applications.
Ideally, service and application enablement should support industry standards, such as the European Telecommunications Standards Institute (ETSI) M2M functional architecture and service capabilities. It should also make use of widespread internet technologies, open APIs, Web 2.0 and mash-ups. Such an open service creation environment will provide access to service enablers in the network, such as location, SMS and charging to support applications that need it.

Device Connection Platform is a managed connectivity platform as a service, for mobile operators and mobile virtual operators for wholesale of connectivity towards enterprises.
Currently, DCP platform focus on support mobile connections, but in future this platform will evolve to support connection of all technologies.
The Service Enablement, which will in the future development become the core part of the Device Connection Platform, acts as the middleware where communication and connected devices blend together and become exposed to service consumers. The Service Enablement is designed to ease device manufactures to integrate their devices towards established, generic API's or to customized adaptors. Consumers of this data and communication assets like voice, video call, SMS etc. can then access the services via exposed API's.
This simplifies the ecosystem for both service resources and consumers. Resources have a way to make their products available faster towards multiple consumers. Consumers have through the Service Enablement the tools to access multiple resources that they otherwise only could access to costly and complicated, customized integration projects.

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