



SIMPLIFY INTEGRATION THROUGH HYPERMEDIA APIS IN THE DIGITAL ECONOMY

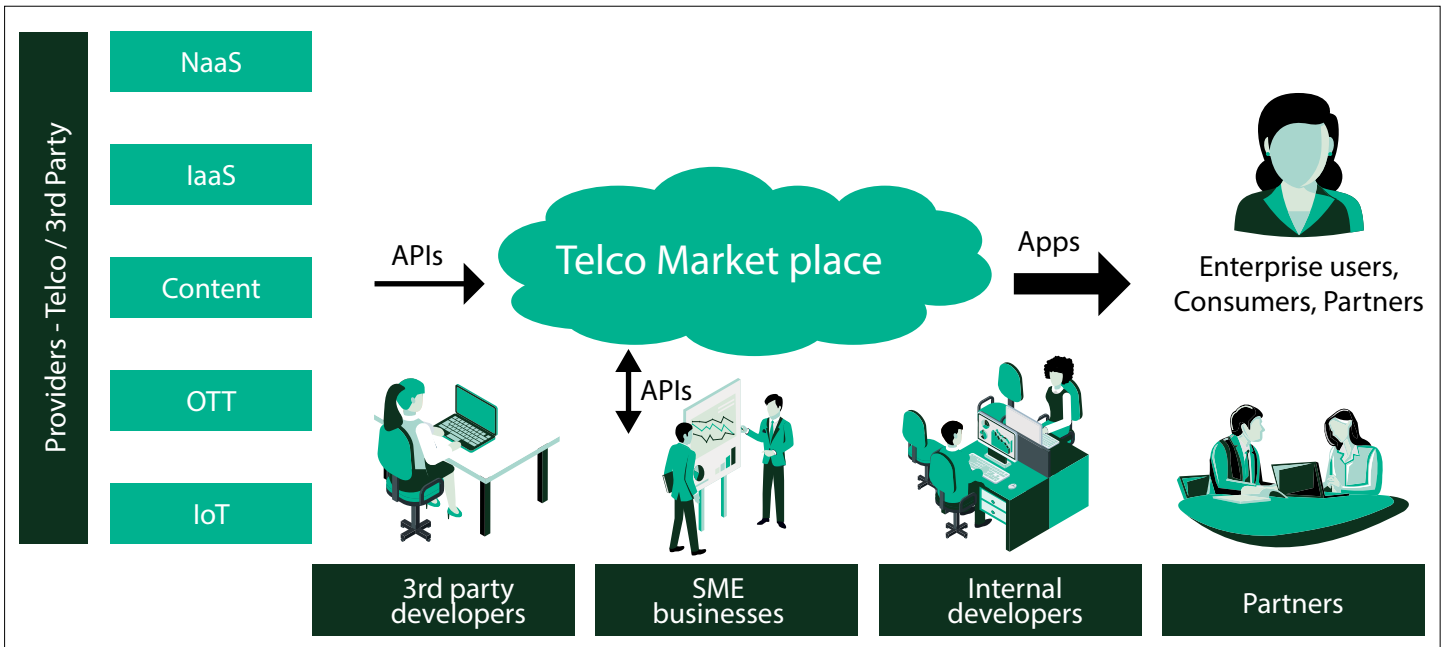
Next generation services and technologies (SDN/NFV, Cloud, IoT), B2B2X business models demand more active collaboration and integration with several north bound and south bound partners of digital ecosystem. Telcos are actively looking to exploit platform based business models to create new revenue streams with various Telco, non-Telco businesses through double sided model. These business models requires agile way of integration and machine readable APIs to drive such integration. Traditional way of creating and deploying APIs will not suffice as there is lot of dependency between providers and consumers to integrate, longer development /change cycles. Hypermedia set of technologies provide ways to create self -descriptive, machine readable and interactive APIs , thus enabling more dynamic integration between Telcos & other businesses, developers. This paper discusses technologies to construct hypermedia APIs and how they benefit platform based models through an illustration.

Introduction

In the digital ecosystem, Telco's are constantly fostering new services, creating dynamic partnerships with various north

bound partners (vertical industry partners, OTT partners, IoT) and southbound partners (Network Function providers, cloud providers, Infrastructure providers). Increasingly API becomes common

currency of transaction among players. Telco APIs are used alike by various Telco/ non Telco partners, 3rd party developers, to create innovative offerings to the consumers.



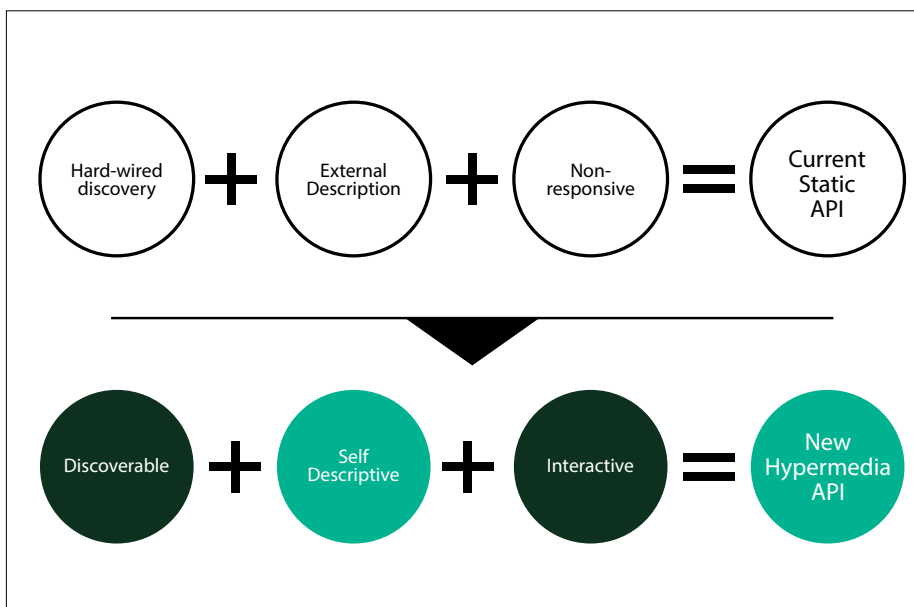
Standardized APIs are common currency in the platform based two sided business models of Digital economy. TMF Open Digital API program provides a set of standard REST based APIs that enable rapid, repeatable, and flexible integration among operations and management systems. The TM Forum API Ecosystem is a family of APIs, making it easier to create,

build and operate complex innovative services. (Source: www. tmforum.org). While these APIs provide a standardized way of communication between consumers and providers, still there is a significant extent of manual effort, hard wiring the integration. Any changes made to the API by the provider, will break the integration unless all the consumers also

change. We understand that such changes in the APIs are unavoidable and evolve over a period of time. So, to truly make it easier for consumers of the APIs to adapt to this dynamically changing environment, the approach for building the API needs to be transformed.

APIs need to have the following characteristics:

- **Discoverable** – The API needs a simple Entry Point (home-page) which allows Clients to interrogate the API and discover its capabilities.
- **Self-Descriptive** – API needs to describe its own context by defining the vocabulary.
- **Interactive** – API needs to describe further interactions that can be performed and provide linkages to other related data.



These characteristics on the API will enable the transformation of the interaction in the digital ecosystem from its current static, non-responsive and brittle nature to a more flexible, loosely coupled way.

Approach using Hypermedia API

Hypermedia is a generic term applied to applications that gives flexibility to the user to navigate through the documents according to users' choice, just like hyperlinks on a webpage do. The next-generation API approach take

these concepts to make these not just read-only sources of data, but interactive APIs where you can create, update and otherwise interact with the data. In order to create APIs which are machine readable, discoverable, self-descriptive and interactive, this paper proposes an extension of TMF APIs using the below

Hypermedia technologies.

JSON-LD combined with Hydra core vocabulary and Schema.Org provides the mechanism for building Hypermedia Web API. Refer to our submission to the TMF API project, for a detailed approach to [Build Hypermedia extensions for TMF APIs](#).



JSON-LD (JSON for linking data) - Organizes and connects the data in JSON by linking the data



The Hydra Core Vocabulary provides a common vocabulary for communication between clients and servers



schema.org

Schema.org provides common vocabulary for structured data on the internet

Telco product catalog use case benefiting from Hypermedia web API

In the fast moving digital world, products need to be created and deployed in days rather than weeks and months. Often the products/ product bundles are created out of Telco and non-Telco resources. The possibilities of products are endless with IoT, content, OTT partners. In this fast pace growth, enabled through API led integration, there is no time for developers to understand the APIs of providers and frequently modify the code as demanded by API providers.

While integrating using standard APIs has been an option, the following situations demand querying the provider in real time and actionizing the next step based on that. For example, the following scenario of Telco offering products in the marketplace with SaaS / IaaS partners.

- Some products will be offered with

certain pre-requisites or base products. For example, for offering IaaS solution, connectivity from customer site to the cloud infrastructure could be a pre-requisite.

- Some products can be offered with a combination of other products. For example, an SME requiring Office Essentials can be offered a bundle consisting of Office365, additional Storage and network connectivity.
- Products are composed of parts which are provided by different partners. In the above Office Essentials, Telco offers the core connectivity product, resells Microsoft's Office365 solution and the storage could be provided by a 3rd party vendor.

A marketplace where the Telco is selling its core products along with the offerings from its partners would benefit immensely by adhering to the Hypermedia API as it enables standardized machine readable

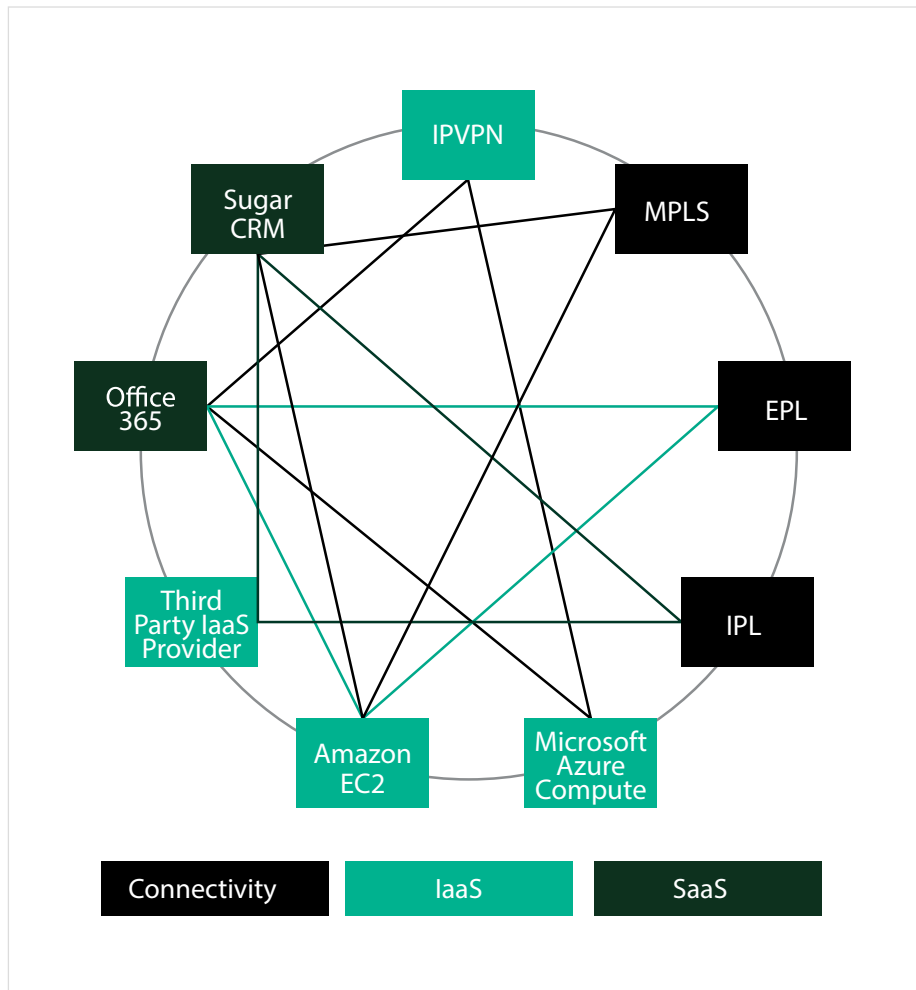
format (using JSON-LD and Schema.org) in which all partners can expose their products, related linked data and operations (using Hydra core vocabulary). Any change done by any partner can be absorbed with minimal change during implementation. The diagram depicts complex product bundles based on different Connectivity, IaaS and SaaS solutions. Pricing models and revenue sharing models are defined by each of the partners and such specifications are agreed with Telco.

Traditionally this model will require pre integration among partners. Telcos construct the VPN Product Offer with the products from Telco Catalog and integrating with Partners catalog. Any change in any of the product construct will require change in the associated parties' systems. In addition, any associated products to the core product cannot be dynamically retrieved

The benefits of using Hypermedia APIs are described below:

Standardized machine readable APIs – All partners adhere to standardized machine readable API. Hence, combining these products spanning across partners is easy. Any changes done by any of the partners in their offering will be available to the consumer. In the above example, suppose the IaaS partner updates the Microsoft Azure product offers, the Telco consumer using the Hypermedia API services provided by IaaS partner would not need to change and it would be automatically available.

Linked Data – In the real world, Product offer data entity is related to other products and offers, pricing models etc., However it is not realized in the current IT systems in a simple way. It is not possible for the consumers of product offering API to query and understand it on the fly. Linked Data technologies such as JSON-LD make such navigation possible. Entities related to core product offer such as - related offers, bundled product offers, pricing models, product specifications etc.



can be traversed from the core product offer. Applications built using Hypermedia API can easily traverse through this data as and when it gets linked to the core product offer API. In the above example, additional offers on SugarCRM at later point and the same could be traversed easily without any changes in Telco consumer systems.

Linked Operations / Interactive API -

Operations such as Eligibility checks on product offers, place order for the offer can

be embedded in the API itself. All required data to perform these operations will be defined in the vocabulary of the API and the consumer of the API can get this data from the end user. Any changes in the data required for these operations or any addition or deletion of operations can be seamlessly handled by the consumer as these changes will be reflected in the API vocabulary itself. For example, when an end consumer orders a bundled product (say IPVPN, Microsoft Azure), the Telco

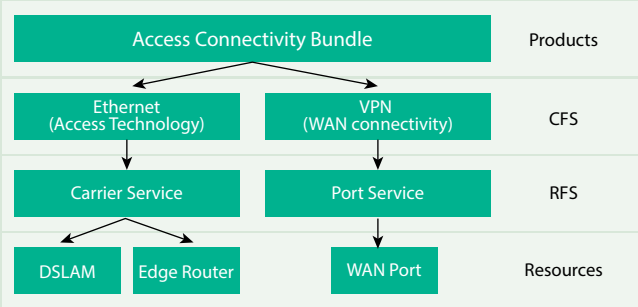
consumer system would automatically trigger the operations provided by the partner Hypermedia APIs to place the order.

Because of the above benefits, addition of new product offer, new partners and their product offers or modification of product offers and related information can be handled seamless with minimal changes in the implementation of the API consumer.



Other Telco usecases that can benefit from Hypermedia API

In the table below we attempt to capture a catalog of use cases that could benefit by using Hypermedia API. We capture these use cases at a high level across customer journeys.

Journey	Use case & Description
Catalog to Catalog	<p>Typically Telco's have three kinds of catalogs. Product Catalogs where product offerings, associated bundle information, pricing and eligibility rules are stored. Service Catalog stores the service data which is used by ordering or CRM systems to break down the commercial order to service components. Resource catalogs comprises of resources and associated provisioning templates. The dependency and association among these catalogs can be built in the catalog APIs in the form of Linked Data enabled by JSON-LD.</p> 
Request To Quote	<p>Simplify CPQ process by dynamically querying offers, related offers, price and validity information The overall quotation process can be simplified by dynamically querying the product catalog and its offers. Cross-sell, up-sell and other related offers can be shown to the customer to enhance the experience. This can be very easily achieved by using the concepts of linked data provided by JSON-LD where the Product offer can be linked to various other offers. Using Hydra core vocabulary, operations can be embedded in the core offer API:</p> <ul style="list-style-type: none"> • Mechanism to perform eligibility checks on Offers can be embedded in the Offer API itself enabling intelligent user experience to be built based on the Hypermedia APIs. • Quote API can have an Approval function embedded to enable digital touch with the SME and Retail customers, where typically dedicated Account Executive are not aligned with the customer.
Order To Activate	<p>Track Service Delivery Status Service Provisioning Request placed in the Fulfillment system generates an instance of the Service which can be shared for tracking the Service Delivery Status. With Hypermedia API, operations to track the delivery status of the Service and progress of the provisioning tasks can be part of the Service API. On similar lines, the delivery status of the Commercial Order and the Service Order and its various subcomponents can be embedded in the core API to enhance the overall Service Delivery Experience.</p> <p>Such operations to track the delivery status of the Commercial Order, Service Order or Service can be embedded in the Order APIs. The GUI layer can be intelligently built based on the Order API to receive appropriate inputs (Order ID, Service ID etc.) so that the status of the entity can be retrieved by invoking the embedded API.</p>
Trouble To Resolve	<p>Hypermedia enable the Incident reporting and triage process. With the emergence of SDN, the overall incident reporting and triage process can be eased by embedding the SDN functions (APIs) on the network elements into the Resource or Service API. This will assist Service Desk perform diagnostics enabling them to provide useful incident related information to L2 / L3 support. This will lead to an efficient ticket resolution and an early restoration of the Service ensuring SLA adherence and enhanced customer experience.</p> <p>Hydra core vocabulary can be used to dynamically embed the above operations in the Resource APIs for resources where such test and diagnostics functions are API enabled.</p>
Usage To Payment	<p>Provide additional information for Billing Customers' require breakup of charges (usage, once-off and recurring) in the Invoice.</p> <p>With Hypermedia, related information (usage data, contract information) can be embedded in the Invoice Details API using the JSON-LD concept of linked data. The Invoice API itself can also have some embedded functions like raise billing disputes, make payments against the invoice etc. which can be embedded in the invoice API using the hydra core vocabulary.</p>
Request To Change	<p>Embed Change Management functions on the Customer Services Service entity exposed to the end consumers can be enhanced using Hypermedia to enable Request to Change functions like placing a MAC Order or a Terminate Order on the Service.</p> <p>Hydra core vocabulary provides the mechanism to make the above enhancement to the service API.</p>
Performance management & Service impact analysis in SDN/NFV	<p>Monitoring in SDN/NFV solutions need monitoring on many layers including dynamic and fluid Virtual layer and underlying physical infrastructure. While some of the management information about hardware can be gathered via SNMP, more context about virtual functions, inventory, topology data is available only through APIs. This demands upstream Fault and Performance monitoring to systems rapidly develop and manage API based integrations with the VNF Managers. The integration costs will be high and time consuming, should the APIs change often.</p> <p>In order to understand dependencies and service/customer impacts in highly dynamic and elastic environment, the navigable/ interactive APIs will be of utmost use in avoiding integration costs.</p>



Conclusion

Hypermedia approach is a step towards making the web API dynamic in nature. Exposing Telco APIs in Hypermedia format makes it less brittle and allows the consumer of the API to understand the semantics and interactions in a machine readable format. With Hypermedia API the semantics of the web API or any changes made to it by the provider is embedded in the API itself. This enables, the consumers of these APIs who could be resellers, 3rd party App Developers or other partners dynamically create new value added mash up for the data and services. These APIs form the global currency in the telco platform based business models in the Digital economy.

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