TM Forum Technical Report

Management Platform Blueprint and application to Hybrid Infrastructure

TR262

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Executive Summary

This Platform Blueprint outlines the key business challenges for implementing agile management solutions and has defined a common management platform model that can be applied to Customer, Product, Service and Resource Management. The Management Platform approach to agility is based on automation of Business Process Framework Operations, Strategy and Enterprise processes realized through Platform Capabilities that are realized using OPEN APIs according to a set of best practices proposals.

The normative specifications for realizing the required platform capabilities are stated in Appendix B.

This blueprint references additional specification documents - mostly in the TMF070, TR263 and TR255 Series - that defines how to implement the management of Hybrid Infrastructure Platform that supports automation of Multi-vendor, multi-technology and hybrid physical and virtualized network capabilities.

1. Introduction

1.1. Business Drivers

Agility

The main business drivers behind Management Platforms and Hybrid Infrastructure Platforms are to increase Operational and OSS/BSS agility through automation, whilst simultaneously lowering costs, especially the integration cost of new resource infrastructure technologies.

The scope of the required automation goes beyond the current BSS /OSS industry vision of automation of operational processes (especially those supporting customers) to include automation of product and service lifecycles, automation of on boarding of network functions and applications, and automation of integration with enterprise processes for security and risk management. Whilst this seems like a ' big ask', Over the Top Operators (OTT) have already embraced Agile and DevOps approaches which deliver these capabilities today and at scale - so there is huge business pressure to catch up with the state of the art from competitors.

Virtualization

An enabler for this agile transition is the growing interest in the use of virtualization and cloud native computing approaches for delivering network services/ applications (used in a more general sense than the ETSI NFV definition of Network Service).

Some business benefits of virtualization include reduced time to market (RTM) by reducing time consuming physical infrastructure installation, and increased agility in creation, composition, and orchestration of networks services (e.g. NaaS) to support a wide range of e2e Network Service requirements, such as those advanced by the NGMN 5G white paper.

Transformation and Platforms

Agility requires that network functionality is designed with agility and automation in mind, and that the Business Support Systems (BSS) and Operations Support (OSS) for Networks and Service Operations are also designed for agility. Many service providers are thinking in terms of transformation of their current BSS/OSS systems into a more agile IT environment, often based on Cloud Native Application principles. This requires a re-appraisal of how network and other resource technologies are integrated with the *'Operations Center of the Future' (see IG1144 Operations Center of the Future)* using *'Future Mode of Operations'* (see IG1118 OSS / BSS Futures). There are also opportunities for use of new approaches to management including intent management, use of closed control loops and emerging technologies such as AI/ML and big data analytics and Policy management.

The implementation approach in this Blueprint is based on the notion of *Platforms* described in the next section. The Platform approach has been adopted and implemented by several service providers, demonstrated in numerous TM Forum Catalysts over the last four years to manage the transformation of current BSS / OSS by reduce systems complexity and improving business agility. The platform approach solves the need for progressive transformation that requires simultaneous operation of hybrid legacy and new OSS systems and hybrid physical and visualized networks.

Moreover, concrete financial and operational evidence of the benefits of a Platform approach have been published in TM Forum Action Week Key notes in 2016 and 2017.

The focus in this version of TR262 has broadened from solely a Resource Management Domain Viewpoint to embrace Service Management and Customer / Product Management. The reasons for this change of scope in R17.5 are twofold:

- Some resource management activities such MEF Carrier Ethernet services [MEF] and nascent work on 5G User Stories IG1152 are positioned in both the Service Management Domain and the Resource Management Domain.
- 5G business scenarios in IG1152 require products to be exposed between partnering organizations across B2B APIs. This results in the design and implementation models having to address Customer, Product and Service Domains.

Fortunately, the Platform concepts advanced in TR262 R17.0 were extensions of member activity on use of platform concept for BSS and OSS e.g., Management Platforms, and for platform/ecosystem based business models - so it is possible to model these more complex solutions using a uniform, implementation proven, design paradigm which is defined in IG1157 Digital Platform Reference architecture R16.5 and realized by available TM Forum OPEN APIs.

Hybrid infrastructure Platforms

The Hybrid Infrastructure Platform (HIP) applies the platform concept and catalysts learning to Resource Management Domain, thus:

- Reducing time to on-board new technology
- Enabling innovation and differentiation from suppliers.
- Whilst reducing integration friction (cost / time) in adopting new technologies.

HIP adds a set of additional design principles and best practices to those for general Management Platforms that address: orchestration, Publication /discovery Lifecycle and enterprise management processes; and careful separation of Vendor Neutral and Technology Neutral aspects into distinct Management Platform Capabilities to realize software best practices such as isolation, cohesiveness and modularity needed for agile DevOps based operations. See sections 4, 8, 9 and 11.

The use of platforms for Platform based Business Models is described in Appendix A and the Digital Platform Reference Architecture (DPRA) in IG1157 DPRA White Paper.

Network Function Virtualization (NFV)

Work in ETSI NFV has focused mostly on the agility aspects of virtualization infrastructure management for Network Function Virtualization, rather than functional management of NFV applications and have assumed that the integration will be with current Operations Support Systems (OSS) using traditional mechanisms and interfacing principles.

IG1161 Parts A, B and C and TMF070C explore the relationships among: the agility business challenges, integration of multiple network technologies; virtualization, use of Management Platforms and Open APIs; and the current scope of work in ETSI NFV and its relationship to HIP.

1.2. Purpose of the document

This document provides a blueprint and complete guide for constructing Management Platforms including Resource Management Platform Aka Hybrid Infrastructure Platforms(HIP) that allow service providers to rapidly on-board network and communication resources and application services – especially those based on software, virtualization and cloud native infrastructures such as NFV, SDN and 5G – into the operational environment of a CSP including:

- Integration with legacy deployed communication resources;
- Operational processes for delivering and maintaining customer services;
- Lifecycle management processes for on boarding and enhancing resources;
- Management of the operational Platform environment and systems themselves.

Management Platforms and HIP leverage the benefits of a platform based approach and exhibits the following characteristics:

- 360-degree integration with all the Operations Value Streams that need to be performed by an operator to acquire and operate a hybrid network and other resources.
- Integration and interoperability of heterogeneous multi-technology multi-vendor and multi-operator solutions.
- Support for Intent-based management of networks services with defined Service Level Agreements(SLA) / Operational Level Agreements. (OLA).
- Composition of network services from different layers/domains of abstraction.
- Support layered and distributed orchestration and policy-based management.
- Built-in security.
- Implemented using TM Forum Open APIs, information and data models.

Whilst the HIP platform focus is on resource/infrastructure management much of the approach can be applied more generally to the Operations Center of the Future Management Platforms.

It defines and specifies the Platform Capabilities required to realize Management Platforms, including Hybrid Infrastructure Platforms, and how the Open TM Forum APIs are used by Platform Capabilities.

For R17.5 Release the focus has been to support operations processes for intent-based management of hybrid networks and network services, and to set out the technical specifications for the Operations Platform Capability and Open APIs in TMF070A Hybrid Infrastructure Platform (HIP) Implementation and Deployment Blueprint R17.5.

1.3. Contents of Document

This umbrella document provides an overview and pointers to other more detailed specifications needed to realize Management Platforms and HIP. The main parts are:

- **Section 2 Platform Architecture and principles** summarizes the platform concept developed in Platform Workshops (2016-2017) and how the resulting IG1157 DPRA R17.0 material is applied to Internal OSS BSS solutions and their evolution.
  It describes the concept of a Platform as a SP governance boundary around groups of software components / systems (including vendor and Open Source defined components) that support standardized Platform capabilities for integration and orchestration.
- **Section 3 User Stories and Requirements** summarizes the main User requirements that Management Platform needs to address. It points to the specific User Stories developed in a number of earlier releases (mostly but not limited to TR229 and TR229A).
- **Section 4 Requirements and principles** (which go beyond user requirements to address design and some implementation requirements) It points to the overall ZOOM project requirements.
- **Section 5 Catalyst Hybrid Infrastructure Platform examples**. Summarizes the results of four catalyst proof of concept implementations (out of about 10 catalysts) that led to the formulation of the core requirements and principles in section 4
  - Use of closed control loops, use of platforms, Autonomic management components, policy based management and interoperability through use and adaptation of general purpose TM Forum Open APIs.
  The final example is based on how to combine these concepts to realize TM Forum HIP and MEF management interfaces.
- **Sections 6 Platform Capabilities** outlines the way that User stories and stakeholders are used to define Platform Capabilities which are informatively defined in Appendix B.
- **Section 7 Deployment and implementation consideration and next steps**
- **Section 8 Extended Platform Principles.** Principles that are yet to be documented in IG1157 but are necessary for Management Platform.
- **Appendices** A number of appendices on which ***'Appendix B: Platform Capability Definitions for Management Platforms and HIP R17.5.0'*** is the most important as it provides the normative references to other specification documents for implementation and compliance to the Management Platform principles outlined in this document. Interoperability specification are based on TM Forum Open APIs.

1.4. Document Map References

This document is an umbrella document that provides an overall blueprint to realize Management Platforms and specifically Hybrid Infrastructure Platforms, and leverages both best practices and standards that are captured in the following specifications:

- Add Document map
- TR229A User Stories for Hybrid Network Management R17.0.0
- TR255 Resource Function - Activation and Configuration R17.0.0
- TR255A TR255 Resource Function - Activation and Configuration R17.5
- TR255B TR255B Specification Requirements for Resource Functions R17.5.0
- TR263 Deployment Integration patterns and Best Practices for HIP: Overview R17.0.0
- TR263A Coordination Terminology and Classification of Associated Problems R17.0.0
- TR263D Platform Security and Policy Management R17.0.0
- TR263E Context Management R17.5.0
- TR269 Onboarding Automation and Package Metadata R17.0.0
- TR274 Digital Services Reference Architecture Guide R17.0.0
- IG1118 OSS/BSS futures
- IG1137 Agile Transformation Suite R16.5.1
- IG1139 Business Rationale and Technical Overview for Orchestration and Autonomic Control Loops R16.0.1
- IG1141 Procurement and Onboarding of Virtualization Packages R17.0.0
- IG1144 Operations Center of the Future
- **IG1152** Dynamic Network Slices Management and Business Models R17.0.1
- IG1157 Digital Platform Reference Architecture Concepts and Principles R17.0.0
- **IG1161 An** Overview: Agile Intent-based Resource Management in Hybrid Environments R17.5.0
- **IG1161B** Business Overview: Agile Intent-based Resource Management (Orchestration) in Hybrid Environments with ETSI MANO exemplar
- **IG1161C** Technical Overview: Agile Intent-based Resource Management (Orchestration) in Hybrid Environments with ETSI MANO exemplar
- TMF070 Implementation and Deployment Blueprints for Hybrid Environments R17.5.0
- **TMF070A** Hybrid Infrastructure Platform (HIP) Implementation and Deployment Blueprint R17.0.1
- TMF070B TMF070B Advanced Platform Deployment Blueprints R17.5.0
- TMF070C TMF070C Relationships to External Architectures R17.5.0
- TMF071 Terminology for Zero-touch Orchestration, Operations and Management R17.5.0

Open APIs

- Add API Map

- TMF664 Resource Function Activation and Configuration API REST Specification R17.0.0
- TMF628 Performance Management API REST Specification R14.5.1
- TMF634 Resource Catalog Management API REST Specification R17.0.0
- TMF639 Resource Inventory Management API REST Specification R17.0.0
- TMF642 Alarm Management API REST Specification R17.0.0
- TMF649 Performance Threshold API REST Specification R17.0.0
- Add Service Ordering, Inventory and Catalogs (must be R17.5 as these are aligned with Design Guidelines 3.
- TMF641 Service Ordering Management API REST Specification R16.5.1
- TMF638 Service Inventory Management API REST Specification R16.5.1
- TMF633 Service Catalog Management API REST Specification R16.5.1
- TMF662 Entity Catalog Management API REST Specification R17.0.0

Note: This list (with one exception) provides the definitive reference URLs to the documents referenced elsewhere in this document and will be updated with each major release. The exception is the URLs used in the normative references in Appendix B: Platform Capability Definitions for Management Platforms and HIP R17.5.0 which will be kept in step with minor releases especially of Open API specifications.

2. Platform Architecture and Principles R17.5.0

2.1. Platform Architecture and principles

2.1.1. Why Platforms?

Some important insights have emerged about the business context in which new networks, including those based on virtualization, and management solutions will be deployed:

- **Network and infrastructure Platforms:** The platform concept can be extended to include Network Services, and other infrastructure services such as Content Delivery Networks and Edge Computing implemented as Platforms which makes it easy for applications to consume and integrate infrastructure / resource capabilities. A Network Platform encapsulates and abstracts dynamically evolving combinations of multiple technologies and multiple suppliers - the so-called “hybrid network" - without the consuming application being aware of the internal details. The Action Week Keynotes from BT and Vodafone already use this concept of an abstract view of the underlying networks and technologies. The “BT and Oracle Collaborate to Make It Easier for Global Organizations to Move to the Cloud” describes a current example of the need for Network Platforms in multiple industry sectors, including IoT.
- **Management Platforms:** the concept of platforms can also be applied to Management where BSS and OSS systems are formed into well-defined platforms with exposed platform capabilities aka Business Services and this is the focus for the latter part of this document.

- **Orchestration, policy management and security built in**: Network Platforms using a set of service abstractions and intent based management as the model for achieving interoperability and integration/ composition of services from multiple suppliers, which supports the use of layers of multiple-orchestrators and policy management technologies which can evolve over time. And simultaneously avoids lock in to technology specific APIs for things like Orchestrators. Platforms form natural software defined perimeters around which enterprise security can be defined and organized - seeTR263D Platform Security and Policy Management R17.0.0

Transforming and rationalizing networks to align with a platform model also creates the opportunity for networks to be positioned as a set of 'Network as a Service' capabilities to support multiple industry verticals.

2.1.2. What is a Platform?

A Platform is typically made up of a number of systems, associated processes, Information and organization managed as a coherent unit to deliver a well-defined set of business/platform capabilities through simple to use Open APIs.

A Platform can be very small (exposing a single simple service, such as YO or Snapchat), or very large (exposing many diverse capabilities and services).

An example of the Platform approach is captured in the following diagram from BT.

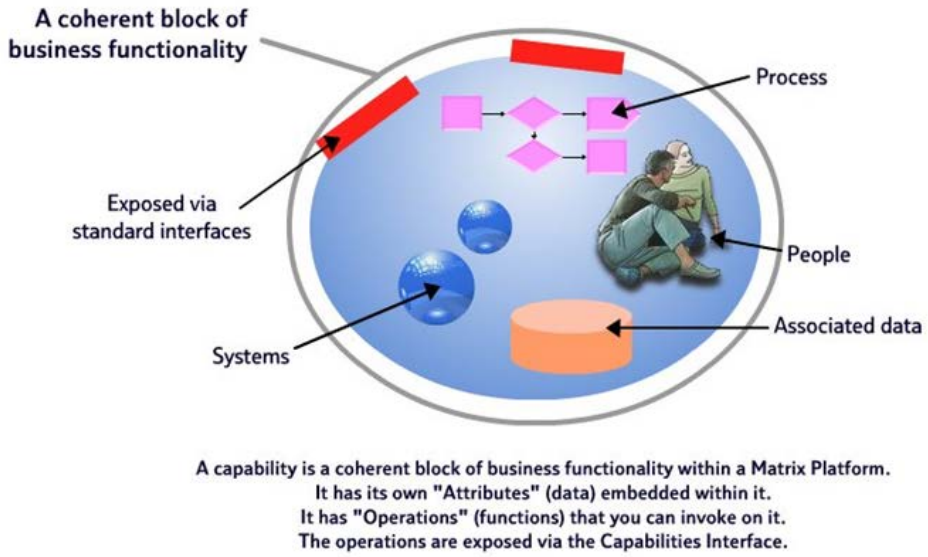

Figure 2-1 - Anatomy of a Platform

This diagram shows that a platform is a governance boundary that exposed one or more coherent blocks of business functionality - 'the What '- that are realized using a combination of systems, people, processes and information - 'the How '. Note that the systems' aspects are related to SoA and Micro-service concepts, but the platform concept goes beyond SOA technology. They also decouple consumers of the platform capabilities from the providers of platform capabilities which leads to modularity and isolation that are prerequisites for agile solutions. See TR 155 for the MIT Sloan Institute background behind this approach.

To help understand the recursive nature of platforms consider IBM BlueMix; it exposes Watson Analytics as part of its platform capabilities, however Watson Analytics can be exposed as a platform itself. It is this dynamic composability that makes the platform approach so powerful, and a major enabler for agility and re-use.

The Platform concept can be applied to both the functional service e.g. Snapchat, and Management Platforms which are the focus of this document.

2.1.3. TM Forum Digital Platform Reference Architecture

This section focuses on Platform characteristics relevant to Management Platform and Hybrid Infrastructure Platform realization, and provides an overview of Platform Architecture concepts developed in the Digital Platform Reference Architecture (DPRA):

IG1157 Digital Platform Reference Architecture Concepts and Principles R17.0.0

The main exclusions from the DPRA concepts in this analysis are Platform based business models:

- exploiting the network effect between consumers and suppliers
- the curation role between multiple suppliers and multiple consumers.

Since the primary focus of BSS/OSS Management Platforms is on single-sided models.

Platform Overview

As shown in Figure 1.2 a Platform is typically made up of a number of systems, information, processes, organization - and could include capabilities provided by people - managed as a coherent unit to deliver a well-defined set of business capabilities through simple to use Open APIs.

Platform concepts - the 'What'

The key concept of a platform is that it is a governance boundary that encapsulates Systems, People / Organization, Process and Information.

Platforms expose their capabilities through interfaces called Platform Capabilities comprising sets of APIs, and rules/constraints for using them in combination, that may be defined and governed by organizations themselves; and some - particularly the DSRA notion of Support Services - can be defined and governed by industry groups such as the TM Forum.

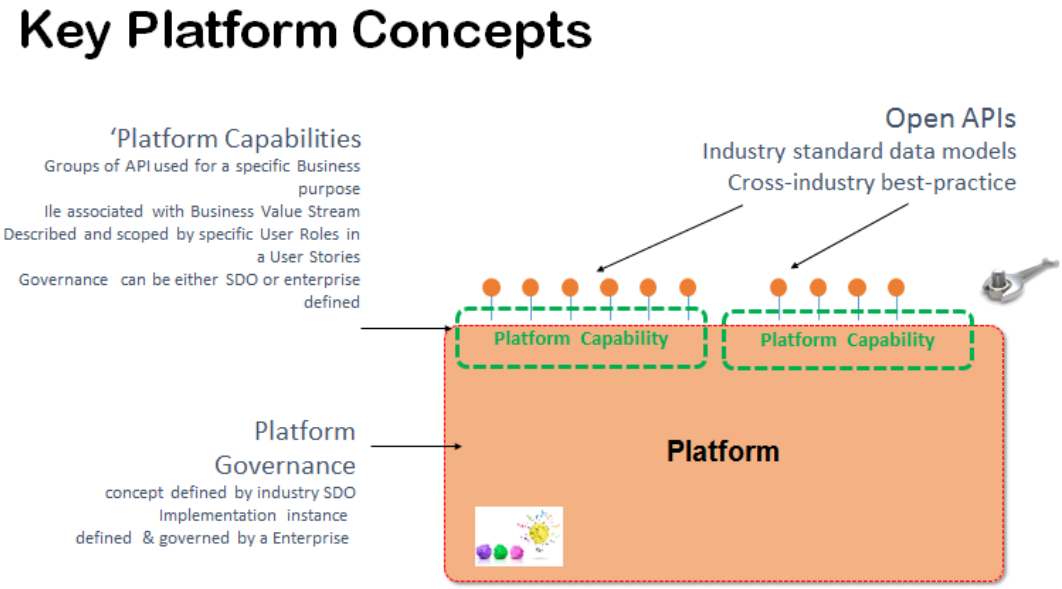

Figure 2-2 - Core Platform Concepts

As shown in the diagram above there are three key concepts relevant to Hybrid Infrastructure Platforms:

Concept	Description	Standards /Governance
Platforms:	Instances are units of deployment defined by enterprises using templates defined by Standards Defining Organizations (SDO), including the TM Forum. They are 'Black box like', can be Vendor/Operator specific, allow for internal evolution and innovation, and	Solely the Platform Templates, and Meta-models can be standardized. and instances of Platforms are a governance boundary set by an enterprise itself rather than a Standards Defining Organization.

Concept	Description	Standards /Governance
	whose implementation can be agile and flexible i.e. time varying.	
Platform Capabilities	Platform Capabilities are exposed by a Platform and are the units of integration used to create composed capabilities from multiple Platform Capabilities / Platforms. Platform Capabilities define the rules and best practices for using the combination of Open APIs used to realize them. Platform Capabilities Definition A coherent block of business functionality and operational patterns. • Are exposed or published in a catalog. • The units of composition and integration in developing a complex business service. This composition can occur within a single platform or across multiple platforms. • Encapsulations of Attributes (data) embedded within it on which you can invoke Operations (functions) that are exposed via open APIs. • Able to host tenant applications. • Specific Platform Capabilities may be governed by organizations themselves and some - particularly Utility Platform Capabilities - will be governed by industry groups. Examples being the emerging Cloud Native Services. • The primary means for supporting integration between separate platforms.	Platform Capabilities can be standardized by SDOs. Platform Capabilities satisfy a part, or all, of a business value stream and are used by business people to describe the required relationships between an Enterprise's Platforms.
Open APIs	Open APIs which are the units of interoperability that realize Platform Capabilities and can be conformance and interoperability tested.	Open APIs are standardized and governed by the TM Forum as well as other SDOs.

These key concepts provide a governance boundary that describe 'What' the Platform does but without mandating 'How' it is implemented. This allows for multiple

implementations to interoperate, including the wrapping of legacy solutions and their evolution towards a modern software component based architectures e.g. Micro-services, SoA and cloud native implementations.

Component software model - the 'How'

There are a few other observations about Platforms which also need to be considered within the Hybrid Infrastructure Platform.

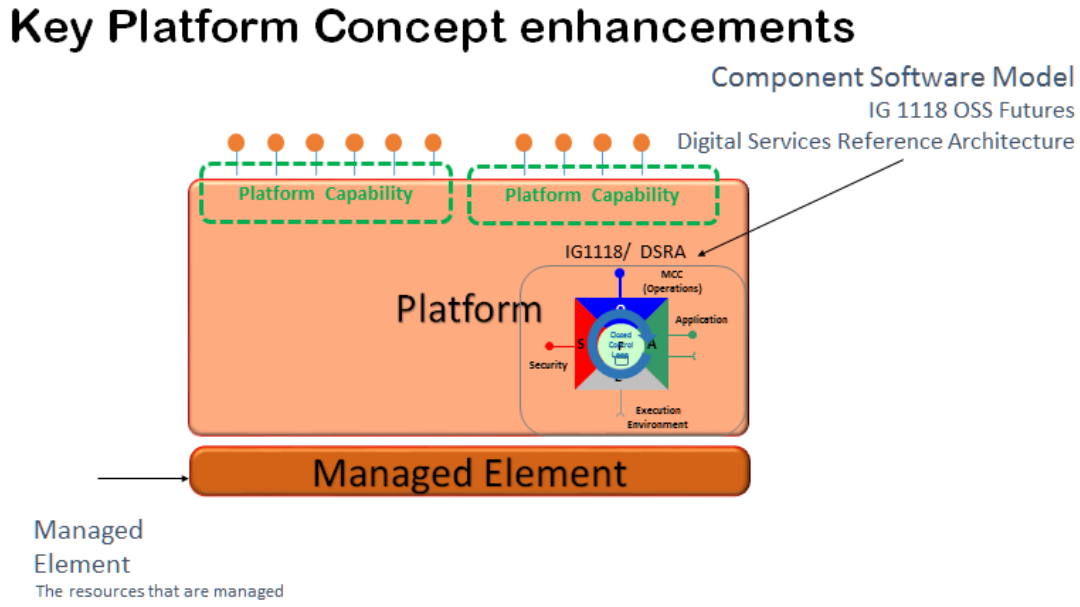

Figure 2-3 - Platform concepts to support Hybrid Infrastructure Platform

Two additional Platform related concepts are needed for HIP:

- **Component Software Models** Prior work on the Digital Service Reference Architecture and IG1118 has shown the need for component based models. The diagram above shows that a software component model and the compositions of component is one way that the systems within a platform can be realized.
- **Managed Components** are needed to model the raw resources that are managed and support management processes of: Assurance, Fulfillment, Charging, Policy Management. Examples include: voice mail service as described in the AT&T ECOMP white paper.

Section 7.3 explores the Component Software Model in some more detail.

Platform Concept extended to Networks

There are a number of extensions and additional principles needed to the Platform model described above for Resource Management Platform Aka Hybrid Infrastructure Platforms apprising both physical and virtualization network functionality.

These concepts are developed further in Section 4 Hybrid Infrastructure Platform Requirements / Principles.

Modeling principles that have to be evolved and aligned with Platforms

There are a number of modeling best practices needed for Management Platforms such as Hybrid Infrastructure Platforms that need also to be documented for general platforms as described in DPRA.

These include:

- How Platforms, Platform Capabilities and API metadata is published in a catalog and discovered and used by potential consumer of those Platform Capabilities,
- How hierarchies or layers of Platforms can be constructed and the rules for their use. Noting that networks will add additional layering principles,
- Component Software Models IG1118 and Managed Components,
- Use of Micro-services and Service Orientated Architecture (SoA).

An initial analysis of these extended principles is contained in Section 7.

3. User Stories for Management and Hybrid Infrastructure Platforms

3.1. User Stories to define and scope Platform Capabilities

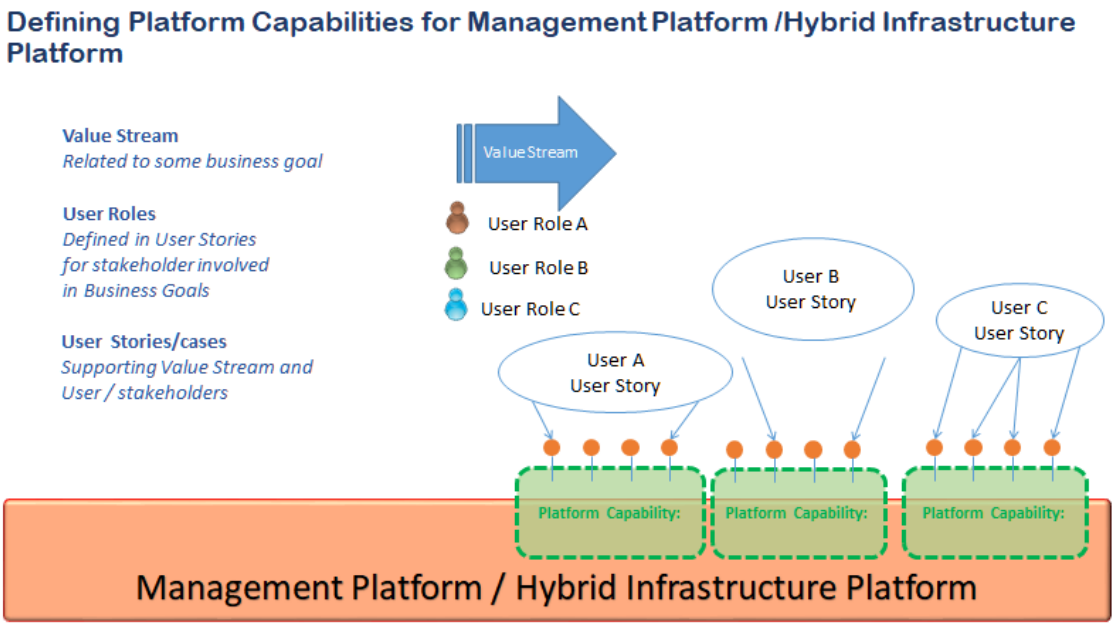

Figure 3-1 - Using Value Streams to define User Stories and Platform Capabilities for Management Platforms /HIP

User Stories for Management platforms and Hybrid Infrastructure Platform have been developed and documented in TR229A.

User Stories for Product, Service and Resource Domain management platforms to address multiple 5G enabled business models have been documented in IG1152.

The Figure 3-1 above shows the reasoning for developing these User Stories and how they are used to identify, define and standardize Platform Capabilities, APIs and Data Models.

- One requirement for Management Platforms and especially Hybrid Infrastructure Platforms is to support a set of Operator Value Streams shown as a blue arrow; these are recognized business objectives and activities.
- Value Streams naturally lead to the identification of Users / Roles or Actors that have responsibility for those Values Streams (shown as icons in the diagram above).
- Associated with each User are a number of User Stories that start at the value stream level and can be decomposed in to lower level specific User Stories / Use

Cases and requirements which can be used to identify which Platform Capabilities are needed to support each User Story. Examples have been published for 5G enabled business models based on IG1152.

- This approach creates traceability between Values Streams, User Stories, the specific Platform Capabilities needed for Management and Hybrid Infrastructure Platforms, and which can confirm completeness of the Platform Capabilities, and help rationalize them.
- Platform Capabilities are realized using Open APIs.

Note: individual generic APIs e.g. Federated ID, Events, Event and Data Streams may be used in multiple Platform Capabilities. A Platform Capability also defines context including the rules, constraints, profiles and best practices for using the combination of APIs that support it. API profiles may differ among Platform Capabilities; for example, one Platform Capability may permit create and delete operations of and API whereas in a different Platform Capability, these API operations may not be permitted.

Two types of user stories have been identified that impact Hybrid Infrastructure Platforms:

- Resource /Network Deployment related User Stories which define what kinds of resources and information models are required for Platform Capabilities and their APIs.
  These define organizational, operational and technology boundary requirements as described in Section 4.
- Management Function related User Stories which define what kinds of management operations are required for Platform Capabilities and their APIs. These also identify some platform architecture modeling practices and patterns such as Intent based Management supported by use of Closed Control Loops, Autonomic Control, Orchestration and Policy Management that influence the design of Platform Capabilities and their integration.

The examples used for this version of the document are listed in the next two sections.

3.2. Benefits of User Stories driving Platform Capability specifications

The separation of platform capabilities based on stakeholder and values streams facilitates:

- simplification of Platform Capability specification change management as each has a smaller number of business objectives aligned stakeholders driving changes
- development of reusable software modules within a Platform that have microservices/ interfaces that evolve solely to address a single stakeholder group;
- re-use of the same generic Open APIs in multiple capability deployments by use of profiles and context definitions (TR263E) thus avoiding the creation of unwieldy brittle interfaces that try to do everything.

3.3. User Stories: Network deployment related

Hybrid Infrastructure Platform Network Deployment User Stories are captured in TR229A Hybrid Infrastructure Platform User Stories and are summarized below:

Overview of Network User Stories:

- Software defined WAN - Microsoft example.
- Multiple Business models For operating 5G Network slides documented in **IG1152** Dynamic Network Slices Management and Business Models R17.0.0
- VPN example derived from the Nokia 7 steps example ZOOM-121
- A CDN example based on the Zoom R15-0 TR245.
- A Vodafone Use Case based on mitigating DDOS attack Video at http://inform.tmforum.org/strategic-programs-2/agile-business-it/2016/04/amdocs-and-vodafone-showcase-multi-vendor-nfv-demo-at-mwc-2016/
- Disaster Recovery example based on Ericsson KDDI discussion.

3.4. User Stories: Management Functions and Value Stream related

A number of Value Streams have been identified:

- Operations focused also referred to as Functional or Tenant Platform Capabilities
    - Fulfillment: Lead to Cash (Note: addition of billing requirements to this User Story is for further study but it is expected that usage events can be used).
    - Assurance: Trouble 2 Resolve including SLA management and Service Assurance.
    - Note: For intent based management the fulfillment process establishes he required outcome e.g., a sub network connection such as a RAN slice. and the associated SLA/OLA. The assurance process is then performance monitoring and thresholding crossing together with alarms on SLA jeopardy and breach. This approach is somewhat different from the traditional TMN FCAPS approach for detailed resource management and the benefit of this approach is that it allows for delegation of management (autonomic computing), implementation of HIP using Closed Control Loops IG 1128, layered orchestration IG1139, and policy based management TR263D.
- Lifecycle Onboarding and Planning focused also referred to as (functional) Platform Capability Management
    - Concept to Market, including Lifecycle, Procurement and Onboarding management.
    - Analytics and change planning including Continuous Improvement in Supply Chain, including Metrics Data Streaming and Big Data Analytics.

- Managing Enterprise Risk, including Security, Platform Administration, including orchestration and policy management. Also, referred to as Platform Management

The following additional User Stories to support these Value Streams have been captured in TR229A:

- Smart City Resource Onboarding User Stories.
- Procurement in Virtualization Transformation
- Service Management and Operations.
- Service Assurance and Continuous Improvement QA Processes.

3.5. Worked examples

TR255 has developed worked examples of the Resource / network modeling required to support HIP APIs.

TR263 is developing requirements for the HIP APIs operations (verb) sets that are required. A first example has been developed in TR255/ TMF664 for the 'Resource Function Activation and Configuration' API operations (formerly Entity Provisioning).

IG 1152 has developed two 5G enabled business models: one based on multi-domain single enterprise operations, and the second on multi-domain multi-enterprise operations.

4. Management Platform and Hybrid Infrastructure Platforms: Requirements / Principles

In setting up the ZOOM project a number of goals and principles were defined and are included for reference in Appendix E. These have influenced Section 3 User stories and this section.

4.1. Management Platform Requirements

1. A Set of User Stories covering the key business activities or Value Streams of an organization planning to use the Management Platform approach.
   The User Stories should cover a 360-degree integration with all the Value Streams that need to be performed by an operator to acquire and operate a Management Platform including Platform capabilities for:
   a. Operational processes for delivering and maintaining customer services;
   b. Lifecycle management processes for on boarding and enhancing resources within a Management Platform;
   c. Management of the Management Platform environment and included systems.
   d. Currently documented in TR229 and TR 229A
2. Definition of these Platform Capabilities (e.g. e2e ordering use of technical feasibility, resource ordering, resource function activation and configuration, etc. associated data model and context definition).
3. Minimum Viable Product scope (Fulfillment / Lead to Cash, Assurance / Trouble to Resolve, Concept to Market / Business Agility and in-depth exploration of at least Platform: onboarding, Continuous QA improvement in Supply Chain, Enterprise Risk Management covering Security, Platform administration including orchestration, policy management, and Billing / charging).
4. Initial focus e2e Service Management and Hybrid Infrastructure Management (HIP) - next section.
5. Support layered and distributed orchestration and policy based management. IG1139 TR263D.
6. Support vendor innovation in technologies such as Artificial Intelligence/ Machine Learning((AI/ML) and Big Data Analytics.
7. Built-in security for Platforms and Platform Capabilities. TR263D.
8. Platform capabilities Implemented using TM Forum Open APIs, information and data models. This document Appendix B.

4.2. Additional Hybrid Infrastructure Platform (HIP) Requirements

The additional requirements on the Hybrid Infrastructure Platform are:

1. A set of User Stories addressing the business activities or Value Streams for hybrid Infrastructure supporting multiple technology domains and viewpoints:
    a. Vendor specific, network domain technology specific
    b. Vendor independent, network domain technology specific
    c. Vendor independent l and network domain technology independent.
2. Integration and interoperability of heterogeneous multi-technology multi-vendor and multi-operator solutions
3. Application of requirements in section 4.1 to Hybrid Infrastructure Platforms that manage combinations of legacy physical networks and virtualized /cloud native network applications.
4. Support both detailed and intent based management based approaches to managing these domain viewpoints for hybrid physical and virtualized networks as described in **IG1128** Dynamic Control Architecture for Managing a Virtualized Eco-System R16.0.1
5. Support for Intent-based management of networks services with defined Service Level Agreements (SLA) / Operational Level Agreements. (OLA).
6. Composition of network services from different layers/domains of abstraction.
7. Deployment scenarios: From the Network User stories identify a set of deployment scenarios identifying where Hybrid Infrastructure Platform boundaries are needed that coincide with the deployment of organizational, operational and technology boundaries. These should identify the network service / resource models that Hybrid Infrastructure Platforms need to expose in each of these deployments. Primary focus is User stories in **IG1152** Dynamic Network Slices Management and Business Models R17.0.1
8. ~~Tracking of APIs used in realizing these Platform Capabilities for traceability.~~
9. Review these requirements with team
10. ~~Contribution to generic Platform, Platform Capability and API principles and templates e.g.~~
    a. ~~Platform, Platform Capabilities, API templates and meta-models.~~
    b. ~~Platform models / patterns for use of catalogs to support publishing, discovery and binding with Platform Capabilities, Platforms and APIs.~~
    c. ~~Platform approach to defining hierarchies / layers / dependencies.~~
    d. ~~Platform Management covering Security and administration.~~

The remaining sections focus on *Service Management and* Hybrid Infrastructure Platform examples and by example identifies general principles that apply to Management Platforms used in Customer, Product, Service and Resource domains.

4.3. Management and Hybrid Infrastructure Platform Principles

This section captures principles that are needed to extend the general Management Platform model to support Hybrid Infrastructure Platforms.

There are two distinct groupings of principles:

- Network: Those principles necessary to describe and model hybrid network deployment scenarios, and result in composable network service models.
- Management Functions: Those necessary to identify the Management Functionality and their grouping into Platform Capabilities / APIs needed for Hybrid Infrastructure Platforms.

4.4. Platform Concept extended to Networks

4.4.1. Overview

One of the most straightforward examples of applying the platform concept to networks has been elaborated in the following Vodafone MEF slide:

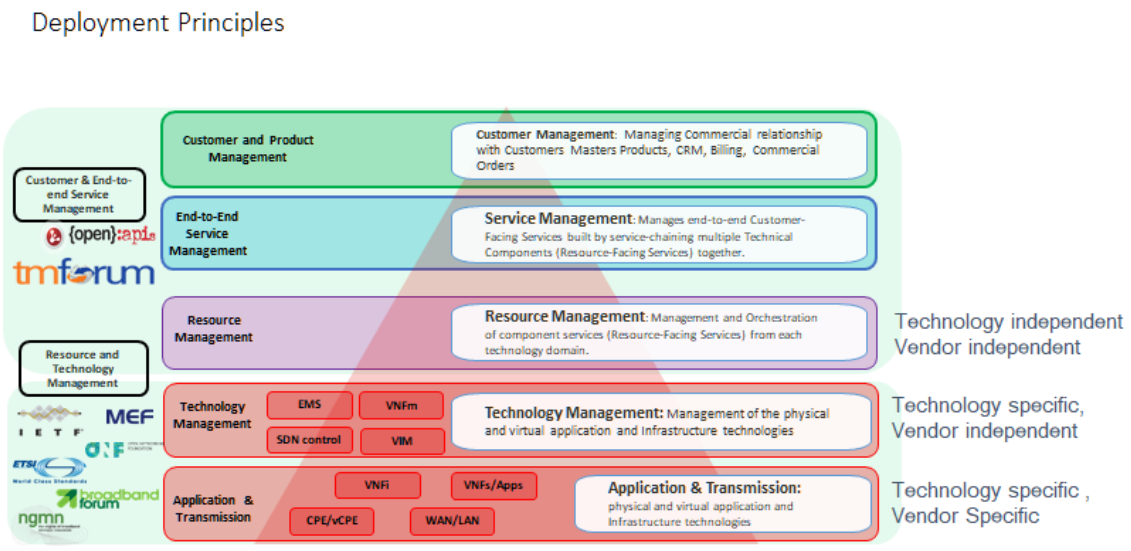

Figure 4-1 - Framework for positioning Hybrid Infrastructure Platform scenarios

This proposal observes that for the Service and Customer Domains that the TM Forum Open APIs are the implementation of choice.

It also proposes logically splitting the Resource Domain into Resource Management, Technology Management, and Application and Transmission Domains (see below).

4.4.2. The HIP Challenge

The challenge for these resource related domains is that there are a large and growing number of organizations defining standards in the form of interfaces and architectures. Moreover, they make independent technological choices, often disjoint from the main stream trends of the Cloud IT industry - which are increasingly dominant given the move to virtualization - and there is limited coordination of their work.

The consequences of these trends are that it is difficult for service providers to integrate standards from multiple technologies and standards organizations to create networking technology neutral models for communication and connectivity exposed as services at North Bound APIs from the Resource Management Domain (Resource Facing Services RFS - in TM Forum Information Model Framework terms).

As a consequence, this creates implementation challenges for the Service Management Domain to expose Customer Facing Services based on Industry Information Models.

HIP addresses how the use of Platform concepts, and Open APIs based on TM Forum Information Models are used to resolve this practical challenge.

4.4.3. Features of Resource Management, Technology Management, and Application and Transmission Domains

The main features of this proposal shown in Figure 4.1 are to structure Network and Resources into three domains: Resource Management, Technology Management, and Application and Transmission.

- The Resource Management Domain exposes Resource / Network Facing Services using TM Forum Open APIs, e.g. Resource Ordering and Resource Function Activation and Configuration. These north bound communication and connectivity services need to be network /resource implementation technology neutral and modeled so that these services can be topologically connected across multiple providers and organizations. This is where an intent based NaaS management model must be defined and supported by autonomic closed control loop realization of a standard topology model (TR 255A Connectivity Patterns for Virtualization Management).
  Domain Managers within the Resource Management may be per vendor, per technology, or multi-vendor multi-technology depending on the deployment situation. These map from the technology dependent services exposed by the Technology Management Domains to the Resource Management RFS services.
- The Technology Management Domain exposes interfaces or APIs, using any of the SDO standards identified e.g. MEF, ETSI NFV Or-Vi / Or-Vnfm, or indeed TM Forum APIs e.g. TR255/TR664 Resource Function Activation and Configuration or proprietary Interfaces / APIs. The main requirement is that these interfaces have defined information models defining their exposed communication and connectivity services as without these it is difficult to concatenate networks and resources. Not all industry standard technology management interfaces support this requirement, and require adaption.
- Application and Transmission Domains may have APIs that are hybrids of Management Control and Usage planes e.g. ONE API SMS messaging which have embedded control or management see AT&T ECOMP White Paper example on SMS.

A challenge in describing and modeling the Network within the Application and Transmission Layer is that they can involve complex network layering which impacts the organization of the Technology Management structure requiring a dynamic and

flexible layering model which can be technology specific - for example under- and over-lay networks L2 over L3 among others. TR 255A Connectivity Patterns for Virtualization Management provides the patterns to achieve transmission layering.

Section 7 Platform Extended Principles provides some general principles for hierarchical layering of Platforms which can be adapted to network layering using the concrete user stories described in Section 3. User Stories for Management and Hybrid Infrastructure Platforms R17.5.0

4.4.4. Examples of Hybrid Infrastructure Deployments

A Platform based model for HIP has a simple design model for platforms (Platform, Platform Capabilities, open APIs) and what matters is how instances of Platform specifications are deployed and how they are configured when deployed.

These examples are based on the idea that platforms instances can be replicated as needed for each specific deployment circumstance, and they can be per vendor, per technology, or multi-vendor multi-technology and fractal – supporting aggregation / containment. These examples show schematically how the core HIP concept could be applied across domains at multiple levels, noting that exposed service for each variant at different level may have different information / data models but use similar or identical API operations e.g. Service/Resource Ordering, albeit with different profiles of the underlying APIs.

Examples of how HIP concepts can or were used in a number of TM Forum Live 2017 catalysts is shown later.

4.5. HIP Deployment Examples

Hybrid Infrastructure Platforms might be deployed in any of the following ways to satisfy the Layering requirements shown above.

4.5.1. General HIP deployment model

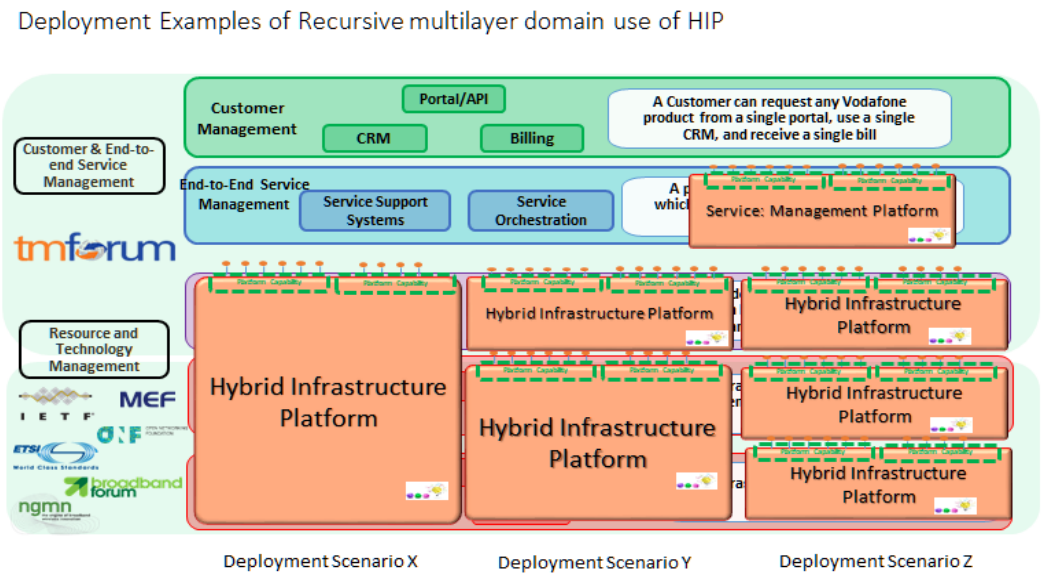

Figure 4-2 - Example Deployment Scenarios for positioning Hybrid Infrastructure Platform scenarios

The assumption which has been broadly verified in a number of catalyst projects is that a HIP can be deployed at multiple levels and that the platform capabilities are similar whatever the deployment i.e. the three types of platform capabilities and that the variation among Open APIs used in different deployment is mostly about variation in Data Models. Three general HIP deployment scenarios are shown which may be used individually or in conjunction with one another depending in part on the current legacy deployment situation within a service provider. These examples are not exhaustive.

- Deployment Scenario X (LHS) is where a Hybrid Infrastructure Platform envelops the three Resource Domains but solely provides TM Forum Standard Platform Capabilities and Open APIs North bound from the Resource Management layer. All internal inter-layer interfaces are either SP or vendor proprietary. This is typically the approach needed for integrating Legacy deployments.
- Deployment Scenario Y(center) is where Technology Management is exposed by one of more SDO standardized platform capabilities and APIs, which may be per vendor, per technology, multi-vendor or multi-technology. This shows how the core HIP concept could be applied at multiple levels noting that exposed services for each variant at different level may have different information / data models. e.g. ETSI NFV VNFM and VIM Interfaces; and differing API profiles.
- Deployment Scenario Z (RHS) The right-hand side example is where each Domain: Resource Management, Technology Management, and Application and Transmission; are each exposing SDO standardized Platform Capabilities and APIs. TM Forum is not focused on native Application and Transmission APIs e.g. SNMP, Netconf Yang, etc. but does support wrapping within HIP Platform Capabilities /Open APIs.

Typical SPs with current networks may find Scenario X the most practical starting point, since much of what is deployed uses proprietary interfaces and use of Open APIs and information models will make it simple to wrap legacy interfaces e.g. MTOSI / MTNM interface functions and information models.

For virtualized networks services and functions Scenario Y is preferred as a common NBI from the technology domain can be created for both legacy physical networks and their equivalent Virtualized Network Functions if the technology domain has SDO defined interfaces such as ETSI NFV Or-Vi Or-Vnfm.

Scenario Z is needed if there are specific Application and Transmissions APIs that need to be supported, e.g. ONE API SMS messaging which have embedded control or management.

Based on the idea that platforms instances can be replicated as needed they can be per vendor per technology, or multi-vendor, multi-technology and fractal – supporting aggregation / containment. This shows how the core HIP concept could be applied at multiple levels noting that exposed service for each variant at different levels may have different information /data models, and different API profiles.

The notion of Management Platform can be applied at the e2e Service Management layer that integrates across multiple resources and is described in TMF 070B Advanced Platform Deployment Blueprints R17.5.0. Specifications. This approach is illustrated in the Vodafone Ocean architecture presented at Action Week Live Lisbon 2017 below Check Vodafone are okay with this slide.

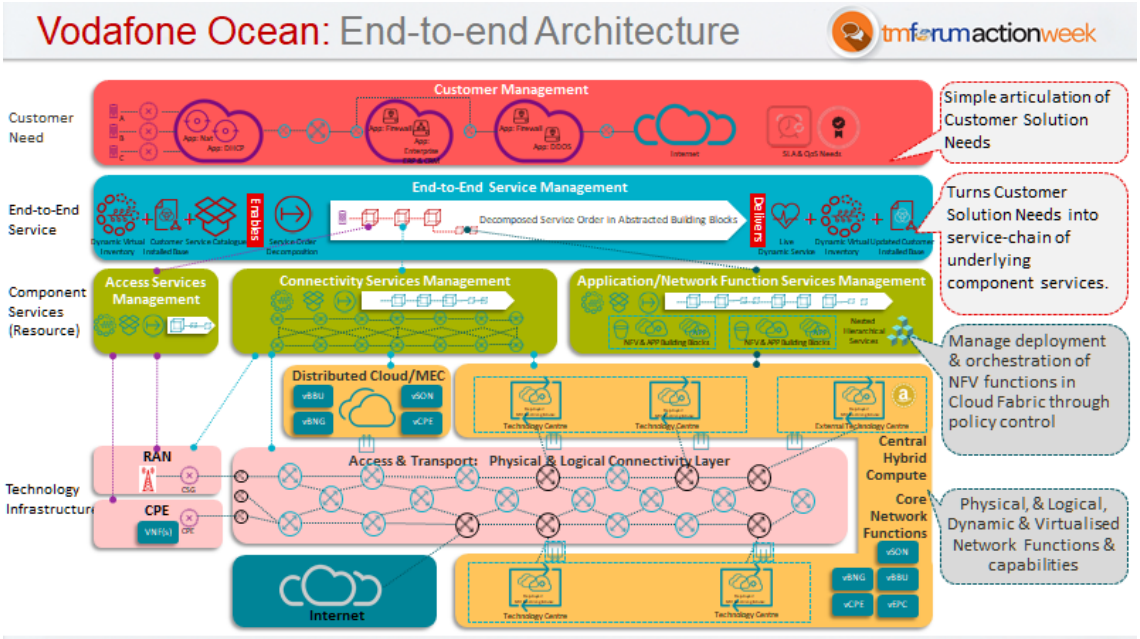

Figure 4-3 - Vodafone Ocean Architecture presented at Action Week Live Lisbon 2017

Note that the technology independent vendor independent aspects are integrated as component services into the E2E Service Management.

4.5.2. TM Forum Live Catalyst inputs

A number of catalysts projects at TM Forum Live 2017 and InFocus Dallas 2017 were used to establish and validate practical requirements for HIP Intent based Management.

The four topics of interest and the catalysts were:

1. Resource Function Activation and Configuration: Real Virtuality Catalyst
2. SLA and Alarm Reporting with scaling: 5G Service Operations- real time service assurance catalyst
3. Network evolution to Edge Computing: Smart City on the Edge catalyst.
4. Partnering Platform with MEF Services

Section 5 provides a more detailed analysis of these catalysts and the learning points that have been used to establish Management Platform and Hybrid Infrastructure Platform requirements and principles- especially Intent Based Management specifications described in this section

4.5.3. HIP enhancement Requirements

Network Modeling Requirements

The catalyst examples described above showed the areas where Section 3. User Stories for Management and Hybrid Infrastructure Platforms need elaboration to provide concrete guidance and definition of:

- Minimum Viable Product (MVP) TMF070 Hybrid Infrastructure Platform (HIP) Minimum Viable Product R17.0 (MVP) extensions to cover
    - Application of HIP to Service Management level
    - Lifecycle on-boarding and planning processes

    - Data models at the Service Management layer that reflect technical, operational and organization boundary requirements e.g. e-Access, e-Core, e-Transit, e-Lan, e-Tree, e-Wire for multi operator, multi- technology deployments.

- TR255A (IG1147) Connectivity Patterns for Virtualization Management R17.0.0 provides the MVP view of Network and Infrastructure Service models are for Platform Capabilities that allows composability of Network Service Models

Network layering

Section 7.2 Chapter 7 Platform Extended Principles describes the general approaches and concept for layering platforms, and was used to inform the User Story development for Network deployments.

Layered Orchestration and Policy Management

IG1139 Business Rationale and Technical Overview for Orchestration and Autonomic Control Loops R16.0.1 describes the notion of layering of orchestration/orchestrators and separation into domains. Platforms support the patterns described in IG 1139 if domains align with platform boundaries i.e. a Platform contains one or more Orchestration domains some of which may be orchestrating Close Control Loops / Autonomic Computing as described in IG1139.

The hierarchical organization of orchestration Domains can be supported by the hierarchical approaches described in Section 7.2 in Chapter 7. Platform Extended Principles.

TR263D Platform Security and Policy Management has extended the concepts in IG1139 for Orchestration domains to support policy management and security domains which have essentially identical requirements.

4.6. Modeling principles that have to be evolved and aligned with Platforms

There are a number of modeling best practices needed for Hybrid Infrastructure Platforms that need also to be documented for general platform principle applied to Operations Support.

These include:

- How Platforms, Platform Capabilities and API metadata is published in a catalog and discovered and used by potential consumers of those Platform Capabilities (see Section 8 Proposal)
- How hierarchies or layers of Platforms can be constructed and the rules for their use. Noting that networks will add additional layering principles (see Section 8
- Components and component composition models in IG1118, the Digital Service Reference Architecture (DSRA) and Managed Components
- Domains, their relationship to Security Policy and orchestration hierarchies and Platform Capabilities described in TR263 Part D Platform Security and Policy Management

4.7. Platform Management Functions and Platform Capabilities

A second group of User Stories in Section 3. User Stories for Management and Hybrid Infrastructure Platforms describe Value Streams or Business activities which define the 360-degree view of what Management and Hybrid Infrastructure Platforms should support.

The notion developed for linking Value Streams to User / roles and User Stories has provided guidance on what are the management functions that Platform Capabilities for Management Platforms/HIP must support.

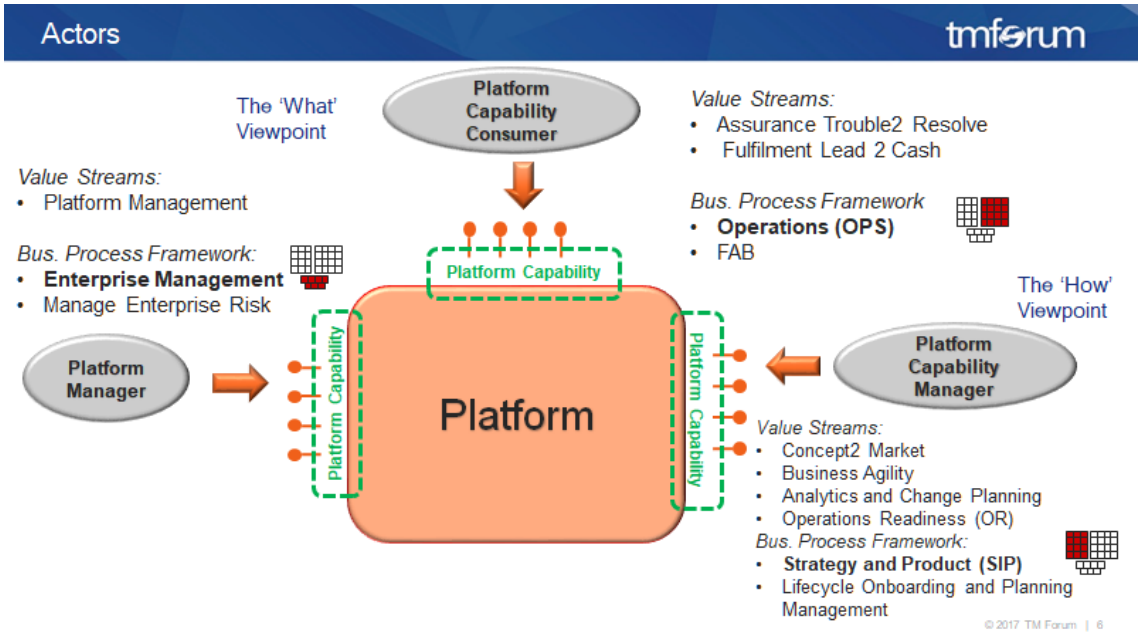

Figure 4-4 - Platform capabilities

Management Platforms have to simultaneously support three set of automation requirements

- Those related to Business Process Framework Operations processes support the Platform Capability Consumer,
- Those related to Business Process Framework Strategy and Product Processes support the Platform Capability Manager,
- Those related to Business Process Framework Enterprise Process support the Platform Manager

4.7.1. Value Streams

This approach is applicable to both Management Platforms generically and to Hybrid Infrastructure Platforms specifically

Using the approach proposed Section 3. User Stories for a Hybrid Infrastructure Platforms Release R17 has taken the user stories from many stakeholders (including TR229 TR229A, IG1152), the results of Catalyst projects from Nice 2017to created to the precise specification of the required HIP Platform Capabilities and Open APIs.

In Release 17-5 three Values Stream groupings have been identified that define reusable HIP Platform Capabilities.

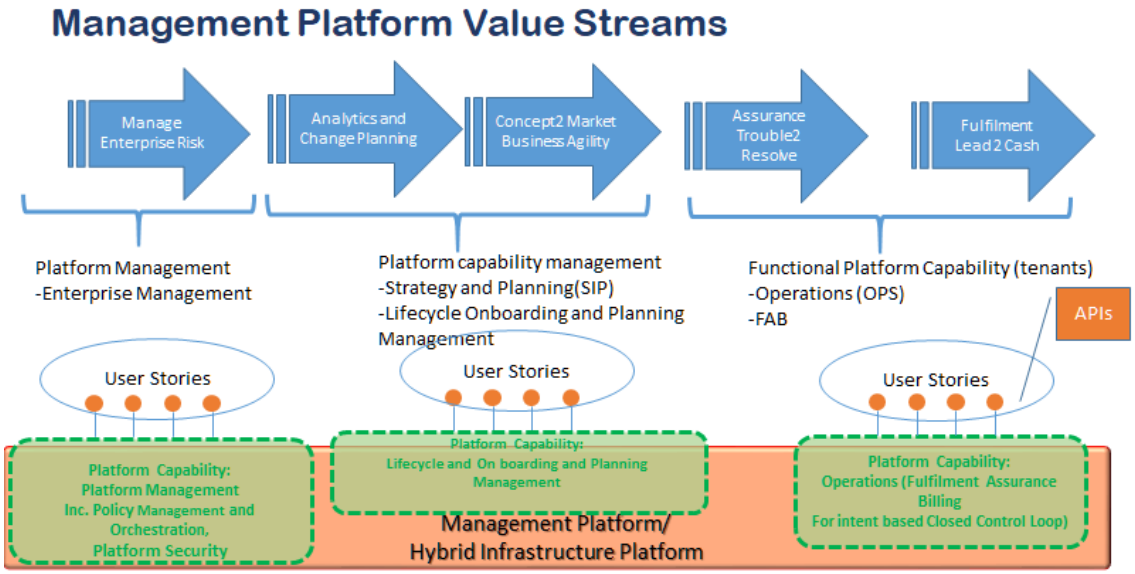

Figure 4-5 - Using Value Stream grouping of TR229A user stories to identify Management Platform Capabilities

These values streams are essentially those identified in Section 3.3. They fall into three macro level groupings which are the basis for scoping and defining HIP Platform Capabilities:

1. **Operations** (Business Process Framework Operations related) that support stakeholders using the HIP Platform features i.e. operationally managing individual customer tenant services on the HIP platform features (application or network) Functional Platform Capabilities
2. **Lifecycle, onboarding and Planning** (Business Process Framework SIP related) that supports stakeholders responsible for HIP platform features: lifecycle, onboarding and planning processes for the HIP platform component functions. It also including data streaming to support planning and change management processes. Platform Capability Management
3. **Enterprise Risk Management** supporting stakeholder responsible for managing HIP Platforms that are not HIP Platform specific, E.g. Platform security and policy management. Platform Management

These user stories have created a concrete set of Platform Capabilities and identified the required APIs and supporting Data and Information Models.

TMF070A Hybrid Infrastructure Platform (HIP) Implementation and Deployment Blueprint R17.0 has focused in Release 17 on the Open APIs and data model requirements needed to realize the Operations (OPS) Platform Capability.

Some elaboration of these Platform Capabilities is expected from further catalyst project, practical implementation experience, and collaboration studies on 5G, automated Onboarding and lifecycle management of virtual functions and platform management capability studies.

4.7.2. HIP Platform Capabilities

The user stories in TR229A were used to define Platform Capabilities for Hybrid Infrastructure Platforms:

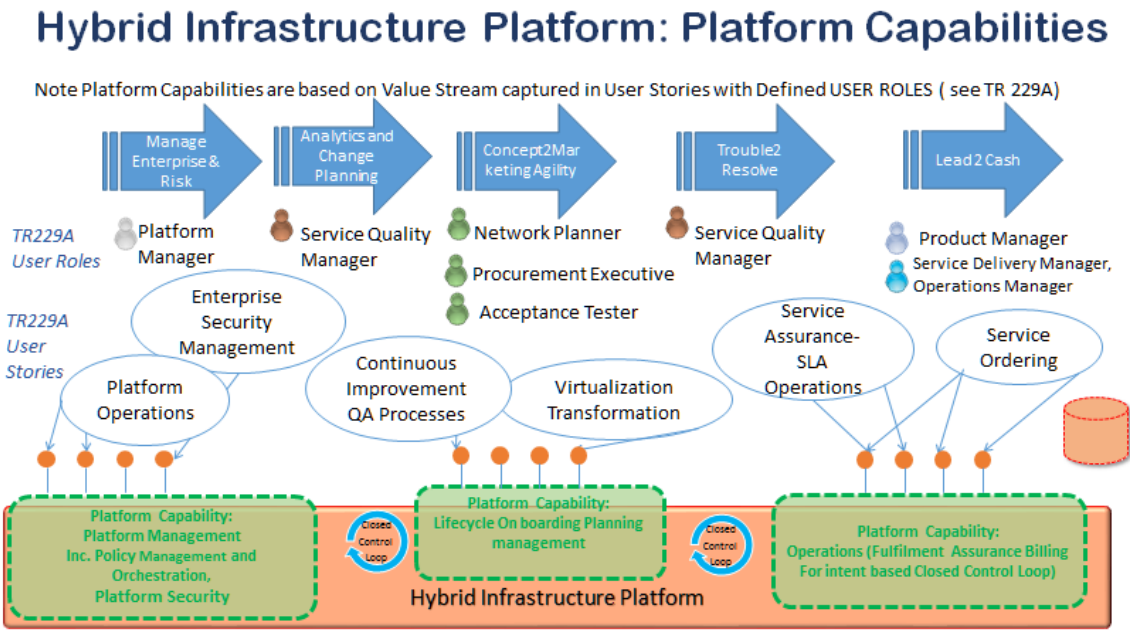

Figure 4-6 - Proposed HIP Platform Capabilities

Noting the following:

- The User Stories shown in the diagram correspond exactly to those in TR229A.
- These Platform Capabilities correspond to the Value Streams and the Actors identified in TR229A
- The Platform Capabilities are defined in 5. Platform Capabilities Incl. Management (DSM-API) and Security and hence this must be linked to this diagram which is depends in turn on TR229A.
- The APIs supporting these Platform Capabilities are identified in 5. Platform Capabilities Incl. Management (DSM-API) and Security and scoped in 6. Requirements on Open APIs
- The Platform Management related capabilities - Security and Platform Administration - are partially covered by the general requirement for Platform Administration proposed for the DSRA Digital Service Management API DSM-API.
- The Platform Management Capabilities need extension to support multi-layered orchestration and policy management as is described in IG1139 and TR263 Part D and will require additions to the DSM-API including data model's extensions for Orchestration and Policy Management.

- Scoping and definition of Security Management Platform Capability is an urgent requirement and has been addressed in Release 17 TR263 Part D Platform Security and Policy Management
- TMF 070A Hybrid Infrastructure (HIP) Implementation and Deployment Blueprint defines the exact scope of what can be achieved with Release 17 HIP specifications and supporting documents.

5. Catalyst Hybrid Infrastructure Platform Examples

5.1. In Focus Dallas 2017/TM Forum Live 2018 Singapore

5.1.1. Partnering Platform with MEF Services

This catalyst is the latest in a series investigating the practical use of TM Forum APIs to realize MEF Legato and Sonata interfaces.

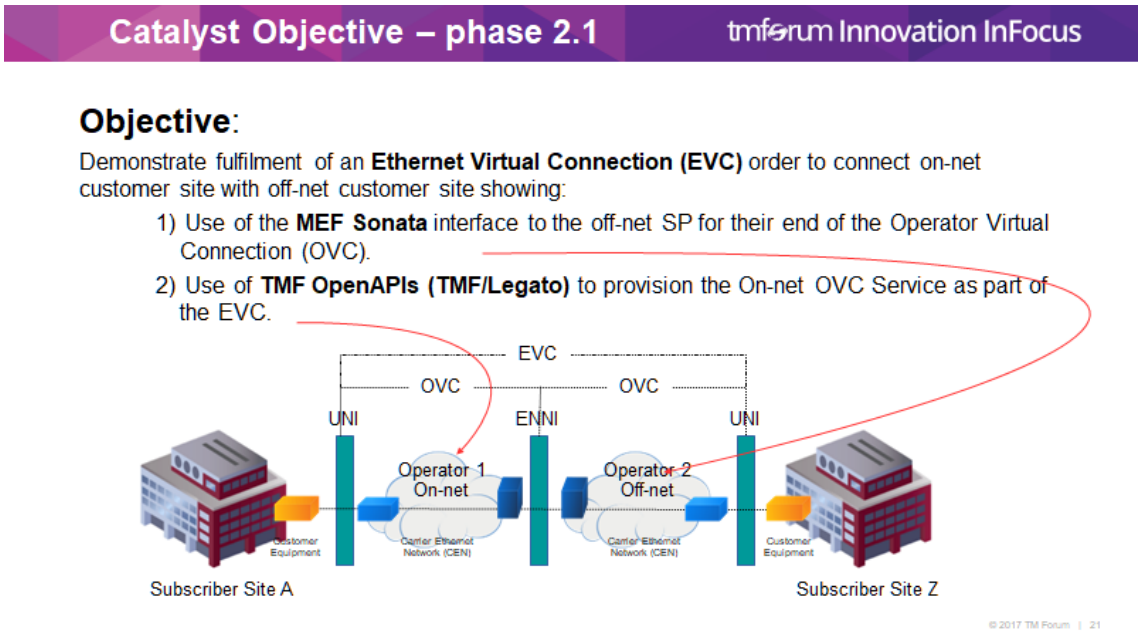

Figure 5-1 - Objectives for Partnering Platform with MEF Services Catalyst - phases 2.1, 2.2, 2.3

The initial focus has been to demonstrate the use of TM Forum APIs for the B2B interface to support off-net Operator Virtual Connection (OVC) provided by a partner defined using MEF services.

At the TM Forum Live 2017 (below Fig 5-2) was to introduce the notion of a HIP platform but using the single vendor native APIs. This reflects the practical stage that are needed to evolve from a legacy situation and is one reason why TMF 664 RFAC API was introduced to support legacy detailed management interface styles.

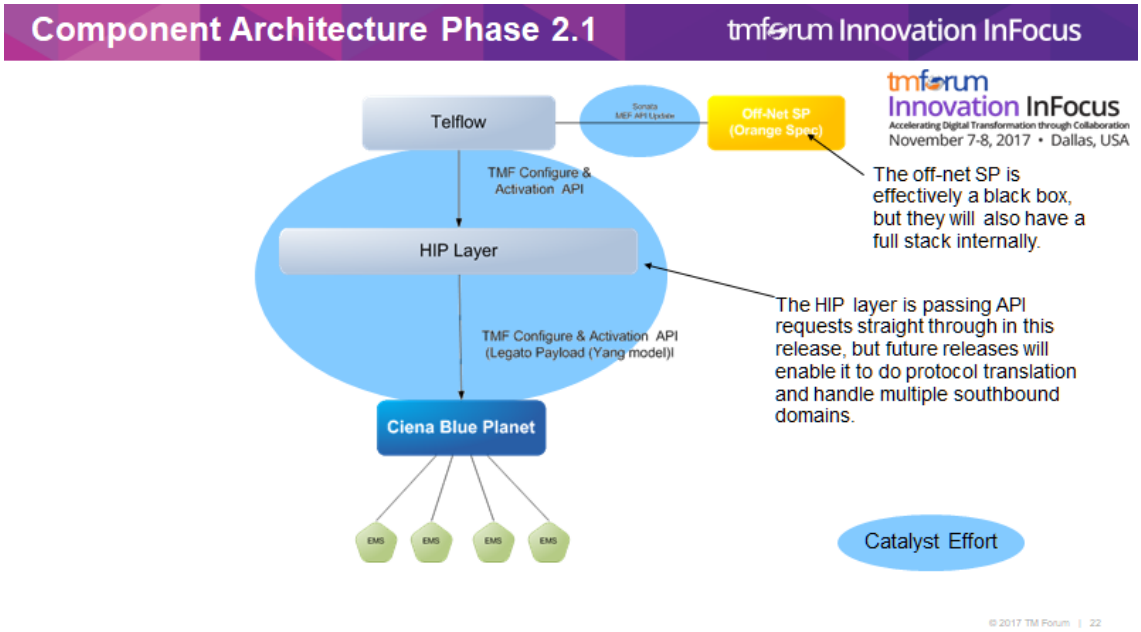

Figure 5-2 - Progressive introduction of HIP concepts

At InFocus Dallas2018 the catalyst showed how the TM Forum APIs can be used to provide an abstraction layer based on HIP Platform concepts above a number of technology domains supplied by several vendors.

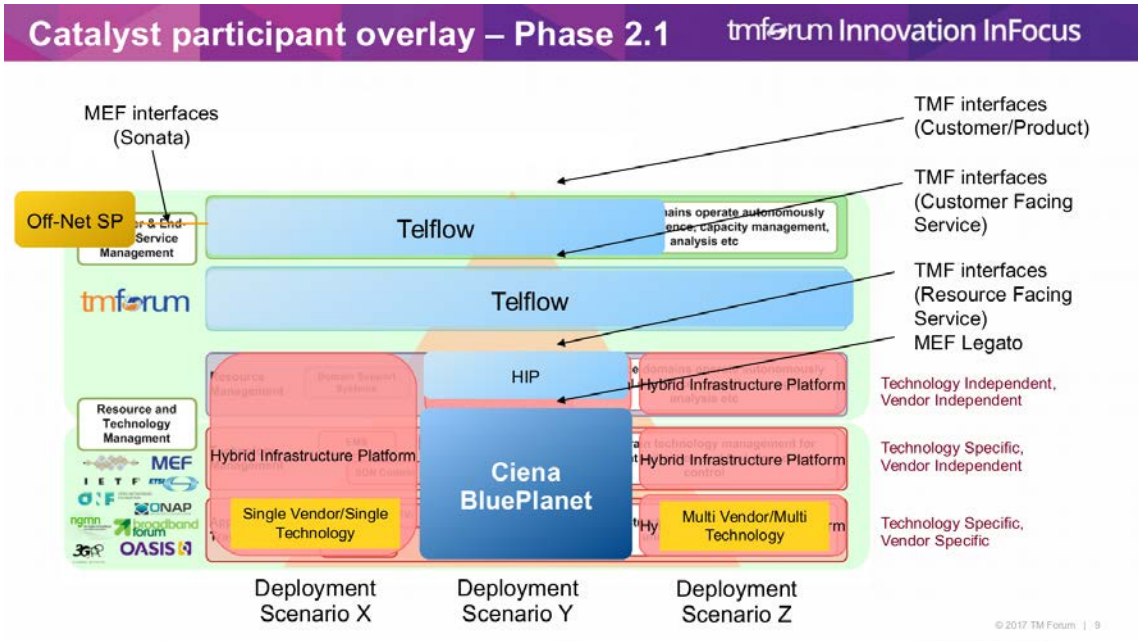

Figure 5-3 - Use of HIP abstraction concepts using TM Forum Open APIs

Phase 2.3 of the Partnering Platform with MEF Services Catalyst for TM Forum Live! 2018 is the planned evolution of this catalyst and should include multiple southbound network domains (using both Ciena and Riverbed domains) as well as a live server for the Off-net orders (via MEF Sonata) supplied by Orange. At that stage of its evolution, it is planned for the catalyst to look more like the illustration below:

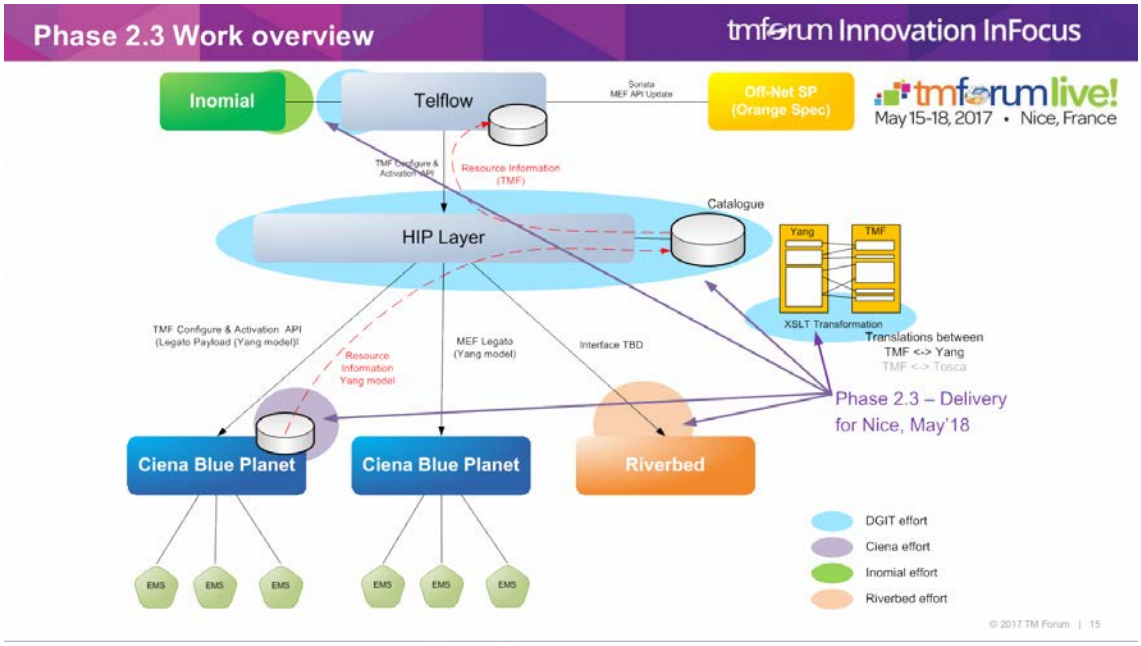

Figure 5-4 - Phase 2.3 of Partnering Platform with MEF Services Catalyst

What was demonstrated is that the use of TM Forum APIs and HIP patterns allows:

- Progressive abstraction of technologies whilst also supporting legacy deployments.
- TM Forum APIs - particularly for ordering can be readily adapted to support multiple domains and multiple abstraction levels both for internal and external integration.
- TM Forum APIs to be applied to the B2B Interfaces supporting MEF Services.

5.2. TM Forum Live 2017 Catalyst inputs

A number of catalysts projects at TM Forum Live 2017 were used to establish and validate practical requirements for HIP Intent based Management.

The three topics of interest and the catalysts were:

1. Resource Function Activation and Configuration: Real Virtuality Catalyst
2. SLA and Alarm Reporting with scaling: 5G Service Operations- real time service assurance catalyst
3. Network evolution to Edge Computing: Smart City on the Edge catalyst.

The following sections provide an overview of what was done and the learning points for development of Intent Based Management specifications.

5.2.1. Real Virtuality Catalyst example

Led by BT, NTT and supported by TechMahindra, the business challenge addressed was to create services dynamically between multiple partners and to be able to scale up and down the resource provided by each partner to meet the dynamically changing workload. I.e. Zero touch flow through of demand changes within all partners.

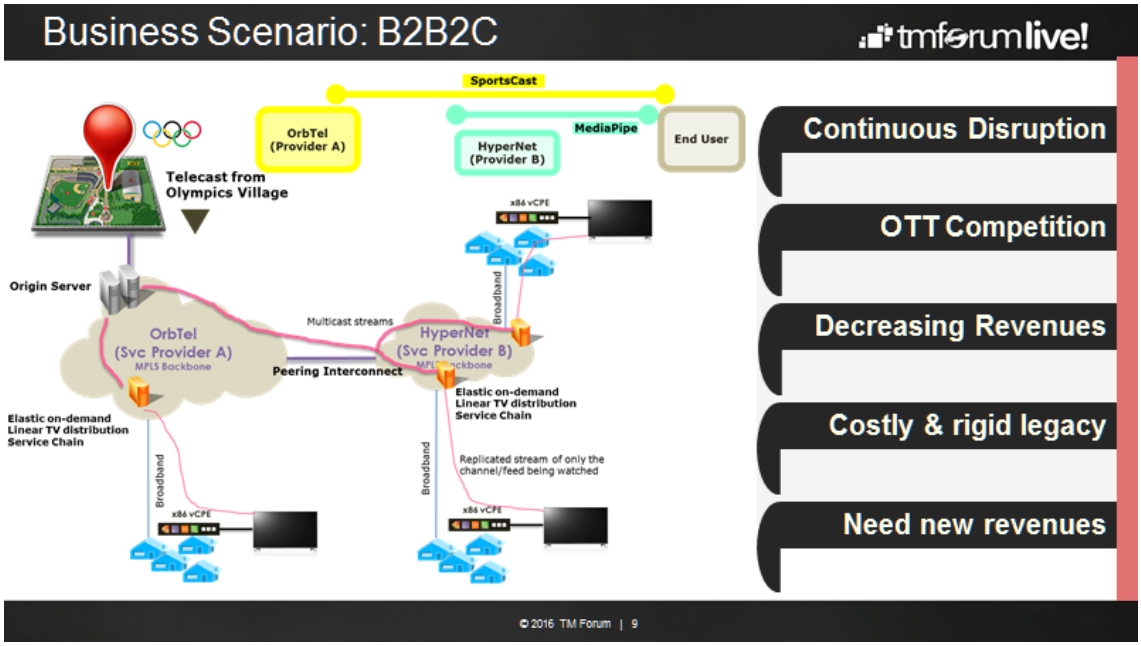

Figure 5-5 - Real Virtuality Catalyst Business Challenge

The scenario above has a number of partners Orbtel, Hypernet offering complementary products: Sportscast MediaPipe and ISP Smart home services. The need is to support elastic demand which has implication on the need to scale resources within all partners to match capacity demands.

In developing the systems design solution, the team established the need for a Programmable operation model based on policy and an Intent Based Management approach to hybrid network management.

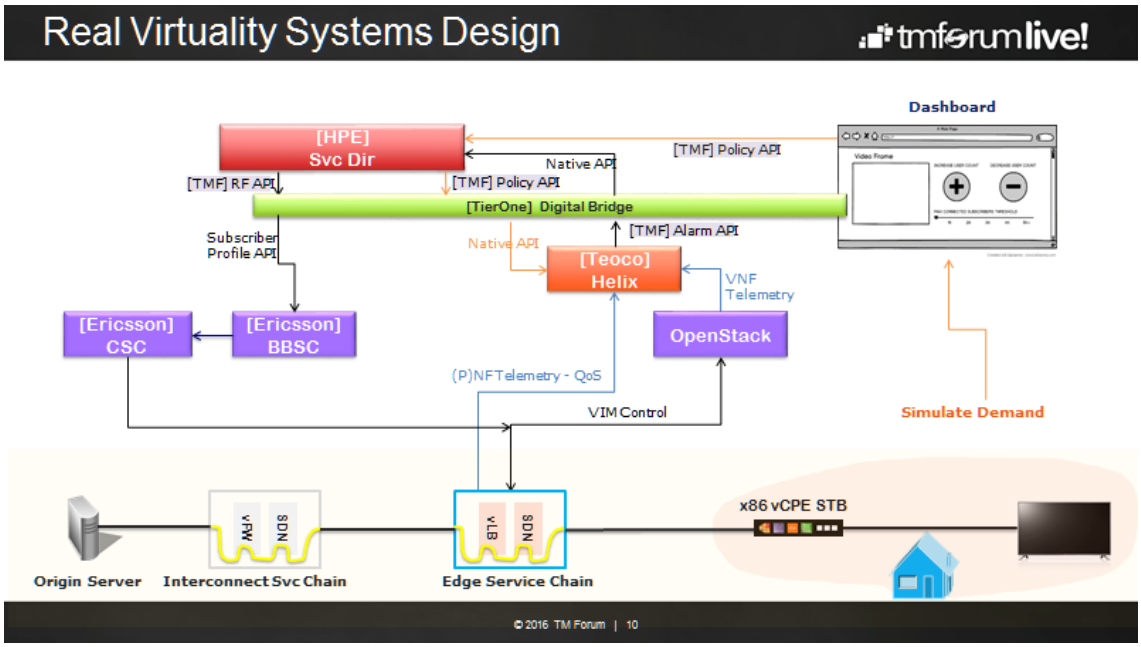

Figure 5-6 - Reality Virtuality Systems Design

The required open APIs were prototypes of:

- TMF644 Resource Function Activation and Configuration API (labeled RF in the diagram)
- A Policy API
- Alarm Management API based on TMF524

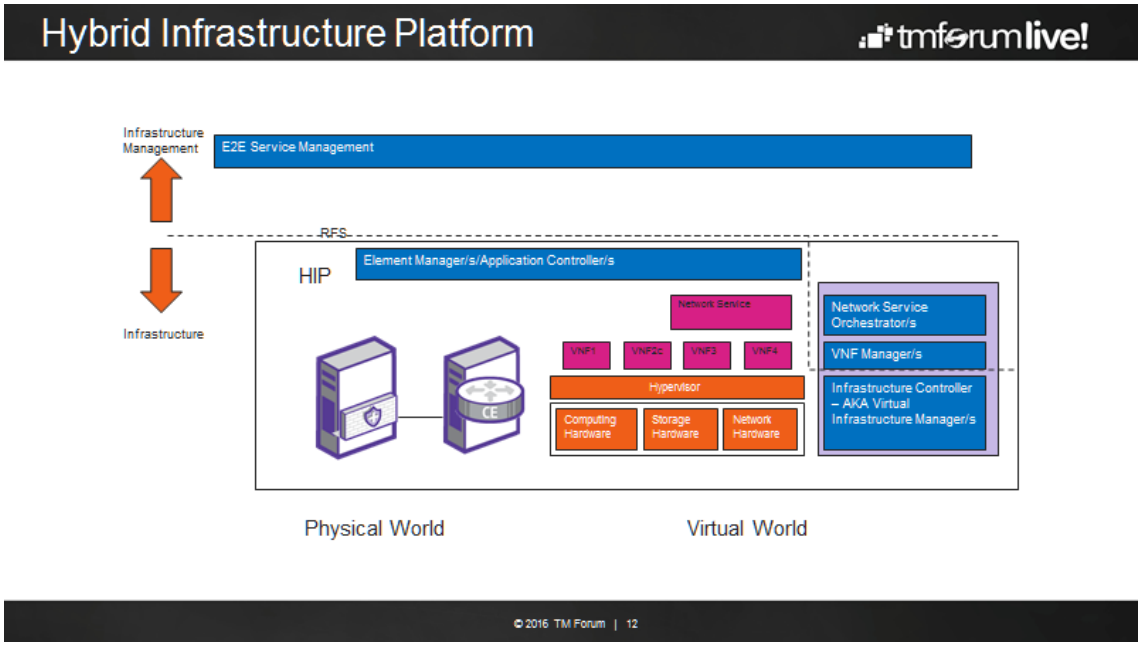

Figure 5-7 - A Hybrid Infrastructure Platform

The requirements for Resource Function Activation and Configuration API were established and include:

1. The need to manage physical and virtualized network functions in an equivalent manner as shown above. For practical and legacy reasons, it was determined that Resource Function configuration API needed to support both intent and detailed based management approaches.
2. The need for Resource Function Configuration to support:
    1. Operations processes to configure tenant services on the Hybrid Infrastructure Platform.
    2. Lifecycle and Change Management processes to manage the dynamic relationship between tenant instances and the underlying physical and virtual resources using policy management.
    3. NFV VNF descriptors defined in ETSI IFA 11, 12, 13, 14 and 15.

Concurrent development of TMF 664 and TR255 Part A: Connectivity patterns for Virtualization Management and the catalyst ensured that these specifications for Release 17 reflected the practical implementation experience in this catalyst.

5.2.2. 5G Service Operations - real time service assurance catalyst example

The service provider leadership was provided by AT&T, BT, NTT, Orange, Telenor, TIM, Vodafone and the project was supported by Mycom-OSI, Teaco, and Netcracker.

The business challenge was to explore how 5G Service operations might be organized and what management capabilities and APIs might be needed.

Based on discussion with industry test beds notably:

- UK 5GIC hosted at the University of Surrey
- EU Funded 5GEx project
- Open Source implementations including Open Baton project and OPNFV vES.

A candidate organization model based on multiple dashboards was developed as the basis of the catalyst scenario.

Figure 5-8 - 5G Service operations scenario

The operational scenario explored the functionality of a set of dashboards managing different aspects of 5G Service Operations using autonomic management as shown above:

- Dashboards for managing multiple 5G Service Type workloads e.g. uRLL, MMTC: Mycom and Teaco.
- Dashboard for managing the efficiency and utilization of the shared infrastructure; Netcracker. This managed the movement of resources dynamically from one work load type to another based on dynamic monitoring of the performance of the workloads against SLAs and the utilization of the underlying resources.

The catalyst developed a simulation of these management dashboards based on a few implementation concepts:

- Using Intent Based Management with Closed Control Loops for each 5G workload Service Type.
- Validating requirements for 5G intent based management use of:

- TMF 644 Resource Function Activation and Configuration.
- TMF 628 Performance Management.
- Minimum viable set of metrics for monitoring SLAs.
- TMF 524 Alarm Management.

Concurrent development of the catalyst prototype accelerated the API development work on TMF628 to support Performance monitoring and thresholding and TMF 524 Alarm management.

The catalysts identified some open issues in the API data models to represent 5G network slicing and how these are established across RAN, Core and Data networks. The key concerns are the multiplicity relationship between RAN Slices and Core Network slices and the exact semantics of Tenant ID in the Mobile Equipment(ME) Multi-Dimensional Descriptor (MDD) which will be explored with network equipment vendors in the planned follow on catalyst.

5.2.3. Smart city on the edge Catalyst example

The project was led by BT and BearingPoint with the support of Agile Fractal Grid, Cloudsoft, EXFO, Intel, IBM, MK Smart, Smart Dublin. The business scenario addressed is applying Edge and Fog Computing principles on Smart City Data Hubs to improve efficiency of City operations by situational, de-centralized decision-making and pushing intelligence and logic from central data hub and IoT apps running in the cloud to microservices (app containers) orchestrated to run at the edge, on a local loop of programmable edge devices, e.g. IoT Gateways and sensors, close to where the data is collected.

The key driver is to reduce unnecessary transmission of data across the network by using edge computing.

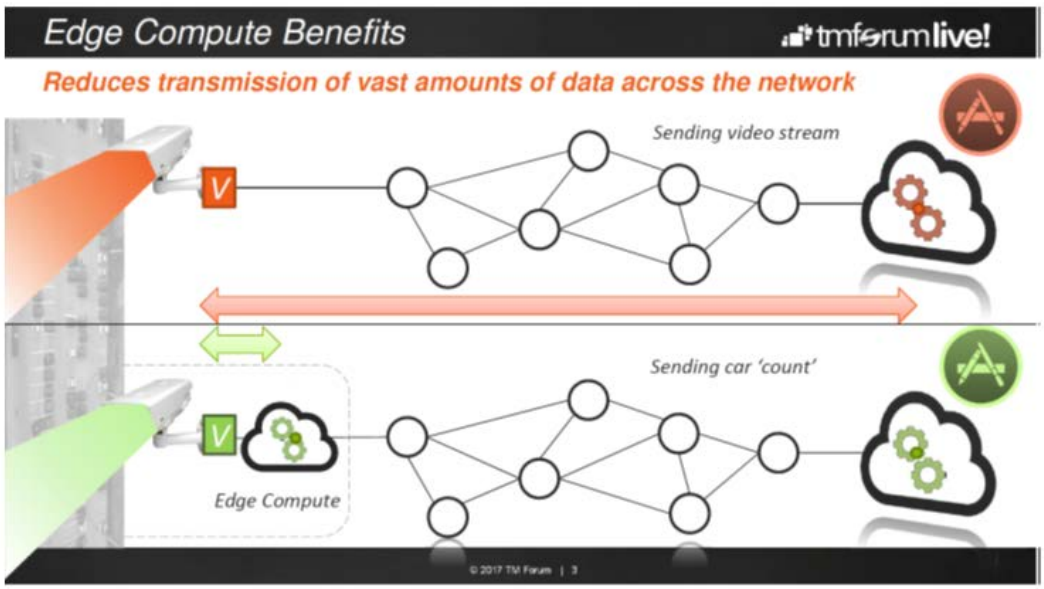

Figure 5-9 - Edge Compute Benefits

The impact on Hybrid Infrastructure Platform is that the resources that are being managed are broader than network functions hosted on a single data center but a set of applications that may be distributed dynamically across multiple data centers some located at the edge. This is similar to the capabilities already offered by Microsoft Azure and AWS except that the edge compute locations can be more numerous.

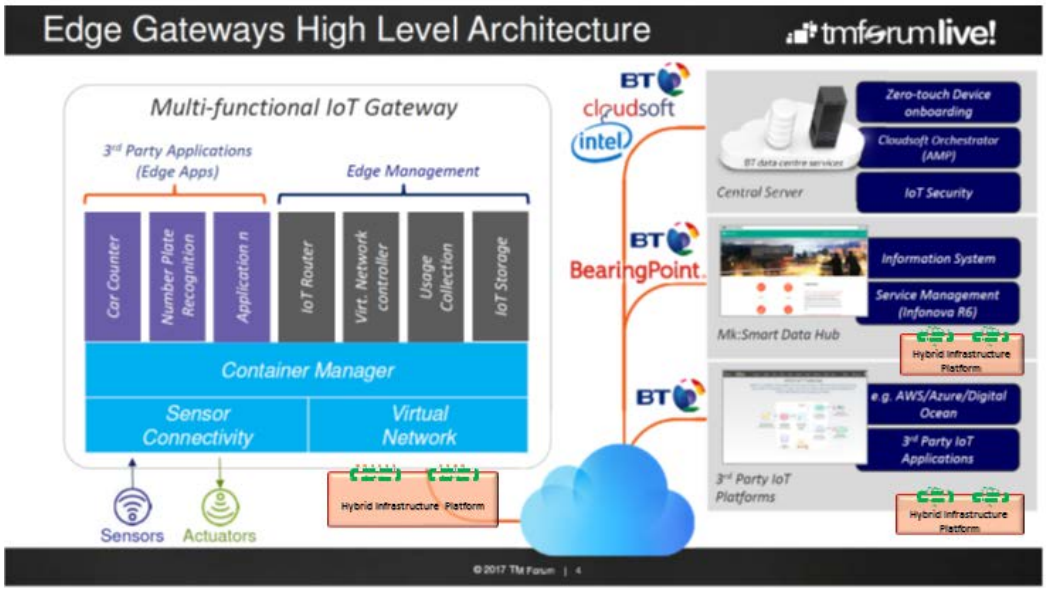

Figure 5-10 - Edge Gateway architecture and example HIP platforms

There can be many 3rd Party applications that need to be run in edge computers including remote management applications. Shown on the diagram are where HIP Platform concepts might be applied to the architecture used in this catalyst:

- Multifunctional IoT Gateway. The 3rd party application are resource that need to be managed which can be done with the HIP Operation Platform capability in either an intent or detailed management manner.
  The (Edge) Management of the gateway is supported by a combination of the lifecycle on-boarding and Planning Platform Capability and the Platform Management Capability.

  The third-party applications are the equivalent of Virtual Functions/VNF and need to be on-boarded using similar approaches to that being developed in the ZOOM On-boarding and Lifecycle Management team. The main difference being that these applications may be working for third parties rather than being o- board for the own use by the gateway owner.

- 3rd party IoT platform are similar to the gateway. The HIP platform capability approach means that simple intent based APIs can be used to manage those 3rd party platform and applications.
- The smart data hub is another example or a resource that can be managed by a HIP Platform.

Concurrent development of the Smart City Catalyst and the HIP Minimum Viable Product has informed the development of TR255A Connectivity patterns for Virtualization Management which have been developed to model distributed content, network applications as well as distributed computing centers.

Based on the catalyst the HIP team have concluded that additional work is needed in Release 17.5 on API data models to support these edge computing scenarios with the HIP Platform model.

6. Platform Capabilities for HIP including Management (DSM-API) and Security R17.5.0

This section has been adjusted to summarize the platform capabilities captured now in Appendix B.

This restructuring reduces the length of main body and makes it more readable by less technical people.

6.1. HIP Platform Capabilities

This section of the blueprint document identifies the set of Platform Capabilities required for realizing Management Platforms and Hybrid Infrastructure Platforms in particular. The identified Platform Capabilities are:

- linked to specific Business / User story requirements expressed in the User Stories of TR229 and TR229A, IG 1123 IG 1127, IG1152 that describe what is required for platform integration,
- implemented as a set of APIs that define how the Platform Capability is realized as inter-operable interfaces using the TM Forum Open APIs.

Four Platform Capabilities have been identified:

- Catalog Platform Capability to support: onboarding, publication and discovery of Platform Capabilities Open APIs and the context definitions for the use of those APIs.
- Functional Platform Capability to support customer zero touch processes I.e. Business Process Framework (BPF) Ops processes.
- Platform Capability Management: Lifecycle Onboarding and Planning i.e. supporting internal planning and Operational Readiness processes i.e. BPF SIP processes.
- Platform Management Enterprise Administration Inc Security, Risk management Policy Management and Orchestration i.e. BPF Enterprise processes.

Appendix B contains the normative specifications for realizing Platform Capabilities of these four types.

6.1.1. Functional Platform Capabilities: Intent and detailed management for multiple Domains

The approach for Management Platforms and HIP is to define Functional Platform Capabilities in such a way that generic Open APIs can be used for all domains that are configured by combining suitable API with data models for each domain, plus the use of specifications that define the context for use of the Platform Capability APIs. The context definition is in an early stage of development in TR263E Context Management R17.5.0 .

For the Resource Domain i.e. HIP the API data models need to support two operational models /styles:

- a Detailed Management Model which is needs for legacy solutions such as those based on TMN FCAPS principles where the consumer has visibility of the detailed resources and orchestrates the configuration of those resources itself across the Platform Capabilities Open API. This is commonly encountered Technology specific Vendor specific integration.
- An Intent based Management Model which abstracts resources as a service and tenant instances of these services are requested by customers with desired SLA for each instance. This approach is preferred for both vendor neutral, technology specific and technology neutral Platform Capabilities and APIs.

For other Domains Customer, Product, and Service Domains the services offered are usually abstracted and hence the complexity of hybrid detailed intent Management model is less common than with Resource Management Domains.

Intent based management - Operations

In Release R17 the focus was on Intent Based Management where there is a coupling between the two groups of APIs: Fulfillment and Assurance

Based on work on orchestration IG1139, Policy Management TR235 and catalyst results on closed control loops IG1128, the following diagram provides a simplified overview of intent based management for the Operations Functional Platform Capability.

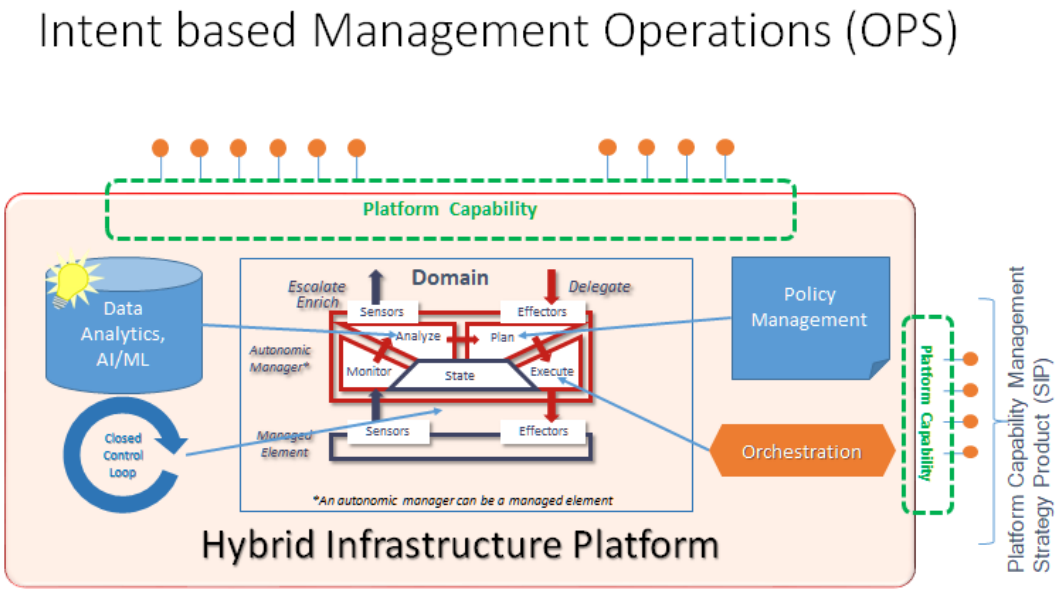

Figure 6-1 - Overview of Intent based Management for Operations Platform Capability

The key features for intent based management are provided through three APIs shown as exposed services at the top of Fig 5-1.

- The Fulfillment operations are provided using TMF644 Resource Function Activation and Configuration API which carries the request for an end state tenant service which might be a connection, e.g. RAN Network slice or resources e.g. CDN Server, together with an associated SLA target.
  Note the functionality of TMF 664 can be integrated with either Service and/or Resource Ordering APIs
    - The Fulfillment service requests in TMF 664 are based on requirements and patterns in:

    - TR255 Resource Function - Activation and Configuration R17.0.0
    - TR255A (IG1147) Connectivity Patterns for Virtualization Management R17.0.0
    - TR255B (IG1150) Specification Requirements for Resource Functions R17.0.0
    - TMF664 supports both intent, and detailed management where the Platform client can control aspects of the internal orchestration of the platform. This combination of intent and detailed based management is needed in some practical legacy and mixed physical and virtualized networking contexts.
- The Assurance service provides for monitoring the performance of the HIP Platform against the target end state tenant service SLA in the fulfillment request.
    - TMF628 / TMF649 Performance Management API provides Monitoring and Thresholding to report how the tenant service on the HIP platform is performing against the target SLA.
    - TMF642 Alarm Management API allows the HIP platform to report tenant service SLAs that are in jeopardy, and those which have been breached.
- The internal operations of the platform are abstracted via these three APIs which accommodates quite different internal and proprietary HIP platform structures, whilst the use of a common information model in TMF 664 means that different implementations can be integrated into an end to end service. This is a very important precondition for multi-technology multi-vendor and multi-provider operations
- Fig 5-1 shows the case of an Autonomic Manager within the platform where a closed control loop is implemented using:
    - Data analytics for the analysis stage
    - Policy management for the planning stage
    - Orchestration for the execution stage
- Two interesting consequences of HIP intent based management are that for operations:
    - There is no need to define a common policy language as the Fulfillment request carries all the necessary parameters.
    - There is no need to define an orchestration API see IG1139).
    - Note: for planning and lifecycle and onboarding management there may need to be policy and orchestration API agreements. However early catalyst studies show these might be represented in an implementation neutral way using OASIS TOSCA (InFocus Dallas 2016: Model Driven Service Orchestration Proving policy is the best honesty - Phase 3; and TM Forum Live 2017: Enabling a VNF Marketplace).

6.2. Implementing Management Platforms

.Appendix B: Platform Capability Definitions for Management Platforms has collected the definitive normative specifications for:

1. Catalog Platform Capability.
2. Functional Platform Capability.
3. Platform Capability Management.
4. Platform Management.

Each capability is captured using a common template and can be used as a check list to guide implementations and establish whether implementation are completeNote that for each platform

- A pattern of three platform capabilities (items 2-4 in the list above) has been established for Platforms including HIP which can be used for any deployment.
- Dependent on the deployment scenario, there will be differing needs for the resource information models supported by differing instances of Functional Platform Capabilities
- HIP platform capabilities and their APIs. Open API tooling has been developed to make accommodation of these variations a straightforward, repeatable and rapid process.
- the forthcoming API guidelines V3 support JSON -LD schema and HATEOS which mean that API operations /verbs can be dynamically bound to the Data models are Runtime (aka known as polymorphic APIs which will simplifies the accommodation of variation using an industry supported approach
- These resources model variations, together with operations variations, e.g. create and delete rights of specific users, are accommodated by profiling the Open APIs in the relevant Platform Capability Specifications though the use of concepts in.TR263E Context Management R17.5.0 .

7. HIP Deployment and Implementation, and Next Steps R17.5.0

Needs a review against TMF 070/A/B/C

7.1. HIP Deployment and Implementation R17

Considerable progress was made in R17 through joint work with the API Program on implementation artifacts to extend TM Forum Open APIs to meet the requirements of HIP.

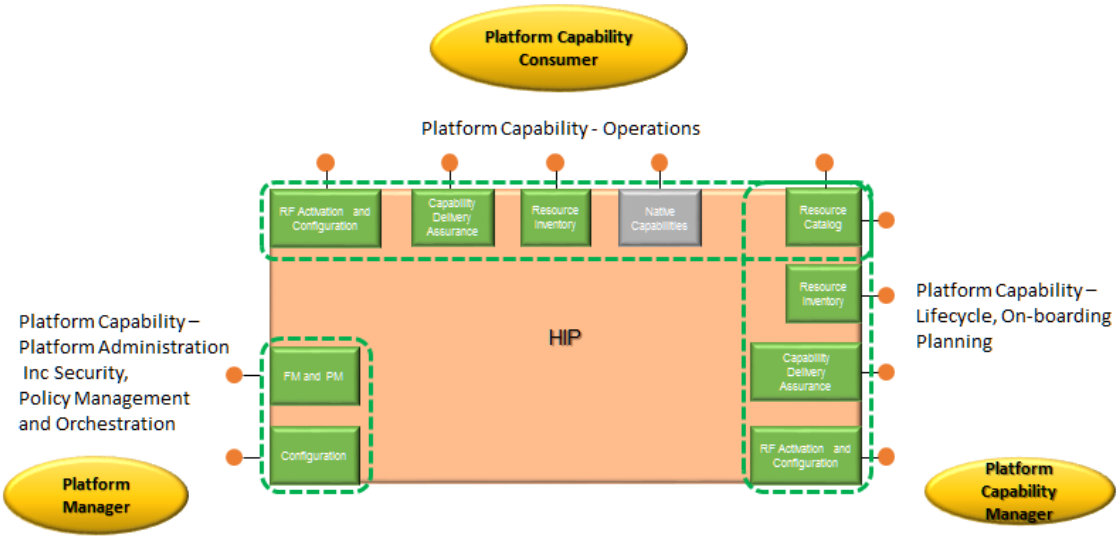

Figure 7-1 - HIP Platform Capabilities

Using the main platform capabilities identified above and shown below, the following artifacts are in place for R17. The focus in R17 has been on the Platform Capability - Operation above although some preliminary work has been completed for all areas as summarized in the table below.

Note that some APIs are used in multiple platform capabilities but with different Information and data models.

General	
TMF070 Implementation and Deployment Blueprints for Hybrid Environments	Overview of the R17 HIP specifications for primarily Platform capability- Operations, and to provide a basic NFV intent based management capability.

Functional Platform Capability: Operations	Actor: Platform Consumer and tenants
	Priority for R17: Intent based Management
TR255 Resource Function - Activation and Configuration R17.5	Sets out the use cases and requirements for the provisioning and life cycle management of Resource Functions (RF). These cover both tenant services for operations but also planning and build requirements for lifecycle processes – mapping tenant services to infrastructure.
TMF070A Hybrid Infrastructure Platform (HIP) Implementation and Deployment Blueprint R17.5.0	Detailed description of Platform capabilities: • Resource Catalog Management • Resource Function Activation and Configuration (where Resource Function includes a special case the ETSI NFV concepts of VNF and Network Service, and the IETF / SDN concepts of Service Function and Service Function Chain) • Capability Delivery Assurance • Metrics • Resource Inventory Management
TMF070B Advanced Platform Deployment Blueprints R17.5.0	
TMF070C Relationships to External Architectures R17.5.0	
TR255 Resource Function - Activation and Configuration R17.5	
TR255A Connectivity Patterns for Virtualization Management R17.5	Explores what connectivity information is needed to create or modify a Resource Function (RF). Two points of view are taken, i.e., external view of the RF (done in conjunction with an intent-based approach such as tenant services) and internal view (done in conjunction with a detailed-based approach such as underlying infrastructure).
TR255B Specification Requirements for Resource Functions R17.5.0	Provides requirements for the specifications (descriptors) needed to support the provisioning of network services and network functions

TMF664 Resource Function Activation and Configuration API R17.0.0	API realizing requirements in TR255
TMF628 Performance Management API REST Specification R14.5.1 (update expected for R17.5)	Performance Management REST API which provides a standardized mechanism for performance management such as the creation, partial or full update and retrieval of resources involved in performance management (Measurement Production Job, Measurement Collection Job, and Ad hoc Collection). It also allows notification of events related to performance
TMF649 Performance Thresholding API REST Specification	Extends TM628 so that SLA performance can be reported as it crosses defined thresholds
TMF634 Resource Catalog Management API REST Specification R17.0.0	Used by the Platform Consumer to select Resource Functions
TMF639 Resource Inventory Management API REST Spec R17.0.0	Allows the Platform Capability Consumer to check and verify the resource functions that it “owns"
TMF642 Alarm Management API REST Specification R17.0.0	
Platform Capability Management: Lifecycle, Onboarding, Planning	Actor: Platform Capability Manager
TMF070A Hybrid Infrastructure Platform (HIP) Implementation and Deployment Blueprint R17.5.0	Detailed description of Platform Capabilities • Catalog Management • Resource Function Activation and Configuration (for Plan and build related resource function to infrastructure) • Capability Delivery Assurance (related to planning processes) • Resource Inventory Management
See TMF070, TMF634, TMF664, TMF628, TMF649, TMF642, TMF639 and TR 255 above	

Platform Capability: Platform management	Actor: Platform Manager
DSM API	Describes the lifecycle operations on the respective Platform entities (generic and not specific to the platform Operations service
TR263D Platform Security and Policy Management	Describes The business challenge of security applied to Platform and set out principles and best practices, checklists and use of Cloud Security Alliance Software Defined Perimeter as an exemplar
Next Steps	

More details on the scope and detail of the R17 Hybrid Infrastructure Platform Deployment and Implementation specifications are in TMF070B.

8. Platform Extended Principles

There are a number of general Platform principles that have yet to be fully developed within the Digital Platform Reference Architecture:

- IG1157 Digital Platform Reference Architecture

some of which turn out to be quite important in the application of platform concepts to Management Platforms and Hybrid Infrastructure Platform solution.

This section is a proposal for what those gaps are, and recommended solutions. In some cases, there are multiple solutions but each comes with particular characteristics that need to be evaluated when platforms are deployed.

It is intended that these will be further developed jointly with the Digital Platform Reference Architecture and the planned Open Digital Architecture in Release 18.

8.1. Modeling catalog interactions: Relationship between platforms, metadata and publishing via catalog

One of the key principles of the Platform approach is that the Platform, and especially its Platform Capabilities, are published so that potential consumers can find them, and bind to them (using Open API URLs).

For most current HIP implementation platforms their implementations will be realized manually, and will be persistent even if the hosted Instance of services (tenants) in the form of CFS and RFS services are dynamically created through platform capabilities.

There is a need to describe the best practices around general concepts of how publishing discovery, and binding might work in a Platform Context.

In the diagram below we show that the Platform A is exposing a set of Platform Capabilities and has associated with it Metadata for the Platform A, its Platform Capabilities and APIs.

Clearly there needs to be a Catalog Platform Capability shown on the right to expose Platform Capabilities (and the URLs of the Open APIs supporting them) of Platform A to all potential clients of Platform A.

It is expected that this Catalog Platform Capability will be based on the TMF662 Entity Catalog Management API REST Specification with some additional best practices and information / data model recommendations.

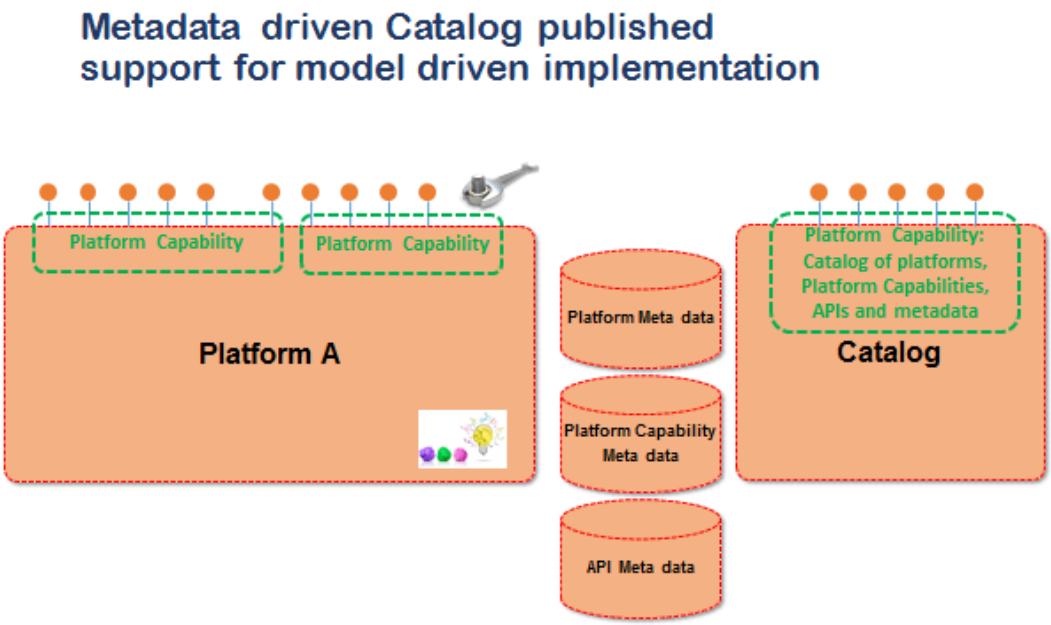

Figure 8-1 - Finding and publishing Platform Capabilities

In this Figure the Catalog Platform Capability is shown on a separate Catalog Platform which can occur if there is some form of intermediary or marketplace providing - on behalf of Platform A - the Catalog of its Platform Capabilities. (This was called a Metadata Coordinator in the earlier Software Enabled Services - SES study).

Recent results in TM Forum Live 2017 Catalyst -Enabling VNF Marketplace was practical example of a catalog that publish VNF capabilities and allow VNF to be on boarded and operated.

Note this distinction is a platform governance matter rather than a technical issue. As shown the governance of Platform A and the Catalog Platform can be by different organizations. One way of validating which solution is being proposed is to ask the simple questions: Who issues the Platform and Platform Capability Identifiers? And Who issues the API URLs? And what formats are used? Such arrangements are commonplace in Multi-sided business platforms, for example, with hotel room ordering the broker is a separate entity from the hotel company, but the broker does expect some payment if / when a transaction takes place which has clear implications on usage, billing and settlement financial models.

In some deployments the governance organization of Platform A and the Catalog could be the same, in which case the Catalog Platform Capability can be regarded as logically equivalent to adding it to the Platform A.

8.1.1. Software Factory

The most common form of platform implementation for networks is that they are instantiated manually, however there is an expectation that ultimately Platform and their lifecycle will be managed by some of software factory which is a component of an automated model driven approach. Examples of this approach are seen in Open Source projects ONAP, and others. Additionally, in the multi-sided business models. there are examples of platforms where they might be instantiated dynamically on demand - for example, the Virtual Call Center example in the Ecosystem Enabler Catalyst. In these cases, there is an implication that when an instance of a Platform (and associated Platform Capabilities, and supporting APIs) is to be created that there needs to be a Software Factory that creates an instance of the Platform using the

metadata within the Catalog. See also the open issues section in this chapter for a further discussion.

8.1.2. Catalog API Requirements

Where the Catalog is separate from Platform A, it is necessary that the Catalog API and the data model explicitly support the ingestion of the Platform A, Platform Capability and API metadata.

At this stage it is anticipated that these requirements will be supported by the generic Entity Catalog API data model proposals. However, the required metadata does need to be standardized by HIP project.

8.2. Modeling Platform Hierarchies

Networks are naturally layered e.g. OSI layer 1-4, over and underlay networks, etc. - and hence management of networks using platform concepts needs to establish and record some principles for Platform hierarchies.

The purpose of this section is to describe the known alternative approaches to modeling hierarchies using the platform concept, and the considerations for choosing which approach should be used in which circumstances. Approach 2 is believed to be the most generally applicable approach.

Note: The concepts of Platform and Platform Capabilities are about governance boundaries addressing technical, organizational and operational boundary requirements.

8.2.1. Approach 1

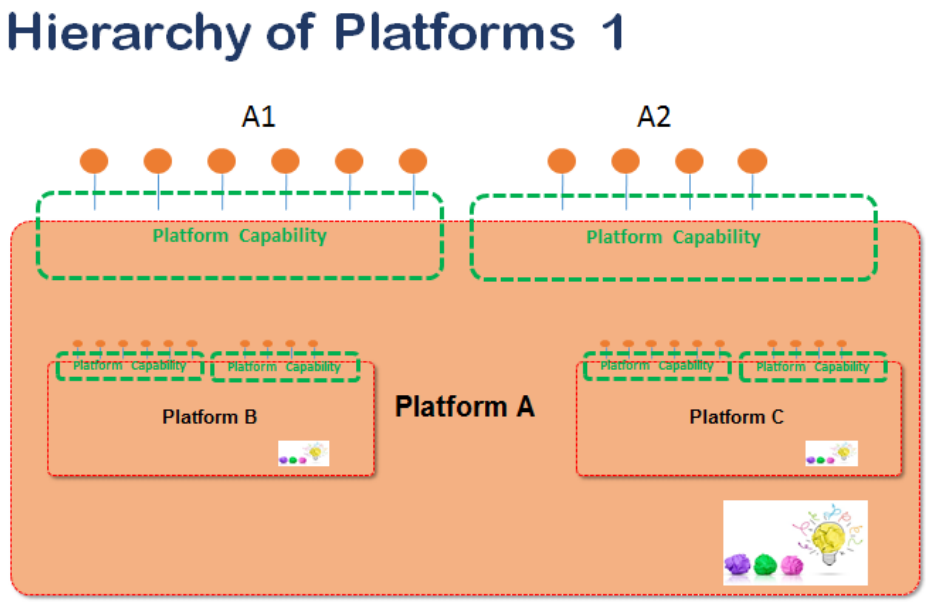

Figure 8-2 - Creating hierarchies / layers with Platforms - Option 1

In this Figure Platforms B and C are shown as within Platform A's governance.

What does this mean?

- The governance of Platform B and C are under the control of the same organization as Platform A.
- The capabilities of Platform A can only be accessed by Platform Capabilities A1 and A2 exposed by Platform A - this is the notion of a Software Contract.
- A Client of Platform A cannot bind with Platform B or C because the use of them by Platform A is completely under the discretion of Platform A's governance and can be changed at will.
- The dependency of Platform A of Platform B and C can be recorded in a Platform template of Platform A, but cannot be used by clients of Platform A

Usage

- This form of hierarchy can be useful if one wants to explain that Platform Capabilities of Platform A use, and are dependent on Platform B and C, i.e. form part of the description of an instance of Platform A, bit not part of the Platform Capability / Software Contract Specification i.e. A 1 and A2.
- Specifically, it may be useful to explain that more information about it can be found in a Catalog Platform described earlier.

Note: This is the most restrictive way of expressing network hierarchies.

8.2.2. Approach 2

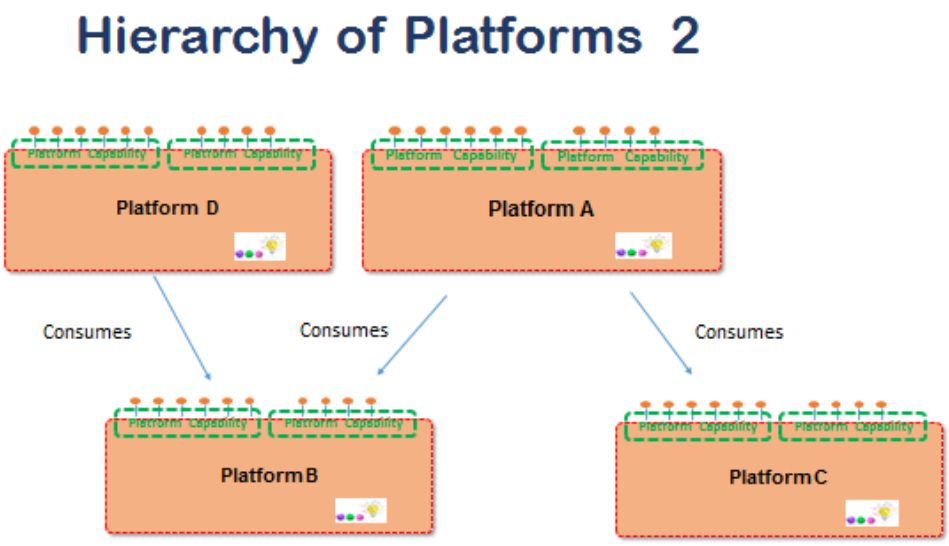

Figure 8-3 - Creating hierarchies / layers with Platforms - Option 2

In this figure all the Platforms can be under different governance, all are discoverable and can be bound to by any Platform. This approach is particularly useful for modeling hierarchies for layering with in networks.

The relationships shown between platforms above are dependencies and are captured in run time configuration information of Platforms D and A when they are deployed/ instantiated.

What does this mean?

- Platform A may use Platform B and C initially but can stop using either Platform at will.
- Platform D which may have not been thought of when Platform A, B and C were deployed can bind to Platform B, i.e. B can be reused without the knowledge of Platform A.
- Each Platform can state its dependency in its Platform Template on other Platforms and Platform Capabilities as part of a deployment template. This is a one-way relationship.
- Platform A can change its dependency from one platform to another one supporting the same Platform Capability which assists in migration of Platforms and the systems they encapsulate.

Usage

- This form of modeling hierarchies is more flexible as all the platforms and their capabilities are publicly exposed and can be published.
- All the Platform and Platform Capability relationships are potentially dynamic and can be changed at run-time in a deployed environment.
- Where platforms are managing networks recursive use of networks layers can be easily and dynamically handled and are only dependent on have robust and composable models for the network services exposed by each platform. This accommodated modeling of connectivity services on top of Networks Services which in turn depend on physical and virtualized functions e.g. VNF.
- Layering can be handled in a flexible manner and layer can be skipped if needed - the so called 'relaxed layering model'

Note: this is the most flexible way of expressing network hierarchies and is the preferred approach.

8.2.3. Security Implications

The finer granularity of platforms in Option 2 means that from security point of view that the threat surface (platform capabilities and Open APIs) is larger than Option 1 and more auditing of the run time configurations of dependencies is needed. See TR 263 Part D: Platform Security and Policy Management.

8.3. Linking Platforms to DSRA and IG1118

Two pieces of TM Forum work:

IG1118 OSS / BSS Futures

TR274 Digital Services Reference Architecture (DSRA) Guide

have described some of the principles for a component based solution to the implementation of systems, and are quite similar. IG1118 extends the concepts of DSRA to support a Management Control Continuum, a service (Platform Capability) composition approach; together with the paramount need for security Platform

Capabilities / APIs and a Future Mode of Operations for network management systems.

Recalling that platforms are sets of processes, people, organization, information and systems, it is clear that the prior work relates most to systems and the subset of processes an information that they host.

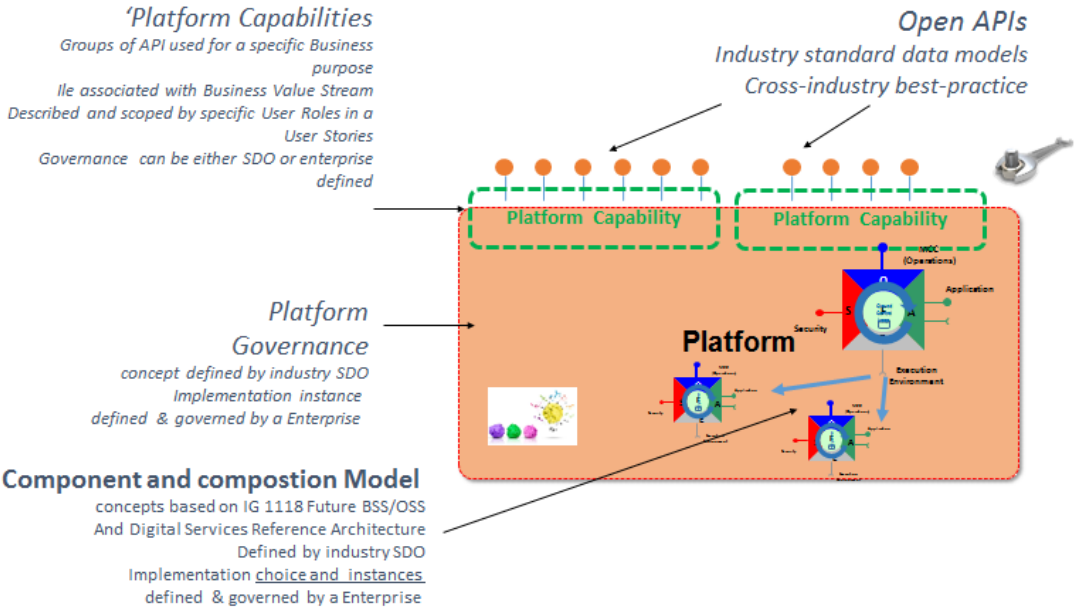

Figure 8-4 - Component and composition model - an Implementation choice

A few observations about this model:

- Platform and Platform capabilities do not assume any specific internal implementation as this greatly eases migration and wrapping of legacy so that internal changes are invisible to the external consumer.
- DSRA and IG1118 define models which can be optionally used to implement the systems portion of a Platform, at the choice of the enterprise defining the Platform, e.g. these components are one way of realizing the systems shown in Fig 1.2 Anatomy of a Platform.
- DSRA and IG1118 components have a number of properties:
    - Application API which exposed the core functionality of the component e.g. configuration or performance management Function or a network function such as Voice messaging.
    - A security API that manages the security capabilities of the component.
    - Operations APIs which are the exposure of a set of component capabilities that are needed to manage the component - these are assumed to be the DSRA Digital services Management DSM-API.
    - Dependencies on the environment which describe the components that must be available for the component to perform its application and operations functions.
    - IG1118 shows how these simple concepts can be used to compose components such that they can be managed at an aggregate level.

- IG1139 introduced the idea of orchestration domains which can be coincident with a Component or an aggregation of components.
- TR263D shows how the Domain concept can be applied to security services.

8.4. Linking to Frameworx

The technical realization of the platform capabilities are Applications or Components. These are built up of Application Functions, composed as pre-defined applications or composed to components following the IG1118 concepts.

The Application Framework offers the Applications and the Application Functions.

The Application Functions are categorized to be Business Capabilities, Operation / Administration Capabilities, Security Capabilities, API Capabilities to realize the open APIs, etc. - all using the Information Framework's information model.

The Business Process Framework's role is to support the Enterprises in creating, maintaining and operating the platforms, and the platform based business.

8.4.1. Example 1

An example would be to imagine the B2B2C scenario, but detail it to be a Bcp2Bsp2C.

Bcp is a business of platform capability provider,

Bsp is a service provider of platform based business services.

Both offer a platform, the Bcp's platform is rich in capabilities and offers flexible Admin., and Operations capabilities, while the Bsp's platform is offering well configured services with limited or no possibility for external administration. To offer their respective platforms Bcp and Bsp, both create processes using BPF-elements to run their businesses, e.g. DevOps, fulfillment, assurance, enterprise, revenue management, etc. and these are internal since the access points to the Platforms are the platform capabilities realized as Open APIs.

8.4.2. Example 2

A variant of Example 1 could be that a **BSp** may offer richer and advanced services hence he could see an opportunity for wider opening its Platform via secure APIs to "Customers" for self Service / Self Ordering and Self Administration of services / Capabilities ordered.

8.4.3. Example 3

Another variant of example 1 could be **Bsp** may become an **Bcp**. (**Traditional SP** becoming a Software Company) and could play both roles.

8.5. Open Issues

Open specification issues for R 17 include:

1. Formal meta modeling of Platform, Platform Capabilities APIs and dependencies.

2. Linkage of Domains to orchestration, Policy Management, Platforms Capabilities and Components.

Open Architectural issues. It is not clear what the priority for resolving these issues is in the context of the Hybrid Infrastructure Platform; however, none are likely to be a high priority and are not required for the HIP Minimum viable Product R17.

1. **Platform Persistence:** Platform instances may be created manually as persistent entities which is the most commonly expected situation especially in early implementations. However, there are examples of more dynamically defined platforms such as a virtual Call Center where platforms may be more ephemeral. The relationship between the persistence of the platform and the instance of the services it hosts such as CFS RFS services needs further study.
2. **Software factories:** As described earlier in this section the use of Software Factories is focused on creation of a platform and the assets that comprise it. The plan is to support these through the Lifecycle Onboarding and Planning Platform Capability. However, a software factory may be external to, or within the Platform, or a mixture of both. The detailed implications, benefits and characteristics of these alternatives on the Lifecycle and Onboarding APIs, needs further study through additional User Stories and scenarios that are planned after Release 17.
3. **Onboarding and operations relationship** In Release 17adtional study is needed the relationship between 'what' a HIP Operations platform capability provides and 'how' the Lifecycle and Onboarding and Platform Capability defines the mapping from the resources used to the tenant / instances provided/hosted by HIP Operations platform capability. IG147 Connectivity patterns is a first step but study of further examples may reveal additional patterns and best practices.
4. **Network layering:** More concrete examples are needed of Modeling Platform Hierarchies. Specifically, how the deployment template of one layer is dependent on lower layer Platform Capabilities. Some examples based on Vodafone deployment scenarios are shown but example for networks services layered on Physical and ETSI Network Services VNF capabilities, VPNs, MPLS and Ethernet VPN would make the use of this approach practically clearer. This could be an evolution of IG1147 Connectivity patterns. This is coupled with the need to model relationships amongst platform implementation components / framelets using Deployment templates such as TOSCA which are being studied in both the HIP and the automated onboarding work streams.

9. Appendix A: Key Platform Concept Definitions R17.5.0

9.1. What is a Platform

9.1.1. Background

The Platforms concept has emerged as a solution to two distinct business challenges:

- First, to manage the transformation of current BSS / OSS to reduce systems complexity and to improve business agility through reuse of Platform Capabilities (Single Sided Business Model); This challenge is described in BT and Vodafone contributions to Action Week Lisbon 2016 and 2017, and AW Vancouver 2016 on Platform based IT Architectures.
- Second, to participate as a partner in modern Platform business models (Multi-sided Business Models) as described in Geoff Parker's book 'Platform Revolution'.

These business concepts have been developed and documented in the Digital Platform Reference Architecture and specifically in the following document:

- IG1157 Digital Platform Reference Architecture

that show how a common platform approach can be applied as a solution to both business needs. The latest version also shows how both approaches will migrate to SaS service running on a distributed federated 'Actualization platform' - and example of which is the ONAP Multi-VIM proposal.

Coincidentally, both needs can be solved in a common fashion, and the evidence of costs saving, improved business agility and reduced IT integration friction are remarkable.

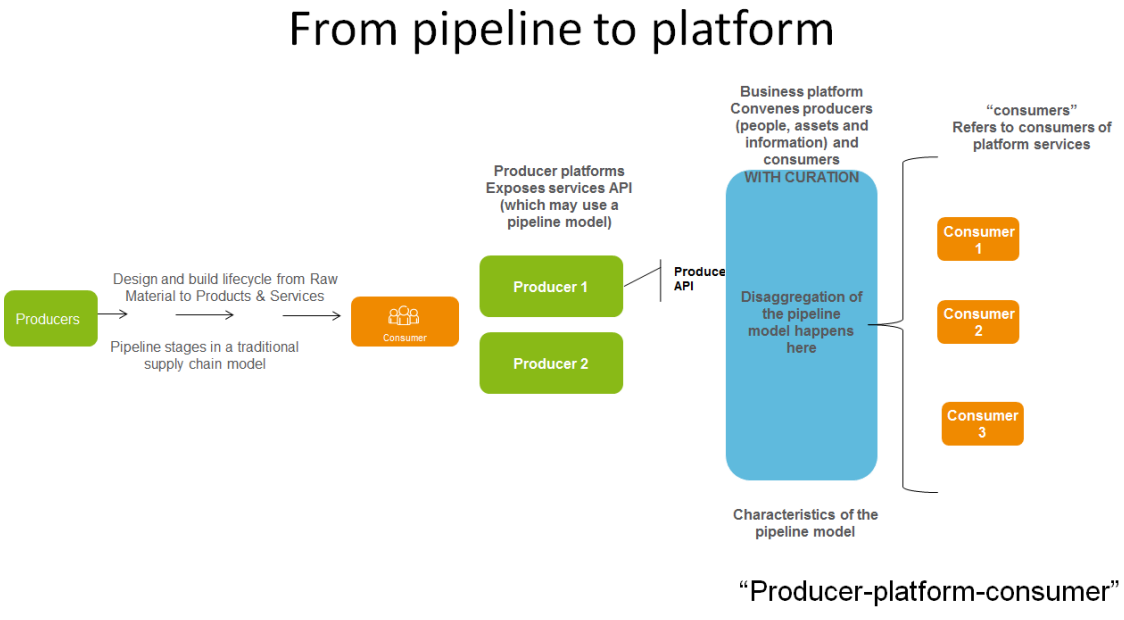

Figure 9-1a - From Pipeline to Platform Models

From Pipeline to Platforms. The key insight from the TM Forum Vancouver Action Week Platform workshop was the decisive move of businesses from a pipeline approach where solutions are designed from raw material through to complete solutions, where the goal is to push out inventory / Products; to the marketplace approach, to a Platform Economy with Business Platforms that convene producers and consumers, and provide Curation (see https://www.weforum.org/agenda/2016/01/the-fourth-industrial-revolution-what-it-means-and-how-to-respond and also the figure above).

9.1.2. Platform Definition

Platforms represent reusable business capabilities defined, governed and administered by an organization following industry templates. Instances of Platforms are usually defined by enterprises rather than by Standards Defining Organizations (SDO). Platforms represent a governance boundary around a specific set of processes, information, people, organization and systems.

There are two types of platforms.

The first type are the platforms that enable a platform business model. Examples of these platforms include Microsoft Azure, Amazon Web Services (AWS) and IBM BlueMix (TM). Platforms enable companies to assume the role of Curators bring together Consumers and Producers in a very flexible and easy to use manner. This pushes platforms beyond the definition of a well enabled SOA service by emphasizing the platforms role in creating business value, not just a function.

The second type is a collection of systems that collectively provide a well-defined block of business functionality exposed via open APIs.

9.1.3. What is a "well formed" Platform?

- A Platform must expose at least one Platform Capability realized via an easy to use Open API.
- The way a Platform Capability is exposed remains consistent independent of how it is consumed.
- A Platform must be able to place its Platform Capabilities and associated API services in a "catalog" as asset for discovery, query & find by various consumers for different purposes /usage.
- A Platform must be able to place its services in a "catalog".
- A Platform must expose its own Management API (e.g. Digital Service Management - DSM)
- All the internal components used to realize a Platform are managed via DSM-API.

9.1.4. What are common Platform characteristics?

- The Platform is data driven and uses analytics to drive intelligent / cognitive business processes.
- The Platform is configurable, extensible and software defined.
- Platform must be able to provide context awareness of services, customer, resources and intelligence (functionality is present at two levels: cognitive business and cognitive service assurance).

- Ability to scale and change behavior of platform component without impacting other components e.g. micro-services.
- Event-driven, using policy management, data, and metadata, enabling automated management. Management is driven via closed control loop, and may be augmented by analytics.
- Runnable anywhere.
- Model Driven architecture and associated to manipulate and implement the model.
- The set of platform capabilities required will vary by the business drivers**.**

9.1.5. How does this differ from Function Blocks and Building Blocks approaches?

In the traditional TMN (Telecommunication Management Network) approach a set of logical function blocks are defined which can be grouped into multiple physical implementation Building Blocks arrangements.

The Function Blocks are usually shown as part of a 'Design' Architecture as being statically interconnected using References Points. Where these Reference Points coincide with the boundary of a Building Block they form the logical specification of the interfaces between Building Block.

The platform approach differs as it defined exposed Platform Capabilities and services where there is no Design time Reference Architecture that statically binds one Platform with another. In principle any platform can consume the Platform Capabilities of another. The interconnections between platforms are dynamically established at deployment or instantiation time and are expressed in templates that define the dependency of one platform deployment on another. It is these differences that allow the platform model approach to be agile and for reconfiguration to occur as part of deployment configuration rather than at design time, which can imply re-coding of the interfaces.

9.2. What is a Platform Capability?

Platform Capabilities are the unit of Business “What" that is exposed via Platform Capabilities, realized via open and secure APIs, and stored/published in and catalog for authorized internal or external use. The exposure is through simple to use Open and secure APIs that allow authorized systems and users to interact the technical content of the platform without having to be aware of the technical complexity.

Platform Capabilities are typically the units of composition in developing a complex business service. This composition can occur within a single platform. For example, combining multiple AWS capability to deliver what appears to be a single service Composition can also be used across platforms. For example, creating a Salesforce Analytic capability by using APIs exposed by Salesforce and Watson Analytic.

Specific Platform Capabilities may be governed / administered by organizations themselves and some - particularly Utility Platform Capabilities - will be governed / administered by industry groups. Platform Capabilities and APIs are the primary means for achieving interoperability, integration and conformance.

9.2.1. Definition

Platform Capabilities are:

- A coherent block of business functionality and operational patterns.
- Are exposed or published in a catalog.
- The units of composition in developing a complex business service. This composition can occur within a single platform or across multiple platforms.
- Encapsulations of Attributes (data) embedded within it on which you can invoke Operations (functions) that are exposed via open APIs.
- Able to host tenant applications.
- Specific Platform Capabilities may be governed / administered by organizations themselves and some - particularly Utility Platform Capabilities - will be governed / administered by industry groups.
- The primary means for supporting integration between separate platforms.

9.3. APIs

Platform Capabilities define a set of APIs that expose the service that it provides and is the sole means by which consumers can interact with a platform capability that exposed services from a Platform.

APIs are the principal means for achieving conformance and interoperability.

10. Appendix B: Platform Capability Definitions for Management Platforms and HIP

Note all embedded URLs need to be checked against final R17-5 Deliverables.

This Appendix B specifies the normative definition for the four Platform Capabilities:

- Catalog Platform Capability,
- Functional Platform Capability,
- Platform Capability Management,
- Platform Management.

That have been identified for realizing Management Platforms and Hybrid Infrastructure Platforms.

The separation of platform capabilities based on stakeholder and values streams facilitates:

- simplification of Platform Capability specification change management as each has a smaller number of business objective aligned stakeholders driving changes
- development of reusable software modules within a Platform that have microservices/ interfaces that evolve solely to address a single stakeholder group;
- re-use of the same generic Open APIs in multiple capability deployments by use of profiles and context definitions (TR263E) thus avoiding the creation of unwieldy brittle interfaces that try to do everything.

Each of these platform capability specifications follows a standard template recorded section 10.6 and identifies the required APIs, data models and supporting implementation documents.

In Release 17.5.0 an implementation document been developed for describing the deployment context for Platform Capabilities and APIs. TR263E Context Management R17.5.0.

Future options include developing instances of these context specifications for specific deployment scenarios e.g. for 5G described as in IG1152 Dynamic Network Slices Management and Business Models R17.0.1

10.1. Catalog Platform Capability

As described later in 7. Platform extended Principles, there is a need for metadata about the Platform, Platform Capabilities and API capabilities to be published in a catalog so that potential consumers / tenants of the platform can discover the Platform, Platform Capabilities and APIs, and have sufficient information to select and automatically on board them. Current work in 'IG1141 Well Enabled Package and TR 269 Packaging Metadata' identifies priority metadata and is proposing the use of

OASIS TOSCA with minimal extensions to capture this information in a machine processable form.

It is expected the Catalog Platform Capability would most likely be realized on a different platform from the HIP - see section 7.1 - but there are strong dependencies between the two, which is why it is addressed first.

The Catalog Platform Capability facilitates several business and technical objectives:

1. Publication of Catalog Platform capabilities may be presented via a proxy, see 7. Platform Extended Principles , so that the burden of publication for this metadata is not placed on each Platform and HIP instance individually.
2. Facilitates a Marketplace for Platforms / HIP and supporting virtualized applications and VNF as shown in the enabling VNF Marketplace Catalyst TM Forum Live Nice 2017.
3. Publication of this metadata (as exhibited in the table that follows) allows for onboarding of instances of HIP platforms to be automated and facilitates the configuration of the Platform Capabilities and APIs, allowing them to be invoked and correctly bound to other OSS functions realized as OSS / BSS Platforms.
4. The publication of such metadata supports a software factory / modeling driven approach for creating instances of Management Platforms and Hybrid Infrastructure Platforms used in multiple different deployments.

Template Field	Comment
Platform Capability Title	Platform Catalog
Platform Capability Description	The Catalog Platform Capability supports a number of operational services for the diverse metadata about a specific Platform and its Platform Capabilities and APIs. • Upload and lifecycle management of metadata • Publication and discovery of metadata Much of this metadata information will be gathered by the automated onboarding and lifecycle management capabilities that are described in IG1141 and covers technical, operational, commercial and collaboration / partnering information.
Supports User Stories / Use Case ID User roles	• TR229: 4.3.3. User Story NR 1: NFV Readiness Procurement for Network Planner here • TR229A: 10. Smart City Resource Onboarding User Stories
Required APIs	• TMF662 Entity Catalog Management API REST Specification R17.0.0 supporting the ability to store content and relationships among diverse entity metadata, covering the Platform

Template Field	Comment
	itself and its Platform Capabilities, APIs and other supporting elements. o Alternative Domain restricted versions include: ▪ For Resource Management Domain: TMF634 Resource Catalog Management API REST Specification R17.0.0 ▪ For Service Management Domain: TMF633 Service Catalog Management API REST Specification R16.5.1 ▪ For Product Management Domain: Product Catalog Management API REST Specification (TMF620) R14.5.1 • Navigation or Topology API to navigate the complete set of metadata defined in onboarding template IG1141 Procurement and Onboarding of Virtualization Packages R16.5.1 • TMF650 Onboarding Management API REST Specification R16.0.1 Onboarding API with extensions to support well enabled software, e.g., VNF and Network Service (NS) Packages, based on o IG1141 Procurement and Onboarding of Virtualization Packages R16.5.1 o TR269 Onboarding Automation and Package Metadata R17.0.0
Specification of Platform capabilities covering: Scenarios, Best practices incl. Biz rules, sequencing of APIs, Technical Rules API constraints, extension mechanisms.	Need a formal definition of: • Catalog API extensions for entry / upload of Metadata about Platform, Platform Capabilities and supporting APIs into an Entity catalog. • Catalog Entity Lifecycle API to allow upload, release to General availability, remove from GA (but with information still available for historical / HNMP), retire and archive metadata. • Topology navigation API to determine dependencies among these metadata entries. • API Operations to support versioning including: o update versions of Metadata individually, or as packages, o determine differences between revisions and versions.

Template Field	Comment
Information and Data model entities used	• Metadata described in o IG1141 Procurement and Onboarding of Virtualization Packages R16.5.1 o TR269 Onboarding Automation and Package Metadata R17.0.0
Template metadata (governance, owner, version, date)	R17-5 ZOOM team, Dec 2017

10.2. Operations Service / Resource Management (functional) Platform Capability

Fulfillment and assurance are listed as separate platform capabilities to simplify presentation and Change Management.

For intent based management the internal implementation of the Management Platform will link the SLA specification of the customer /tenant Fulfillment request to the Assurance SLA reporting.

See section 6.1 for description of the difference between Intent based management model which is preferred and detailed management that supports legacy integration models and is needed for Hybrid Infrastructure management.

10.2.1. Service / Resource Management Fulfillment Specification

Template Field	Comment
Platform Capability Title	Service / Resource Fulfillment Operations
Platform Capability Description	This capability allows the ordering and/or provisioning of instances of Domain models, including service and resource models, in response to individual client requests for network capabilities or services (tenants in Cloud Native Language) that may be partitioned vertically and layered horizontally. (Note: "Client " refers to the client of the Management Platform and not the end user or customer.). These service and network capabilities may use resource models that are detailed or intent based, or combinations of both, and may include SLA targets for instances of service

Template Field	Comment
	and network capabilities. Instance of these service and network capabilities can be considered to be equivalent to tenant services in cloud native language. Partitioning and layering needs to support: • e2e services across component services, networks, content and application servers. • Horizontal layering of network services going from vendor and technology neutral, to technology and vendor specific. • Vertical partitioning of those E2e networks to support domains representing network roles, e.g. access, core; and technology partitions including legacy networks. • Networks capability requests needs to support inclusion of SLA targets, service and network capability characteristics. *The approach here is extensible to other Management Platform Domains e.g., Customer and Product Domains with additional work on Platform Capabilities including information and data models.*
Supports User Stories / Use Case ID User roles	• TR229: TR229 User Stories Fx15-5 4.5.1. User Story O1 Operations manager managing digital communications services • TR 229A: 11. Service/Resource Fulfilment and Operations 11.2. Resource Ordering and Provisioning - supporting Product Manager
Required APIs	• For both Intent and Detailed based management: o Service Management Domain: ▪ TMF641 Service Ordering Management API REST Specification R16.5.1 ▪ TMF638 Service Inventory Management API REST Specification R16.5.1 o Resource Management Domain: ▪ TMF652 Resource Ordering Management API REST Specification R16.5.1 ▪ TMF639 Resource Inventory Management API REST Specification R17.0.0 • For detailed management (legacy) : TMF664 Resource Function Activation and Configuration API REST Specification R17.0.0

Template Field	Comment
Specification of Platform capabilities covering: Scenarios, Best practices incl. Biz rules, sequencing of APIs, Technical Rules API constraints, extension mechanisms.	Scenarios: • **IG1152** Dynamic Network Slices Management and Business Models R17.0.1 (5G Network Slicing related) Implementations Guidelines (technical rules, API constraints etc.) according to: • TR255 Resource Function - Activation and Configuration R17.0.0 • TR255A (IG1147) Connectivity Patterns for Virtualization Management R17.0.0 Check for R17-5 • TR255B (IG1150) Specification Requirements for Resource Functions R17.0.0 Check for R17-5 • TMF070A Hybrid Infrastructure Platform (HIP) Implementation and Deployment Blueprint R17.5.0 • TMF070A Hybrid Infrastructure Platform (HIP) Implementation and Deployment Blueprint R17.5.0 • TMF070B Advanced Platform Deployment Blueprints R17.5.0 • TR262 Management Platform Blueprint and application to Hybrid Infrastructure R17.5.0 Appendix C: Additional HIP Principles Ordering and Entity Provisioning R17.5.0 • TR263 Deployment Integration patterns and best practices for HIP: Overview R17.0.0 Check for R17-5 • TR263A Coordination Terminology and Classification of Associated Problems R17.0.0 Check for R17-5 check this list and URLs
Information and Data model entities used	Models based on • TR255A (IG1147) Connectivity Patterns for Virtualization Management R17.0.0 Check for R17-5 • TR255B (IG1150) Specification Requirements for Resource Functions R17.0.0 Check for R17-5 The core Information Models notably Service and Resource models are now in: • **GB922** Information Framework (SID) R17.0.0 Specifically: • Service Management Domain: o GB922 Service Overview R17.0.0

Template Field	Comment
	• Resource Management Domain: o GB922 Logical and Compound Resource R17.0.1GB922 o Logical and Compound Resource Computing and Software R17.0.1 o *Note the Information framework enhancements for virtualization proposed in TR244 TM Forum Information Framework Enhancements to Support ZOOM R15.0.1 are now deprecated as the requirements have been incorporated in the updated GB922 Logical Resource Documents. The updated GB922 Logical Resource documents have included the flexible Resource Function model which is the basis of TMF070 and TR 255 specifications and a generalization of NFV specific concepts like Network Services Virtual Resources and VNF. This permits these models to be applied uniformly to multiple technologies including SD-WAN, 5G, etc.* Data models: • TMF625 API Data Model R16.0.1 • For Detailed management where SLA requirements are transferred use of models in Management API REST Specification (TMF623) R14.5.1, i.e., o Resource Model - TMF623 o SLA Operations - TMF623 o TMF623SLA Violation Resource Model UML
Template metadata (governance, owner, version, date)	R17.5 ZOOM team, Dec 2017

10.2.2. Service / ResourceManagement Assurance

10.2.3. Specification

Template Field	Comment
Platform Capability Title	Service / Resource Assurance Operations
Platform Capability Description	This capability allows the assurance of instances of Services and Network capabilities / services. For detailed based services the assurance process many include traditional Alarm management / event reports, for intent based management the approach will be based on reporting against SLA targets set in the ordering / provisioning requests.
Supports User Stories / Use Case ID User roles	• TR229A: 12. Resource/ Service Assurance and Operations; and Continuous Improvement QA Processes 12.2. Resource/ Service Assurance Operations
Required APIs	*For Both Intent based and Detailed Based management* • TMF623 SLA Management API REST Specification (TMF623) R14.5.1 • TMF649 Performance Threshold API REST Specification R17.0.0 • TMF 628 Performance Management API REST Specification (TMF628) R14.5.1 • TMF642 Alarm Management API REST Specification R17.0.0
Specification of Platform capabilities covering: Scenarios, Best practices incl. Biz rules, sequencing of APIs, Technical Rules API constraints, extension mechanisms.	Scenarios • IG1127 Hybrid/Virtualized Network Management: E2E Service Assurance and SLA Management R16.0.1 Implementation Guidelines (technical rules, API constraints etc.) according to: • TR178 Enabling End-to-End Cloud SLA Management V2.0.2 • *SLA Management API REST Specification (TMF623) R14.5.1* • *Additional scenarios and Guidelines are being mined from prior work on MTNM R4.5 and MTOSI 4.0 management interfaces* o TMF513 MTNM Business Agreement R4.5 o Resource Management & Operations related – DM-DDPs – NetworkResourceAssurance (NRA)
Information and Data model entities used	• TMF623 SLA Event Model • TMF623 Resource Model

Template Field	Comment
	• TMF623 SLA Violation Resource Model UML
Template metadata (governance, owner, version, date)	R17.5 ZOOM team, Dec 2017

10.3. Platform Capability Management: Lifecycle Onboarding and Planning

Even though the stakeholders are similar, this platform capability is divided into two separate platform capabilities:

- Lifecycle On-boarding Management,
- Analytics and change management,

to simplify presentation and change management.

Both of these Platform Capabilities are concerned with managing the functional platform capability for tenants, and its evolution over time including planning the available capacity.

Note: The priority in this release has been to identify and codify the metadata hat has to be exchanged as information may be exchanged as files or in a catalog- using say CSAR structure - rather than by use of transactional or event based APIs.

10.3.1. 6.3.1. Lifecycle onboarding management

Template Field	Comment
Platform Capability Title	Lifecycle Onboarding Management
Platform Capability Description	This capability allows onboarding of software components / packages used to realize Management Platforms including HIP both when the Management Platform instance is first created and on an ongoing basis as updates are required. Initially The focus is on basic linkage between the supplier and consuming SP through the exchange of metadata for Well Enabled Software (VNF) Packages covering technical, operational, commercial business and financial aspects. It also supports configuration changes to various templates, plans and run books used to deploy software components including VNF Packages.

Template Field	Comment
	Subsequently, the linking of continuous integration and DevOPs development environments of supplier and consumer will need to be supported - aka Joint Agile Delivery - JAD.
Supports User Stories / Use Case ID User roles	• IG1123 NFV Readiness: Packaging Virtualized Network Services for Procurement and Operations R14.5.1 • TR229 ZOOM/NFV User Stories Suite R17.0.0 o TR 229: 4.3.3User Story NR 1: NFV Readiness Procurement for Network Planner 4.3.4 User Story NR 2: NFV Readiness Procurement for Procurement Executive 4.4.2 User Story NR 3: NFV Readiness Procurement for Developer 4.5.3 User Story NR 4: NFV Readiness Procurement for Operations Manager o TR229A: Section 9 Procurement and Onboarding User Stories
Required APIs	• TMF662 Entity Catalog Management API REST Specification R17.0.0 see section 5.1 in which to record Metadata. Work in progress and candidate APIs (Note priority has been to agree required metadata rather than transport mechanisms • *TMF650 Onboarding Management API REST Specification R16.0.1 extended to support Well Enabled Software (VNF) Packages (extensions are work in progress)* • *Licensing API* to allow on boarding of Licenses, License Pools, changes to licenses following IG1143 (R 16-5) principles. (Proposed work) • *Engineering Change Management API Specification* (add URL) (with Well Enabled Software(VNF) Packages (R17-0) to initiate requests for changes to software components/packages used to realize Management Platforms. • *Testing API:* CI / CD Agile DevOps APIs to support Joint Agile Delivery (based on pragmatic use of current tools such as Puppet, Jenkins, Chef, Ansible among others.)

Template Field	Comment
Specification of Platform capabilities covering: Scenarios, Best practices incl. Biz rules, sequencing of APIs, Technical Rules API constraints, extension mechanisms.	Scenarios: IG1123 NFV Readiness: Packaging Virtualized Network Services for Procurement and Operations R14.5.1 Implementation Guidelines (technical rules, API constraints etc.) according to: • o IG1141 Procurement and Onboarding of Virtualization Packages R17.5.0 o IG1141A Onboarding Automation: Package ID, Software Assets and License Management Support o IG1141B Onboarding Automation: VF Categorization and Orchestrateability o TR269 Onboarding Automation and Package Metadata R17.5.0 Metadata types identified in Open Baton, OSM, OPEN-O and OPNFV Open Source projects, and ETSI IFA 11 &14, encoded using a TOSCA template.
Information and Data model entities used	Metadata specified in: • IG1141 Procurement and Onboarding of Virtualization Packages R16.5.1 • IG1141A Onboarding Automation: Package ID, Software Assets and License Management Support • IG1141B Onboarding Automation: VF Categorization and Orchestrateability • TR269 Onboarding Automation and Package Metadata R17.5.0
Template metadata (governance, owner, version, date)	R17.5 ZOOM team, Dec 2017

10.3.2. Analytics and Change Planning

Template Field	Comment
Platform Capability Title	Analytics and change planning
Platform Capability Description	Release 17-5 has been mostly about establishing requirements for this platform capabilities although partial solutions have been established. The primary business goal is to provide the stakeholders responsible for the planning and evolution of the Management Platforms with a set of platform capabilities for them to operate OSS /BSS analytics function to identify failures / impairments of both the on-boarded capabilities themselves, and any induced by or related to the Platform Infrastructure (PaaS) or Hardware on which it is run. This approach is inspired by techniques published by AT&T ECOMP, Microsoft Azure and Amazon Web Services, and the technical moves towards using to Big data Analytics AI/ML and Policy based management technologies. The two key capabilities are: 1. Analytics. This Platform Capability provides the stakeholder with the data streams of metrics and other information to allow them to assess: a. Traffic/ throughput capacity of the platform and whether resources pools (compute, storage, network) need to be scaled up or down. This is similar to the scaling up and down of tenant services however it applies to the underlying resources used i.e. the how, rather than the service i.e. what SLA has to be offered. This distinction emerged in the development of TMF 664 where one needs to configure and activate tenant services and the mapping from the tenant service to the underlying Topology resources. Initial results suggest that the same TMF 664 API can be used but with different resource models. See TR255 Part A: (IG1147) Connectivity Patterns for Virtualization Management R17.0 b. Performance of the components comprising the platform and the extent to which they operate correctly on the underlying PaaS/IaaS infrastructure supporting the HIP platform service (SaaS) c. Drive QA improvement processes to improve the quality of all suppliers on boarded capabilities that make up the HIP Platform, i.e. supply chain or value fabric quality assurance.

Template Field	Comment
	d. This capability is associated with onboarding capabilities - well enabled Software Packages - and provides mechanisms and patterns for a standard approach to event data streaming metrics information from the on boarded capability (well enabled Software Package) to a BSS / OSS capability based on Big Data Analytics or other analysis approaches, e.g. AI, cognitive analysis, CEP, ... e. The characteristics of this analytic capability are: i. The vendor of the well enabled Software Package publishes the metadata about the total set of metrics that are available (some are fully standardized and some are partially/vendor standardized by following a common metrics template and measurement principles). ii. The consuming SP decides as part of the onboarding process which metrics to consume and sets up 'the publish and subscribe mechanisms' supported by the vendor to stream the required metrics information to the required OSS functions. 2. Change Management. OSS functions, on detecting patterns of software and software/hardware failures / impairments, will carry out corrective actions by initiating the onboarding and lifecycle processes which can included: a. Initiating additional metrics feeds to further refine and determine the root cause. b. Initiate configuration the HIP Platform through the LIfecycle and Onboarding Platform capability to change internal policy, orchestration and configuration, e.g. prohibit specific versions of software from running on specific types and versions of hardware, or to change the way the tenant services are mapped to the computing, storage, Infrastructure PaaS/IaaS similar to the ETSI NFV Deployment flavors concept but handled outside the operations processes. c. Initiate Engineering Change Request (see On-boarding platform capability to cause the impaired software and or hardware to be upgraded and on-boarded).

Template Field	Comment
Supports User Stories / Use Case ID User roles	• TR229 4.5.4 User Story: O3 Service Quality Manager responsible to a set of major customers • TR229A: 12. Resource/ Service Assurance and Operations; and Continuous Improvement QA Processes 12.3. Continuous Improvement QA Processes • IG1146 Metrics Framework for Big Data and Policy Driven Operations R16.5.1 (Multi-SDO study showing why a common metrics and data/ event streaming approach is need for the highly variable and agile onboarding of well enabled software packages,)
Required APIs	Work in progress and candidate APIs: • Data / Event streaming API aligned between TMF631 Notifications and OPNFV vES *Note the event streaming services may also be used for the Service / Resource Assurance Operations Platform Capability.*
Specification of Platform capabilities covering: Scenarios, Best practices incl. Biz rules, sequencing of APIs, Technical Rules API constraints, extension mechanisms.	Scenarios: • IG1146 Metrics Framework for Big Data and Policy Driven Operations R16.5.1 Implementation Guidelines (technical rules, API constraints etc.) according to: • Draft proposal from AT&T for an event steaming service ONAP vES
Information and Data model entities used	Need a metrics data structure that is partially standardized and extensible to support vendor specific metric. Metrics structure needs to follow Quest Forum and TM Forum Business metrics structure (Proposal provided in R16 and IG 1146 Metrics Framework for Big Data & Policy Driven Operations R16.5) and accommodate open sources specifically OPNFV, OSM and Open Baton). Alignment of NIST Metrics meta-model GB922 Metrics and 3GPP Metrics proposal needed.

Template Field	Comment
	Partly covered by • TR269 Onboarding Automation and Package Metadata R17.5.0 • GB988 TM Forum Metrics Definitions R16.5.1
Template metadata (governance, owner, version, date)	R17.5 ZOOM team, Dec 2017

10.4. Platform Management: Administration Inc Security, Policy Management and Orchestration

10.4.1. Platform Security

TR255D Platform Security and Policy requirements defines a comprehensive model for securing platforms, platform capabilities and Open API based on the concept of software defined perimeters It covers best practice for identifying threat surfaces, carrying out a threat and risk analysis, and configuring security and access control to protect platform capabilities and Open APIs. Use of the CSA SDP approach h gives protection against network attacks including DDoS, Man-in-the-Middle, Server Query (OWASP10) as well as Advanced Persistent Threat (APT).

TR255D Platform Security and Policy requirements recommends the use of specific access control mechanisms using federated identity for all clients invoking Open APIs. Based on identity and roles, access control lists are used to control access to operations and information, including PII, exchanged over Open APIs. Platform management security described in this section is where those access control lists are configured and maintained.

Template Field	Comment
Platform Capability Title	Platform Security
Platform Capability Description	This capability allows the enterprise to manage the security of the resources contained within the Platform Boundary - which include systems, processes, people and information. An

Template Field	Comment
	approach based on Platforms and Platform boundaries intrinsically defines a soft perimeter that is protected by a set of security capabilities that are managed through this Platform Security capability including: • Access Control • Security Configuration • Integrity Verification • Privacy Specification • Monitoring • Incident Response This approach is generic for all TM Forum defined Platforms and Management Platforms and provides the enterprise with a uniform and practical way to manage ALL Platforms.
Supports User Stories / Use Case ID User roles	• 2016-10_PlatformSecurityCapabilityUseCases.pdf • ZOOM-151 ZOOM-151 - Summary of Platform Security Use Cases (Draft) • DSRA Security
Required APIs	Work in progress and candidate APIs: : Platform Security API supporting management of the security services listed above and described in the use cases • TMF672 User Roles and Permissions API REST Specification R17.0.0 • TR243 Privacy Management R16.0.1
Specification of Platform capabilities covering: Scenarios, Best practices incl. Biz rules, sequencing of APIs, Technical Rules API constraints, extension mechanisms.	Scenarios: • 2016-10_PlatformSecurityCapabilityUseCases.pdf Implementation Guidelines (technical rules, API constraints etc.) according to: • TR263D Platform Security and Policy Management R17.0.0 - architectural framework for security of platform access control and assessment methods.

Template Field	Comment
Information and Data model entities used	Access control lists based on federated Identity and roles with a configuration based on threat analysis results described in TR255 Part D. Access control configuration will depend on each specific HIP platform instance of platform capabilities: Operations and Lifecycle onboarding and planning.
Template metadata (governance, owner, version, date)	R17-5 ZOOM team, Dec 2017

10.5. Platform Administration Inc Policy Management and Orchestration

Template Field	Comment
Platform Capability Title	Platform Administration Inc Policy Management and Orchestration
Platform Capability Description	This capability provides the ability to manage the platform itself and the component and well enabled software packages from which it is constructed and their configuration. This capability and the API supporting will be aligned with the DSRA and DPRA .
Supports User Stories / Use Case ID User roles	• IG1139 Business Rationale and Technical Overview for Orchestration and Autonomic Control Loops R16.0.1
Required APIs	Work in progress and candidate APIs: • Digital Service Management API R17.0.0? / • *Orchestration and Policy Management APIs R17-0* • Usage Management
Specification of Platform capabilities covering:	Scenarios:

Template Field	Comment
Scenarios, Best practices incl. Biz rules, sequencing of APIs, Technical Rules API constraints, extension mechanisms.	• IG1139 Business Rationale and Technical Overview for Orchestration and Autonomic Control Loops R16.0.1 Implementation Guidelines (technical rules, API constraints etc.) according to: • DSRA Support Services R17.0.0 ? • IG1139 Business Rationale and Technical Overview for Orchestration and Autonomic Control Loops R16.0.1
Information and Data model entities used	Full list unknown but will include: • Policy (rules) • Orchestration scripts/ TOSCA Plans and run books
Template metadata (governance, owner, version, date)	R17.5 ZOOM team, Dec 2017

10.6. Platform Capability Template

It may be better in the future to do capture this information in a spreadsheet so it can be machine readable and have field constraints and enumerations. It might also be more compact.

Template Field	Comment
Platform Capability Title	
Platform Capability Description	
Supports User Stories / Use Case ID User roles	
Required APIs	
Specification of Platform capabilities covering: Scenarios, Best practices incl. Biz rules, sequencing of APIs, Technical Rules API constraints, extension mechanisms.	
Information and Data model entities used	
Template metadata (governance, owner, version, date)	

11. Appendix C: Additional HIP Principles Ordering and Entity Provisioning R17.5.0

11.1. Ordering and entity provisioning

At first sight the API for Resource Ordering and TMF644 Resource Function Activation and Configuration appear to be alternative proposals for the HIP and its use in a layered context.

Historically the relationship between these two needs has been addressed in the MNTM/MTOSI / MTOP work and specifically in:

Order Management Business Agreement TMF_OM_BA Version 2.1 November 2014

Specifically, the following extract:

This document details the orders between BSS/OSS applications to support:

- Fulfillment Operations eTOM processes (e.g. Fulfillment/Activation/Provisioning)

In addition, this interface proposes an approach that allows for harmonization with MTOSI standards such as Entity Provisioning (and the earlier Service Activation and Resource Provisioning).

11.2. Service/Resource Ordering and Entity Provisioning scenarios

Different vendors/systems have different capabilities. Some are capable of support for entity provisioning (service activation and resource provisioning), others are service or resource order managers and some systems combine these functions. The scenarios below show permutations of systems and how each uses its API to play a role in fulfillment.

Note: These do not necessarily show CFS/RFS layers of Service Ordering/Provisioning and any Catalogue or Inventory interactions

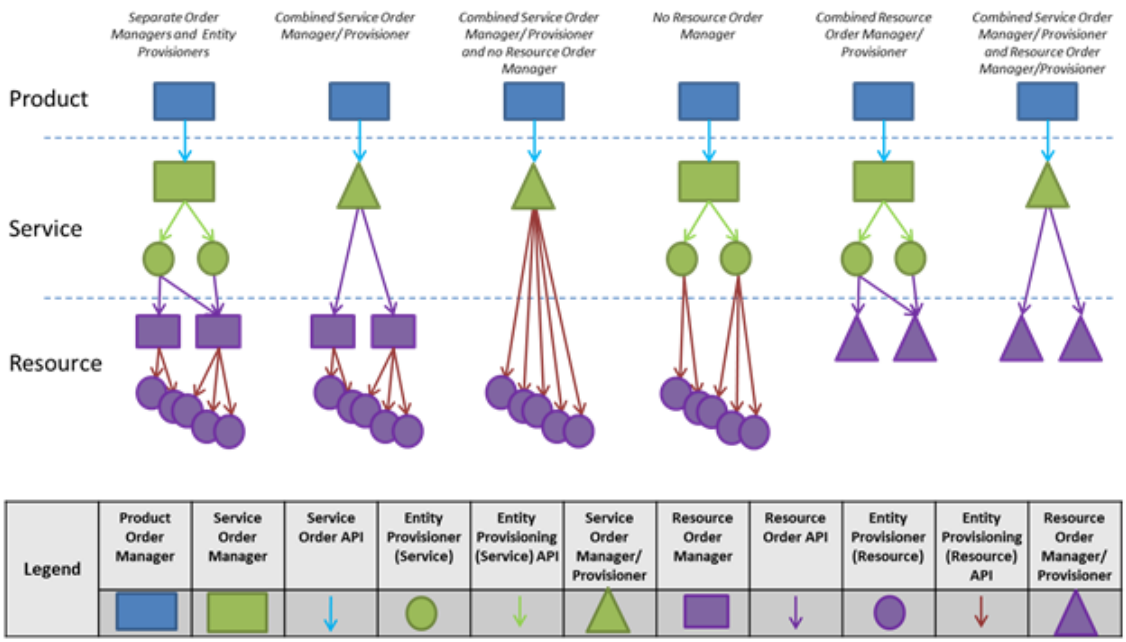

Figure 11-1 - Scenarios of Interface Usage

11.3. Ordering and Entity Provisioning Alignment

In the context of this document the alignment between ordering and entity provisioning is achieved by following the guides laid out below:

- Entity Provisioning Requests contain the information for provisioning service(s) and resource(s). They do not support ordering features such as long execution, scheduling, bundling, dependency sequencing, etc.
- If these features are required then a system capable of supporting the Ordering APIs should be used.
- Service and Resource Orders can be used to “carry” Entity Provisioning Requests in the manner depicted below:

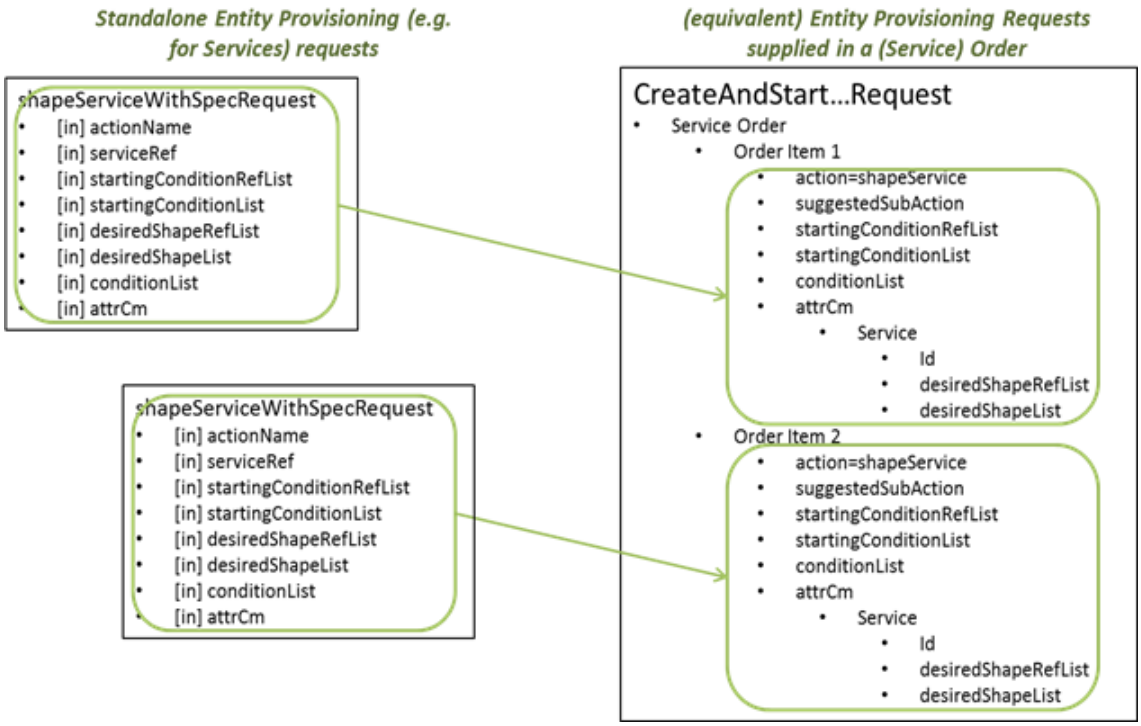

Figure 11-2 - Using Orders for Entity Provisioning (Activation/Provisioning)

12. Appendix D: Exemplar HIP deployment scenarios R17.5.0

Using the high-level models proposed by Vodafone we see that the resource Layer has been explicitly decomposed in three layers one Resource Management with Domain Managers/ Orchestrators, another Technology Management, and finally the Application and Transmission resources themselves.

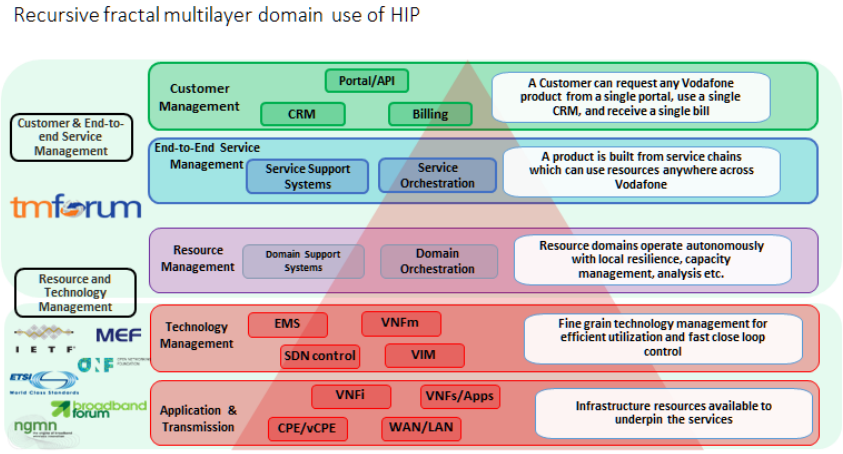

Figure 12-1 - Resource Layering Model

An example set of deployment scenarios for HIP is shown below:

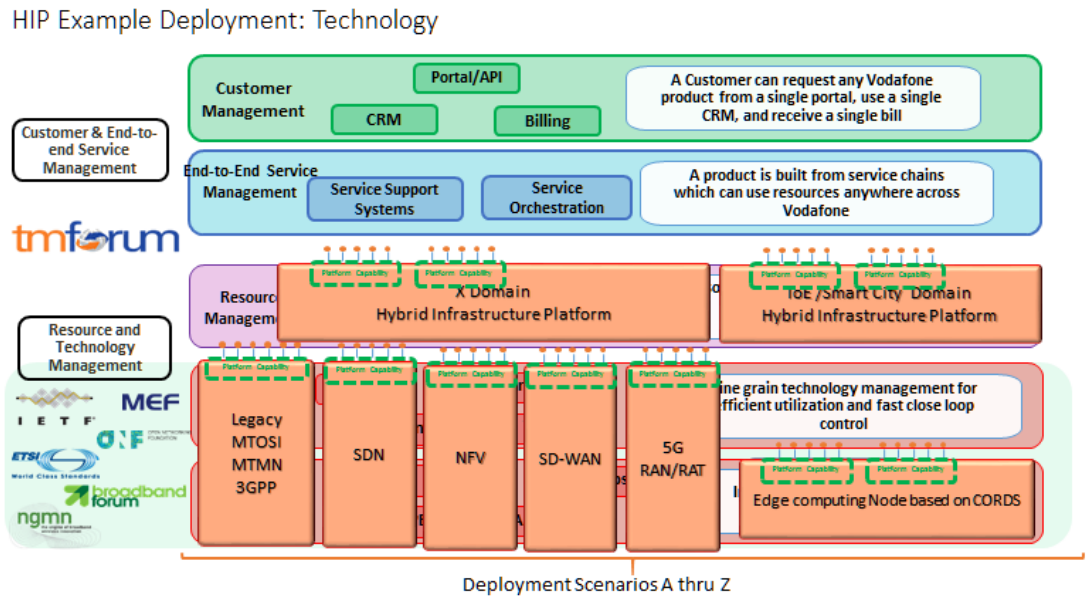

Figure 12-2 - Exemplar deployment scenarios

Which then suggests that as all HIP platform support multiple Platform Capabilities - see below from draft TR 262 TR262 Hybrid Network Management Platform Blueprint

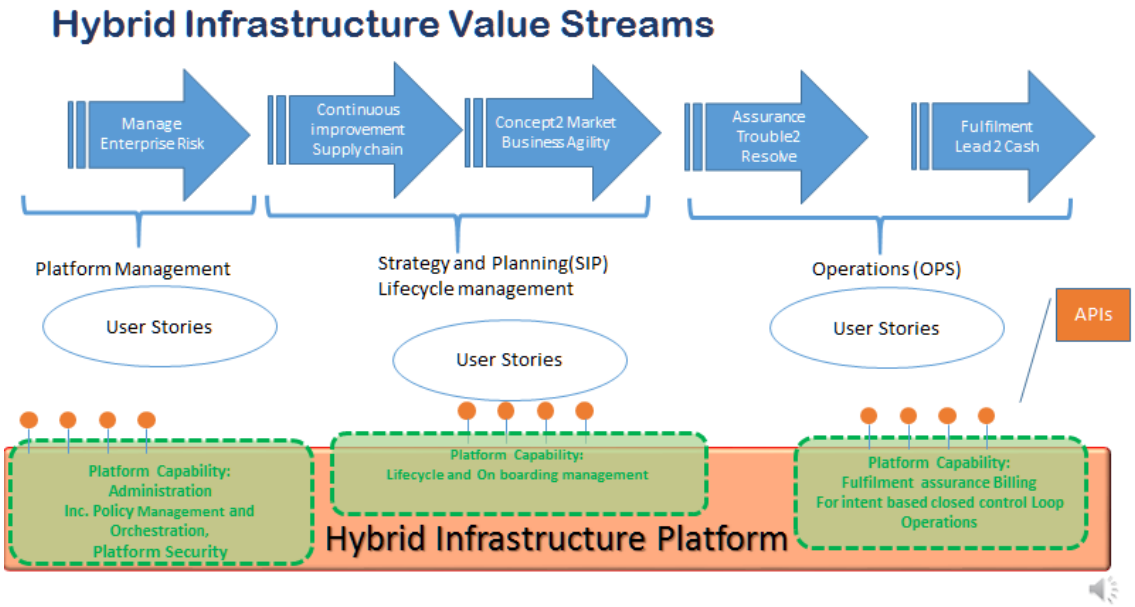

Figure 12-3 - Platform Capabilities to support Ordering and Resource Function Activation and Configuration

The one on the RHS is Service Resource Fulfillment and Operations which will use Resource Ordering and Entity Provisioning APIs in some combination.

What remains to be done is to propose guidelines best practice for using these platform capabilities at different levels in the deployment examples, and for different types of technology.

This leads essentially to profiles for the combined use of Resource Ordering and Entity Provisioning APIs to support the deployment examples as above or extended.

13. Appendix E: ZOOM Project Goals and Principles

Management Platform and Hybrid Platform Infrastructure is a workstream within the current ZOOM Project.

In setting up the project a number of goals and principles were defined which have influenced Section 3 User stories and Section 4 Management Platform and Hybrid Infrastructure Platform Requirements / Principles.
As these goals and principles were not captured in a formally published document they are reproduced here noting that two other work streams are also contributing to this vision.

- On-boarding and Lifecycle Management (OLM) focused on automated commercial and technical onboarding;
- Operations Center of the Future (OCF) which covers DevOps and other operational considerations.

13.1. Goals: Virtual Operations Vision

Achieve a Virtual Operations Vision that supports:

- Zero-touch, self-service operations that can respond with the speed and agility to outpace competitors.
- Adaptive automation, where changes in user needs, business goals, and/or environmental conditions are recognized, and a new, agile OSS uses these inputs to provide the resources and services needed at that point in time.
- Personalized services that are easily configured to fit individual customer preferences and requirements, by the customer themselves.
- Significantly lower operating costs and capital expenses achieved through automation of manual tasks, simplification of configuration, virtualization and use of commodity-based resources.
- Technology-driven innovation, where business agility meets rapid development and experimentation and enables the transition from NetOps and SysOps to DevOps.

13.2. ZOOM Principles

- **Open**, dynamic APIs, exposing standardized network and management functions all layers.
- **Transparent end-to-end management** across both horizontal and vertical boundaries.

- **Event-driven**, **using policy management, data, and metadata,** enabling automated management. Management is driven via closed control loop, and may be augmented by analytics.
- **Integrated analytics**, enabling consistent view and analytics from physical to virtual, by design.
- **Self-service**, requiring minimal intervention from expert resources and enabling customer configuration.
- **Service and business model agnostic**, enabling a flexible range of services and monetization models.
- **Multi-tenancy capabilities** native to the infrastructure.
- **Near Real-time and zero-touch**, executing requests rapidly without human intervention.
- **Hardware agnostic**, separating hardware and software layers, with intelligence held in the software.
- **Resilient** to hardware failure and localized load demands through intelligent software.
- **Security and privacy** assured by design and at multiple levels.
- **Software License management** built in rather added on to enable flexibility.

14. Appendix F: Terms & Abbreviations Used within this Document TR262 R17.5.0

14.1. Appendix F: Terms & Abbreviations Used within this Document

14.1.1. Terminology

Term	Definition	Source

14.1.2. Abbreviations & Acronyms

Abbreviation/Acronym	Abbreviation/Acronym Spelled Out	Definition	Source
API	Application Programming Interface	general industry term	
BSS	Business Support System	general industry term	
CFS	Customer Facing Service	GB922 Service addendum	
OSS	Operations Support System	general industry term	
HNMP	Hybrid Network Management Platform	this document	
RFS	Resource Facing Service	GB922 Service addendum	

14.2. Appendix F: References

OASIS TOSCA **IG1139** Business Rationale and Technical Overview for Orchestration and Autonomic Control Loops R16.0.1

Reference	Description	Source	Brief Use Summary
Project Charter	Project Charter		
Link to Models			
Diagrams	TR262 Hybrid Network Management PlatformDiagrams-v8.pptx		
	Platform Revolution Geoffrey G Parker		ISBN 978-0-393-24913-2
	DSRA Digital Services Reference Architecture Guide R16.0.1		
	IG1118 OSS / BSS futures		
	TR229 ZOOM/NFV User Stories R14.5.1		
	TR229A User Stories for Hybrid Network Management R17.0		
	TR255 Entity Provisioning for Network Functions and Network Services		
	TR263 Managing Network Service and Network Function Packages for Automation		
	IG1137 Transformation of NetOps to DevOps R16.0.1		
	IG1139 Business Rationale and Technical Overview for Orchestration and Autonomic Control Loops R16.0.1		
	IG1140 title tba		
	IG1147 Connectivity Patterns for Virtualization Management		
	Open APIs		

14.3. Administrative Appendix

This Appendix provides additional background material about the TM Forum and this document. In general, sections may be included or omitted as desired; however, a Document History must always be included.

14.3.1. Document History

Version History

Version Number	Date Modified	Modified by:	Description of changes
1.0.0	14-Nov-2016	Dave Milham	Initial team approved version
1.0.1	17-Nov-2016	Alicja Kawecki	Updated cover, formatting/grammatical edits, renumbering sections prior to publication for Fx16.5
1.0.2	6-Jun-2017	Dave Milham	updated to use term Hybrid Infrastructure Platform and to include APIs and documents developed for release 17
1.0.3	5-Jul 2017	Alan Pope	Corrected all references to TMF664 Resource Function Activation and Configuration API
1.0.4	12-Jul-2017	Alicja Kawecki	Minor formatting/style edits prior to publication for Fx17
1.0.5	20-Nov-2017	Adrienne Walcott	Minor formatting/style edits prior to publication
1.0.6	15-Nov-2017	Dave Milham	Restructure to handle change of scope from HIP to cover management platforms in general e.g. Customer, Product, Service Resource Domains
1.0.7	27-Dec-2017	Adrienne Walcott	Formatting/style edits prior to publishing
1.0.8	05-Apr-2018	Adrienne Walcott	Updated to reflect TM Forum Approved Status

Release History

Release Number	Date Modified	Modified by:	Description of changes
17.0.0	14-Nov-2016	Dave Milham	Initial release
17.0.1	20-Nov-2017	Adrienne Walcott	Updated to reflect TM Forum Approved Status
17.5.0	4-Dec-2017	Dave Milham	Extend scope form HIP to Management Platforms
17.5.1	05-Apr-2018	Adrienne Walcott	Updated to reflect TM Forum Approved Status

14.3.2. Acknowledgments

This document was prepared by the members of the TM Forum ZOOM team:

- Dave Milham, TM Forum
- Stephen Fratini, Ericsson
- Tayeb Ben Meriem, Orange
- Milind Bhagwat, BT
- Jenny Huang, AT&T
- Johanne Mayer Oracle
- Johanne Mayer Telstra
- Yuval Stein, TEOCO
- David Milham, TM Forum

Additional input was provided by the following people:

- Michel Besson, TM Forum, MTOSI inputs
- Nigel Davis, Ciena, MTOSI Inputs
- George Glass, BT, Platform transformation
- Milind Bhagwat, BT - TMF644 Resource Function Activation and Configuration and catalyst inputs
- Lester Thomas, Vodafone, Platforms diagrams
- Kevin Brakenpool, Vodafone, MEF deployment architecture slides

15. Business Model Canvas

Board Options

- Remove all cards
- java script:
- Need help?

Key Partners	Key Activities	Value Propositions	Customer Relationships	Customer Segments
Who are our key partners? Who are our key suppliers? Which key resources are we acquiring from partners? Which key activities do partners perform?	What key activities do our Value Propositions require? Our Distribution Channels? Customer Relationships? Revenue Streams?	What value do we deliver to the customer? Which one of our customer's problems are we helping to solve? What bundles of products and services are we offering to each Customer Segment? Which customers' needs are we satisfying?	What type of relationship does each of our Customer Segment expect us to establish and maintain with them? Which ones have we established? how are they integrated with the rest of our business model? How costly are they?	For whom are we creating value? Who are our most important customers?
Who are our key partners? Who are our key suppliers? Which key resources are we acquiring from partners? Which key activities do partners perform?	What key activities do our Value Propositions require? Our Distribution Channels? Customer Relationships? Revenue Streams? Key Resources	What value do we deliver to the customer? Which one of our customer's problems are we helping to solve? What bundles of products and services are we offering to each Customer Segment?	What type of relationship does each of our Customer Segment expect us to establish and maintain with them? Which ones have we established? how are they integrated with the rest of our business model? How costly are they? Channels	For whom are we creating value? Who are our most important customers?
	What Key Resources do our Value Propositions require? Our Distribution Channels? Customer Relationships? Revenue Streams?	Which customers' needs are we satisfying?	Through which Channels do our Customer	
	What Key Resources do			

	our Value Propositions require? Our Distribution Channels? Customer Relationships? Revenue Streams?		Segments want to be reached? How are we reaching them now? How are our Channel integrated? Which ones work best? Which ones are most cost-efficient? How are we integrating them with customers routines? Through which Channels do our Customer Segments want to be reached? How are we reaching them now? How are our Channel integrated? Which ones work best? Which ones are most cost-efficient? How are we integrating them with customers routines?	

Cost Structure	Revenue Streams
What re the most important costs inherent in our business model? Which Key Resources are most expensive? Which Key Activities are most expensive? What re the most important costs inherent in our business model? Which Key Resources are most expensive? Which Key Activities are most expensive?	For what Value are our Customers really willing to pay? For what do they currently pay? How are they currently paying? How would they prefer to pay? How much does each Revenue Stream contribute to overall revenue? For what Value are our Customers really willing to pay? For what do they currently pay? How are they currently paying? How would they prefer to pay? How much does each Revenue Stream contribute to overall revenue?

16. ZOOM Business Model Canvas R17.5.0

16.1. Business Model Canvas

Board Options

- Remove all cards
- JavaScript:
- Need help?

ZOOM Procurement and Onboarding	Key Partners Who are our key partners? Who are our key suppliers? Which key resources are we acquiring from partners? Which key activities do partners perform? Who are our key partners? Who are our key suppliers? Which key resources are we acquiring from partners? Which key	Key Activities What key activities do our Value Propositions require? Our Distribution Channels? Customer Relationships? Revenue Streams? What key activities do our Value Propositions require? Our Distribution Channels? Customer Relationships? Revenue Streams? Key Resources What Key Resources do our Value Propositions require? Our Distribution Channels? Customer Relationships? Revenue Streams? Software	Value Propositions What value do we deliver to the customer? Which one of our customer's problems are we helping to solve? What bundles of products and services are we offering to each Customer Segment? Which customers' needs are we satisfying? What value do we deliver to the customer? Which one of our	Customer Relationships What type of relationship does each of our Customer Segment expect us to establish and maintain with them? Which ones have we established? how are they integrated with the rest of our business model? How costly are they? What type of relationship does each of our Customer Segment expect us to establish and maintain with them? Which ones have we	Customer Segments For whom are we creating value? Who are our most important customers? For whom are we creating value? Who are our most important customers?

	activities do partners perform?	products and services operating on cloud computing distributed platform operated by SP or third party. What Key Resources do our Value Propositions require? Our Distribution Channels? Customer Relationships ? Revenue Streams? Software products and services operating on cloud computing distributed platform operated by SP or third party.	customer's problems are we helping to solve? What bundles of products and services are we offering to each Customer Segment? Which customers' needs are we satisfying?	established? how are they integrated with the rest of our business model? How costly are they? Channels Through which Channels do our Customer Segments want to be reached? How are we reaching them now? How are our Channel integrated? Which ones work best? Which ones are most cost-efficient? How are we integrating them with customers routines? Self-service automated channel using web and Phone Apps -Back up manual call Centre support Through which Channels do	

				our Customer Segments want to be reached? How are we reaching them now? How are our Channel integrated? Which ones work best? Which ones are most cost-efficient? How are we integrating them with customers routines? Self-service automated channel using web and Phone Apps -Back up manual call Centre support	

	Cost Structure What re the most important costs inherent in our business model? Which Key Resources are most expensive? Which Key Activities are most expensive? What re the most important costs inherent in our business model? Which Key Resources are most expensive? Which Key Activities are most expensive?	Revenue Streams For what Value are our Customers really willing to pay? For what do they currently pay? How are they currently paying? How would they prefer to pay? How much does each Revenue Stream contribute to overall revenue? For what Value are our Customers really willing to pay? For what do they currently pay? How are they currently paying? How would they prefer to pay? How much does each Revenue Stream contribute to overall revenue?

17. Conclusions and Next steps

17.1. Conclusions

This Platform Blueprint has outlined the key business challenges for implementing agile management solutions, and has defined a common management platform model that can be applied to Customer, Product, Service and Resource Management. The Management Platform approach to agility is based on automation of Business Process Framework Operations, Strategy and Enterprise processes realized through Platform Capabilities that are realized using OPEN APIs according to a set of best practices proposals.

The normative specifications for realizing the required platform capabilities are stated in Appendix B.

This blueprint references additional specification documents - mostly in the TMF070, TR263 and TR255 Series- that defines how to implement the management of Hybrid Infrastructure Platform that supports automation of

Multi-vendor, multi-technology and hybrid physical and virtualized network capabilities.

17.2. Next Steps

It is expected that this document will evolve based on feedback from further Catalysts and other implementation experiences.

- Extension of Platform Capabilities implementation specifications to address:
    - Platform Capability Management to support Lifecycle onboarding and planning processes particularly Virtual Function metadata on boarding as Identified in TR269 and IG 1141 Parts A and B
    - Platform Management capabilities to support management of the platform itself based on extension to the DSM-API being developed in R17-5
- Explicit support of Onboarding Automation using TOSCA principles for Management Platforms including HIP.
- Formal linkage/ incorporation in the Open Digital Architecture (Future OSS) which will define software components called Framelets to implement the architectural concepts in:
    - This document
    - Digital Platform Reference Architecture (DPRA).
    - Digital Service Platform Architecture (DSRA) that identifies a (software) component model for composition and a set of Support Service some of which are used by the Platform Capabilities as defined in this document.
    - Future OSS BSS including IG1118 covering future mode of operation.

- Management Platform Implementation examples for 5G and Edge computing where Hybrid Infrastructure Platform concepts will be extended to cover Resource, Service Product and Customer Management Platforms to address:
    - Multi-party business model for delivering 5G enables services
    - Hybrid networks comprising Legacy and virtualized networks.
    - Hybrids of network and edge computing applications
    - Network Slicing and associated assure Quality ServiceHybrids of networks and content servers.
    - Others identified in scoping Release 18.