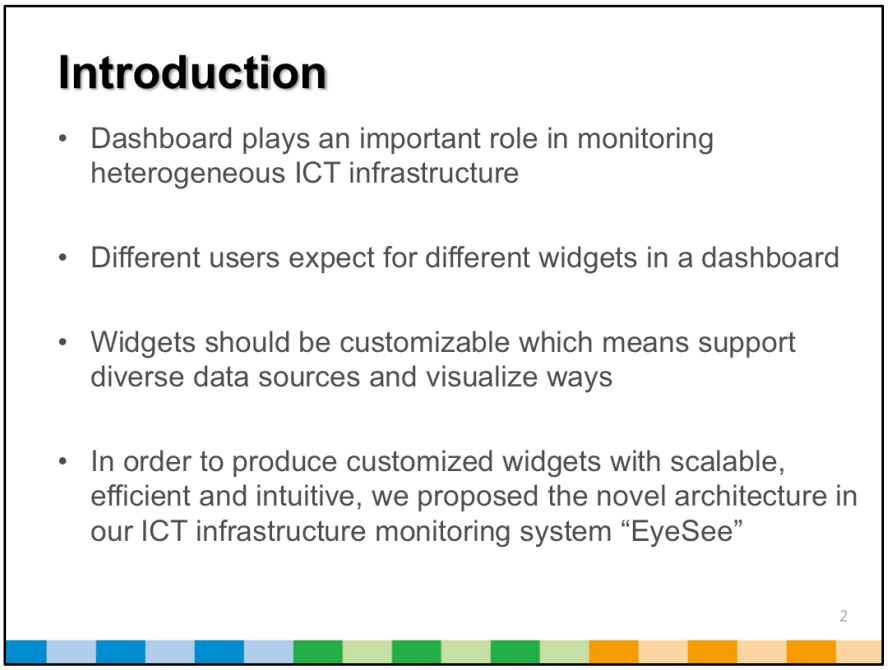
ABSTRACT

Monitoring plays a significant role in improving the quality of service. For better visualizing the performance data, it is used to adopt dashboard, which is comprised of widgets, to allow humans to interpret and transform the raw monitored data into meaningful information. However, due to the diverse perspectives of user on virtualization, the main challenge to tackle is how to produce customizable widgets with efficient process and simple configuration. In this paper, we present a novel template-based architecture for ICT infrastructure monitoring system that offers a construction method of dashboard widgets which allows operation team to customize the metric data in a widget using dynamically binding mechanism to link between metric data and the user layout. Besides, a dashboard user in different positions in a company or different scope of official duties can construct their own dashboard to support them work more efficiently and accurately. This architecture has been implemented in our network management service called EyeSee, which will be introduced later.

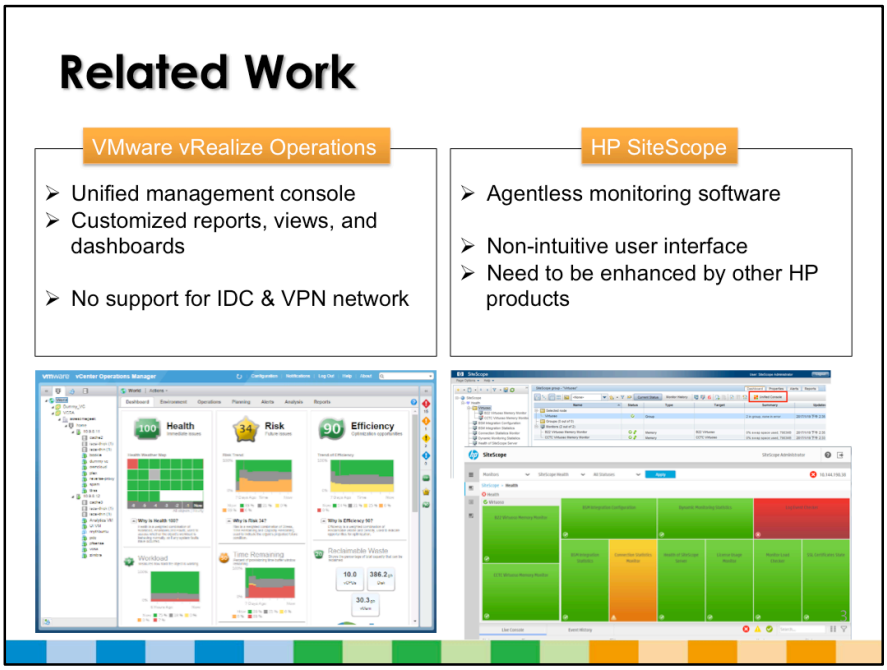


1. INTRODUCTION

According to the industrial report from Ovum 2016, the transformation from CT to ICT happens so tremendously to those global telecommunications companies. The report also forecast that the revenue from ICT business will exceed the revenue from traditional CT business in 2018. Therefore, with the rapid growing of ICT businesses which integrated traditional CT and IT technologies stacks, knowing how to work with heterogeneous ICT environment seems to be a big issue to the telecommunications companies.

In regard to monitor servers, VMs, applications and network devices across multiple platforms running on-premise, IDC, or in the Cloud, an unified dashboard plays an important role in monitoring these IT infra proactively. By providing a global view of ICT environment’s health to operators or customers, design widgets in a dashboard that is easily customizable, drag-and-drop or even data-binding is inevitable. Another design concern is the purpose to provide different users with different visualize way or data source of widgets, since different user might see different angle of data.

To best describe the innovated idea we proposed is the construction of a widget factory which produces customizable widgets for dashboard with efficiency, easy configuring, and fully meet customer demands.



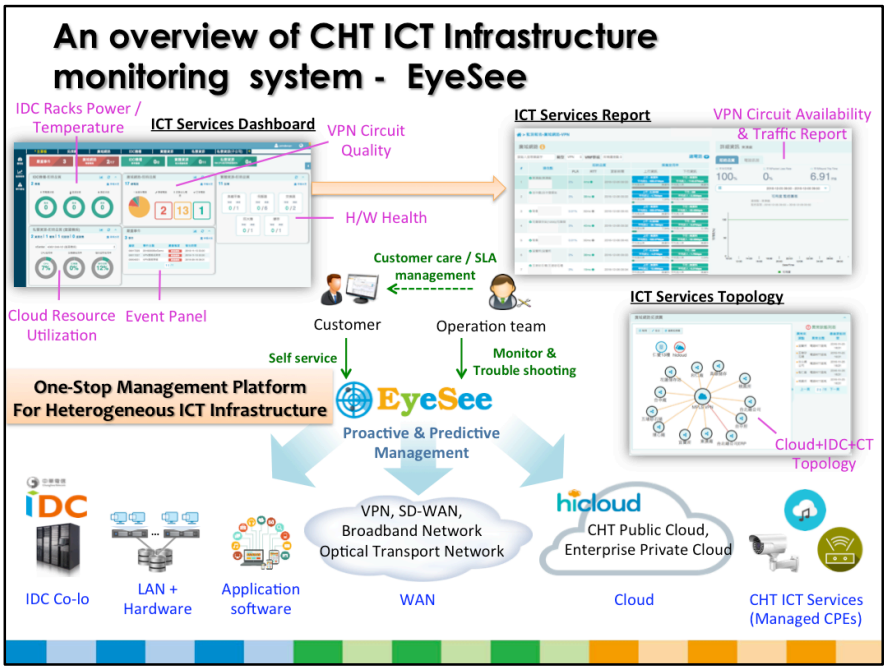
2. RELATED WORK

There are some monitoring solutions for ICT infrastructure already. The enterprise level solutions, for example, VMware vRealize Operations and HP SiteScope, have been proposed to support customers to monitor the availability and the performance of their IT environments using a portal to access the aggregated event and performance data.

VMware vRealize Operations [1] provides comprehensive visibility from a single console across cloud infrastructure, physical, virtual, and applications. But it doesn't support IDC and VPN network that operator can't handle engine rooms at a glance. It provides customized reports, views, and dashboards to help operation team visualize key performance indicators (KPIs), but it's not practical due to the complicated setting.

HP SiteScope [2] is agentless monitoring software to support various components in physical and virtual environment. Despite with a complete set of monitoring targets, its user interface is non-intuitive and difficult to use. Besides, the product is not a full solution and needs to adopt other HP products like HPE Operation Manager to accomplish centralized event monitoring and enhanced monitoring capabilities.

Compared to the existing productions, our solution provides customers a single console to monitor their IT components and the intuitive user interface to emphasize the most important aspects in measuring performance as well as the different visualization of data on demand. Our goal is not only the monitoring system as discussed above but also to develop a novel and flexible approach to construct and onboard user interface with performance data.



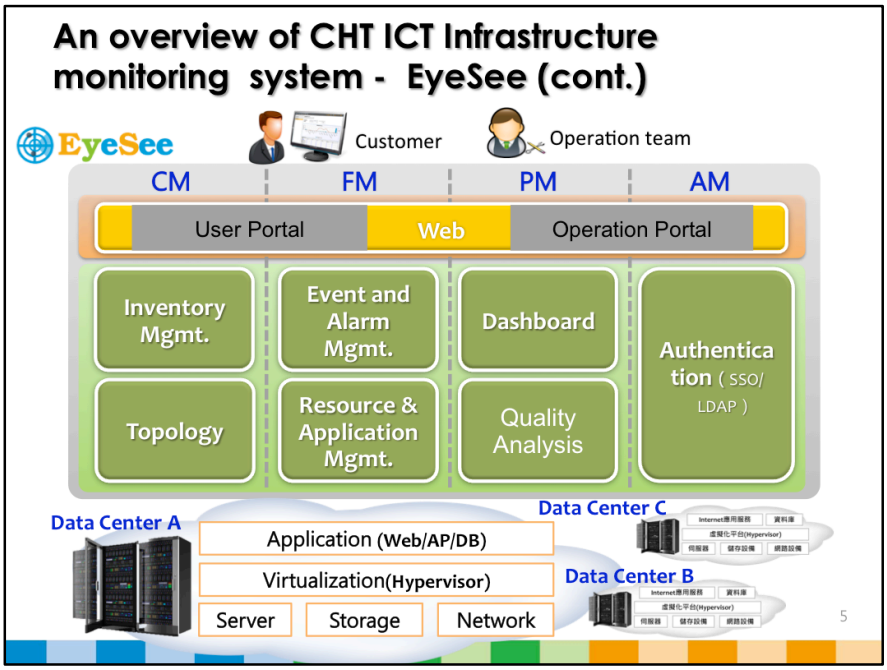
3. An Overview of CHT ICT Infrastructure Monitoring System - EyeSee

3.1 One-Stop Management Platform for Heterogeneous ICT Infrastructure

The ICT services grow in a rapid manner in the telecommunication companies. Among those ICT services, “Managed Service” like Network Managed Service (NMS) is one of the critical products for telecommunication companies.

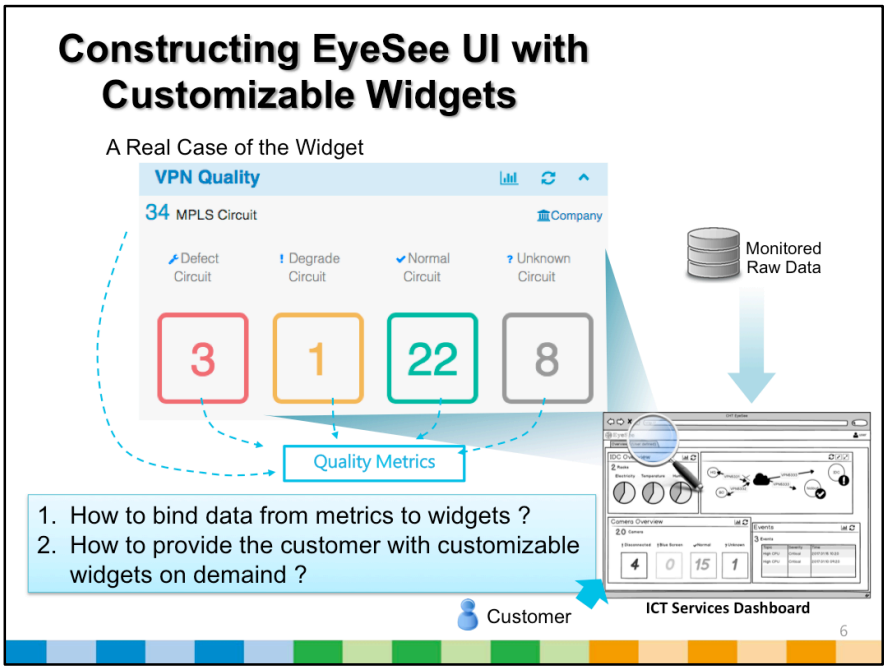
For the purpose of providing a high quality managed service to our customer, we develop a monitoring solution called EyeSee, a one-stop management platform for heterogeneous ICT infrastructure. Its target users include customers and CHT operation team.

After logining into EyeSee user portal, customers simply monitor or manage their servers, VMs, networks or even applications in ICT Services Dashboards. For instance, they have the opportunities to see IDC rack’s power consumption or temperature, VPN circuit’s quality, cloud resource’s utilization and triggered event in a glance. If an abnormal condition occurs, customer can drill down into ICT Services Report to check in detailed. Moreover, we offer ICT Services Topology page which visualize all customer’s resources (e.g., Cloud, IDC, CT).



3.2 EyeSee Function Blocks

The function blocks designed by EyeSee can be divided into four parts, CM, FM, PM, AM respectively. In respect to CM, operation team or customers manage resources from distributed IT infrastructures through bi-directional protocols (e.g., SNMP, WMI , JMX) in inventory management function block. Also, we provide operation team and customers with topology graph so that they know the relation between resources and locate the abnormal resource which distinct by the node color in real time. In respect to FM, we offer the event and alarm management ability. If an error is detected by the system, the alarm will soon be sent to operation team or customers by email or SMS message. For monitoring application like database, web or operating systems, we let operation team and customers set the threshold values to related metrics. If the real-time data surpass specific threshold, the alarm will be triggered. In respect to PM, we develop customizable dashboards for operation team and customers to track and monitor their IT infrastructures and provide various historical reports. Furthermore, the data in the report like cpu usage, network flow and number of connections can be used to analysis quality. The last part is AM, we offer two authentication methods including SSO and LDAP.



4. CONSTRUCTING EYESEE UI WITH CUSTOMIZABLE WIDGETS

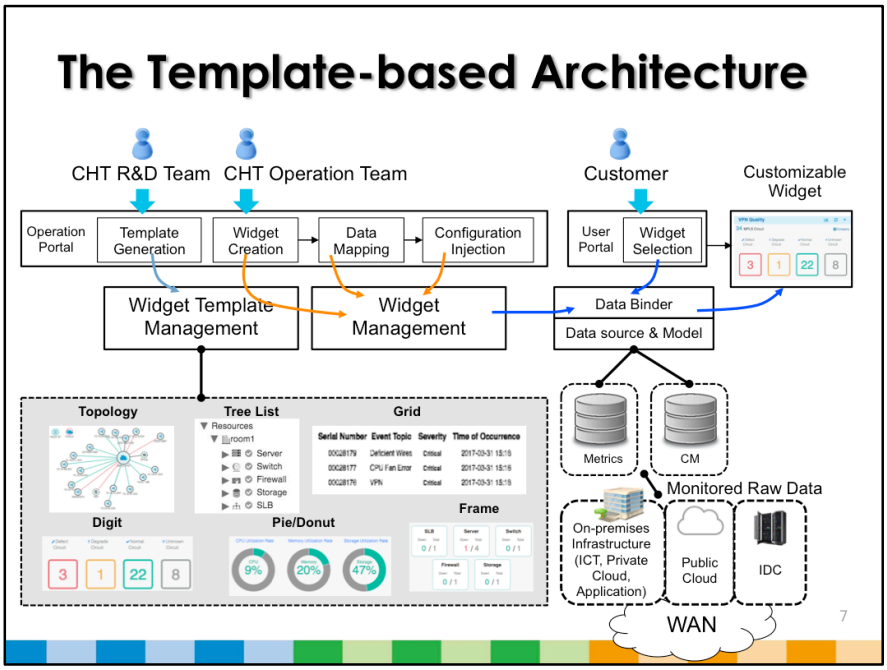
A typical way to display monitoring data is on a dashboard which is generated by multiple widgets. Customers need to adopt these widgets to quickly identify system problems. Furthermore, these widgets need to be customizable on customer's demand. Operation team should modify or generate widgets in response to the customer needs.

A real case of widget in EyeSee dashboard is consisted of the following three parts (i) Header, which includes the name of the monitored company and usually the total counting related to this widget; (ii) Binded quality metrics, which contains the monitored data and each data value in the widget will map with a metric or the combination of metrics; (iii) Additional style setting, which contains the setting or the meaning of the data for user friendly.

To this end, we address two fundamental questions related to support the process of building these widgets:

(1) How to bind data from metrics to widgets

(2) How to provide the customer with customizable widgets on demand

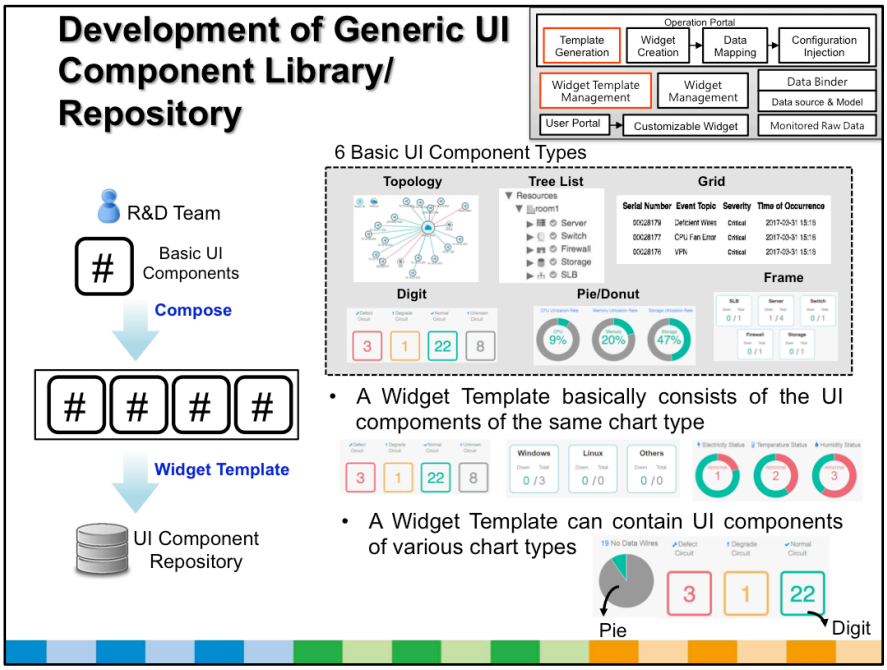


4.1 The Template-based Architecture

We proposed a template-based architecture to monitor ICT service that tackles the challenge identified in the above section.

The figure shows the architecture of our system, which is divided into four main parts. At first, the monitored raw data from on-premises infrastructure, public cloud, IDC and the wide area network (WAN) are continually collected and stored in the metrics and cm database. The R&D team generates basic UI components and the combinations of components as widget templates (Section 4.2) for the following widget generation process. Operation team then uses operation portal to create various widgets from these predefined templates and assign the mapping rules between the data metric and the UI components (Section 4.4). Besides, operation team injects other configurations like the color or text of the subtitle into widget templates to provide more informative details about the monitoring widgets. In the end, customers can use user portal to choose among these widgets to generate customizable widgets on their demand (Section 4.5). In this process, the monitored data is injected by data binder to produce final widget instances.

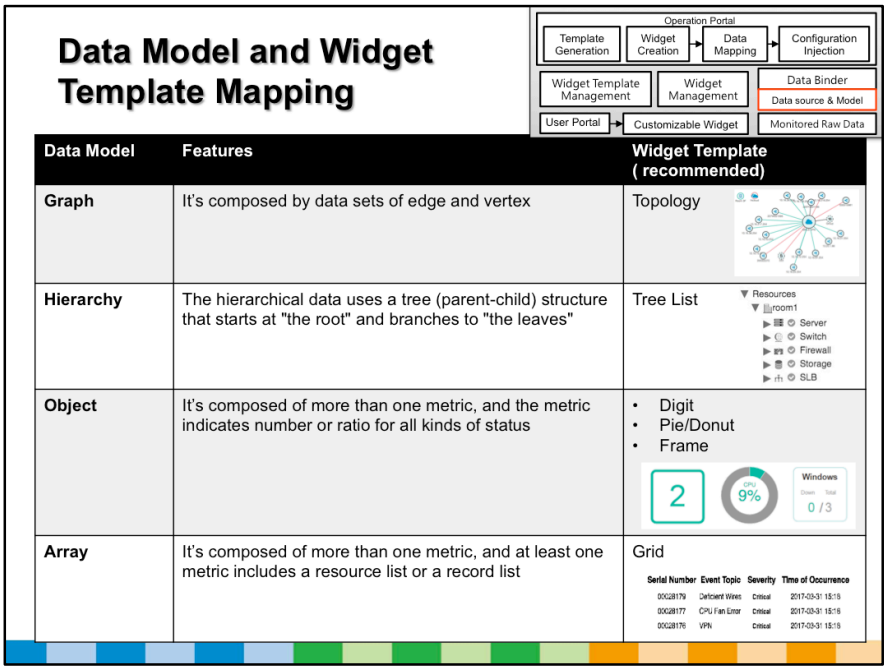
In the following sections, we will discuss each of these steps in detail.



4.2 Development of Generic UI Component Library/Repository

4.2.1 Widget Template Management

A rich variety of widget templates predefined in UI component repository by R&D team make visualizations fascinating. The basic UI component is the primary elements for creating a widget template, and we define six basic UI component types including Topology, Tree List, Grid, Frame, Digit, and Pie/Donut. Some widget templates are best presented by a single basic UI component, like Topology and Tree List. Some widget templates basically consist of the UI components of the same chart type, for example, using 3 Pie components in a row to compose a widget template. Furthermore, to create richer visualizations, a widget template can contain UI components of various chart types, for example, using 1 Pie component and 3 Digit components in a row to compose a widget template.



4.2.2 Data Model and Widget Template Mapping

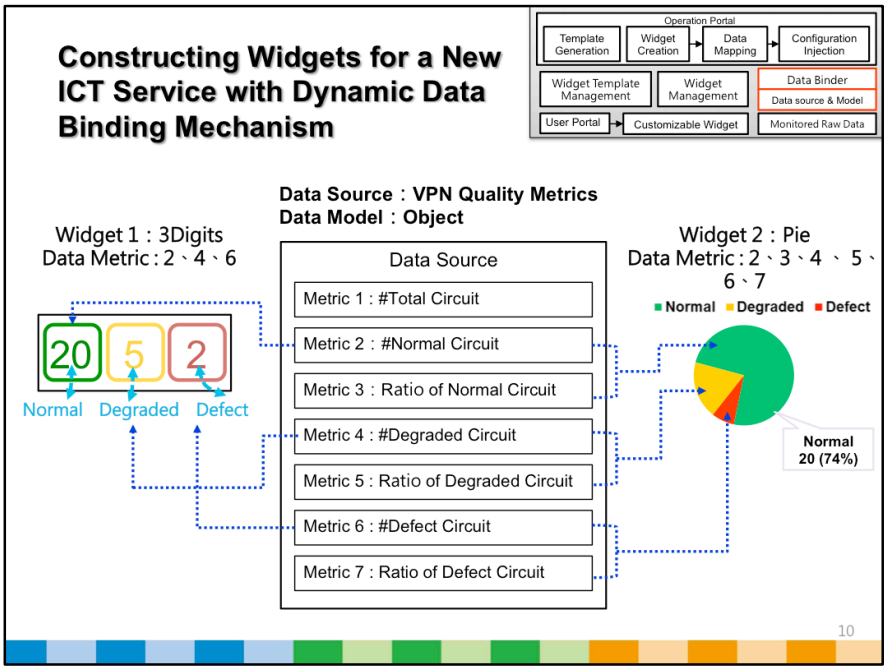
A good visualization can tell a complete story in moments, or simplify complex data problems into a bottom line that's easy to understand. In order to choose the proper chart for visualization, data source is classified into four models according to its composition characteristic: Graph, Hierarchy, Object and Array. Each model is suitable for specific widget templates. The following are the features of data models:

(1) Graph: It's composed by data sets of edge and vertex. Topology widget template is the best suitable.

(2) Hierarchy: The hierarchical data uses a tree (parent-child) structure that starts at "the root" and branches to "the leaves". Tree List widget template is suitable for visualizing hierarchical data.

(3) Object: It's composed of more than one metric, and the metric indicates number or ratio for all kinds of status. The widget templates that are composed by Digit, Pie/Donut or Frame are recommended for this modal.

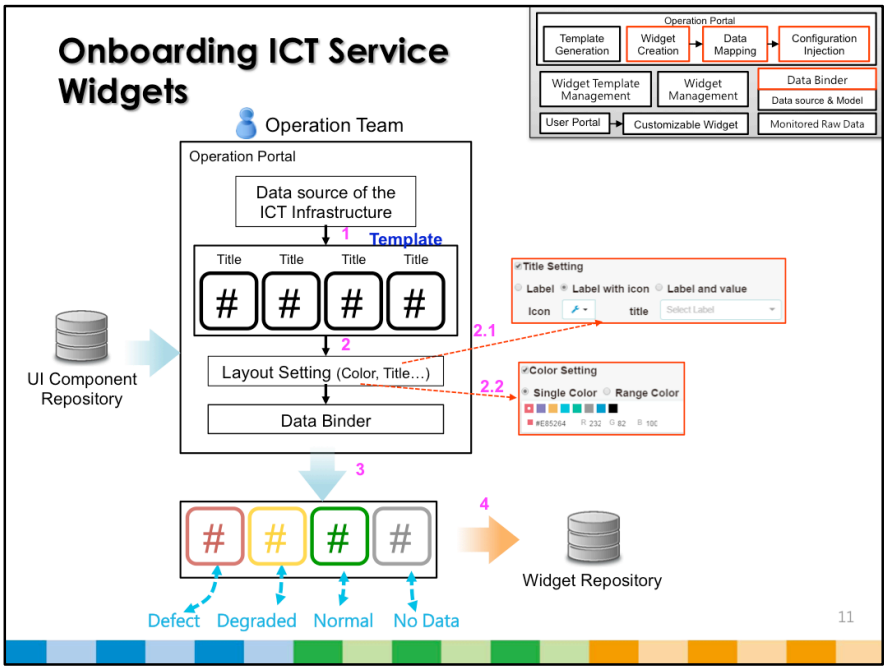
(4) Array: It's composed of more than one metric, and at least one metric includes a resource list or a record list. Grid widget template is right for showing record-level details.



4.3 Constructing Widgets for a New ICT Service with Dynamic Data Binding Mechanism

The data model and widget template mapping technique are meant to help operation team decide among different types of data visualization methods. Data source is composed of metrics or sub-datasets, and operation team can pick the specific metrics or sub-datasets that are best suited to visually represent with dynamic data binding mechanism.

The following scenario is how we use the mechanism to construct the VPN quality widget. The data source of VPN quality is classified into object, and there are metrics with numeric values such as Number-of-Total-VPN-Circuit, Number-of-VPN-Normal-Circuit, Number-of-VPN-Degraded-Circuit, and Number-of-VPN-Defect-Circuit. There are also metrics with ratio like Ratio-of-Normal-VPN-Circuit, Ratio-of-Degraded-VPN-Circuit, and Ratio-of-Defect-VPN-Circuit. If the customer only focuses on the abnormal counts of VPN circuit, 3 Digits widget will be formed by Number-of-VPN-Normal-Circuit, Number-of-VPN-Degraded-Circuit, and Number-of-VPN-Defect-Circuit. Otherwise, if the customer intends to display proportional data, donut widget will be formed by Number-of-VPN-Normal-Circuit, Number-of-VPN-Degraded-Circuit, and Number-of-VPN-Defect-Circuit, Ratio-of-Normal-VPN-Circuit, Ratio-of-Degraded-VPN-Circuit, and Ratio-of-Defect-VPN-Circuit. For greater customization, widget can be tailored to a variety of customers' needs.

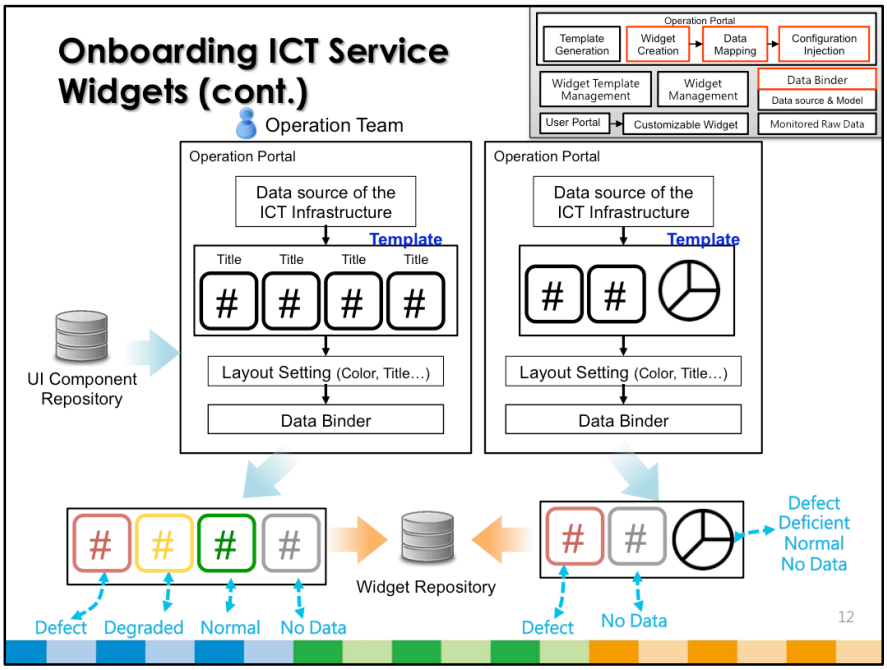


4.4 Onboarding ICT Service Widgets

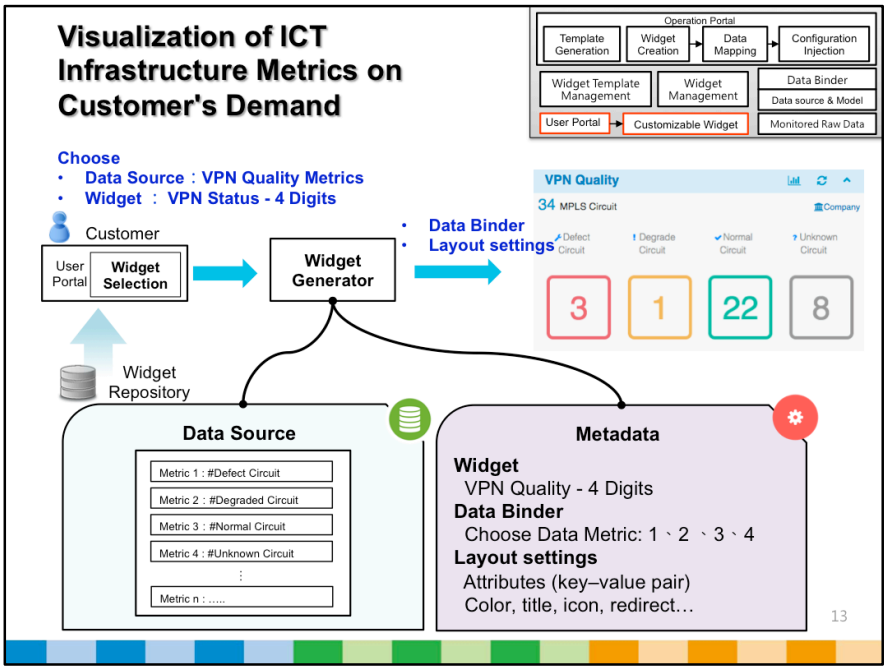
The flow diagram above tells us how operation team interacts with the system to construct widgets. The process is explained as follows.

(1) The operation team member selects an ICT service.
(2) The system gets the data source of the selected ICT service.
(3) The operation team member selects a widget template.
(4) The system then pops up related settings of the widget template.
(5) The operation team member selects metric codes and sets up widget appearance.
(6) The system stores the settings into database.
(7) System then generates metrics for user portal to render the ICT service widget.

The flow indicates how an ICT service widget will be onboard in the operation portal. While an ICT service is selected, the system automatically gets the data source of the service and then parses the data source to get its data model. The operation team then selects among the widget templates that generated from Section 4.2 (UI component repository). According to the selected widget template, the operation portal pops up related settings, such as title setting, metric codes setting, component color setting,. The operation team member fulfills all the necessary settings needed for the widget to display. After committing, the system stores the settings that the operation team made into the database (widget repository). Finally, the system would generate metrics for user portal to render the ICT service widget according to the settings stored in the database.



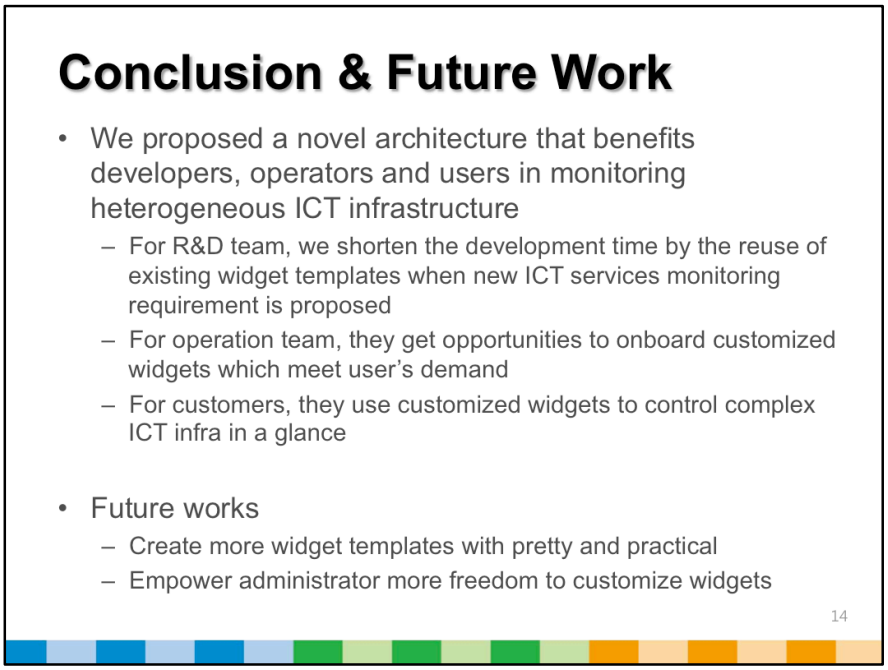
The following section describes the advanced case of onboarding ICT service widgets as a motivating example for our contribution. In this advanced case, the operation team generates two widgets from a single data source of the ICT service. The left widget consists of 4 frame components while the right one consists of 2 frame components and one pie chart component. This indicates that the operation team can generate multiple widgets for a single ICT service thus the customer can choose from the set of widgets and decide the way to present data. Once onboarding the widgets, operation team member can manage them, e.g., edit the widgets or delete one of them, on the operation portal. The widgets could be various, from tree to frame, from topology to pie, or the combination of two kinds of components. Take the figure above as example, the widget in bottom left corner displays data as a number in one frame, while the widget in bottom right corner uses only two frame to display the number of deficient data and no data, plus a pie chart to convey the percentage of the four indexes. The customer can decide the appearance of the ICT service widget that meets their needs the most by choosing from the widget set generated by the operation team.



4.5 Visualization of ICT Infrastructure Metrics on Customer‘s Demand

When customer adds a widget into a dashboard through the user portal, a widget instance will be created. Customer first chooses the data source and the widget predefined by operation team. The appearance of widget instance will be simulated on the user portal to make it easier for customer to choose. The widget instance will be created depending on the choice after widget selection.

Metadata is the configuration about a widget, including layout settings and data binder that indicates how to bind data source property. In our scenario, data source is VPN Quality Metrics and Widget is VPN Quality - 4 Digits. Data binder describes that uses 4 data metrics including metric 1 (Number-of-VPN-Defect-Circuit)、metric 2 (Number-of-VPN-Degraded-Circuit) 、metric 3 (Number-of-VPN-Normal-Circuit) and metric 4 (Number-of-VPN-Unknown-Circuit), and each data metric binds to one digit. Besides, layout settings define the widget appearance like color, title, icon, and redirect…etc. Widget generator will generate a widget instance according to data binding rules and layout settings.



5. CONCLUSION & FUTURE WORK

To summarize, we have implemented the template-based architecture with customizable widgets in CHT EyeSee. Lots of widgets are onboarded by this novel widget factory which helps provide more diversified widgets for customers. For customers, we fulfill their demands and enable them to control complex IT infra in a glance. For operation team, they get opportunities to define and onboard customized widgets which meet customer's needs. For R&D team, we shorten the development time by leveraging existing widget template when new ICT services monitoring requirement is proposed.

To further improve our approach, we plan to add more widget templates which follow the principles defined by domain expert in each ICT services. By adding more meaningful widgets to our monitoring system, we can enhance the ability of monitoring to discover or predict problems behind the services for customers; moreover, we decide to increase the freedom of widget configuration on operation team. Therefore, the operation team can define the widgets that will be closer to customer's demand.

REFERENCE

[1] VMware, "vRealize Operations," https://www.vmware.com/products/vrealize-operations.html.
[2] HP, "SiteScope", https://saas.hpe.com/en-us/software/sitescope