

Open IT Infrastructure to Drive Innovations at SKT

주석원리더/SW CoE
SW기술원



SKT's Innovation - AI

인공지능 운전비서 서비스

Navigation

- 집으로 / 회사로
- 인천공항에 가자
- 교통정보 알려줘
- 주유소 찾아줘
- 주차장 찾아줘
- 길안내 볼륨 키워줘
- 음악소리 줄여줘

Infotainment

- 음악 틀어줘
- 일정 관리
- 긴급알림

* NUGU App 연동 후 이용

- 날씨 알려줘
- 뉴스 들려줘
- 라디오 틀어줘
- 운세 알려줘
- 주차장 찾아줘
- 프로야구 결과 알려줘

* 모든 운전자 바로 이용



국내최초 지능형 음성인식 서비스



멜론 Melon

말 한마디로 멜론에서 원하는 노래를 듣고!

“아리아, 요즘 유행하는 노래 좀 들려줘”

스마트홈 Smart Home

쇼파에 앉아 내 집을 내 맘대로!

“아리아, 공기가 탁한데 공기청정기 좀 켜줘”

일정

언제나 나의 스케줄을 관리해주는

“아리아, 오늘 일정 알려줘”

날씨 알림

집 나서기 직전, 하루 한번은 꼭!

“아리아, 오늘 날씨 좀 알려줘”

알람

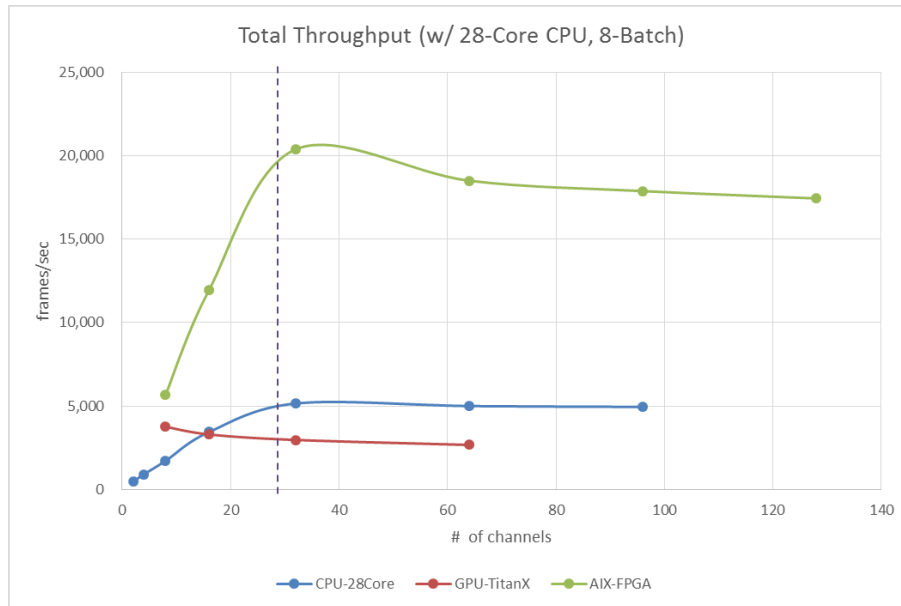
잠들기 직전 마지막 인사

“아리아, 내일 7시에 깨워줘”

SKT's Innovation – AI Infra

FPGA Version (AIX-F) is accelerating NUGU services for speech recognition.

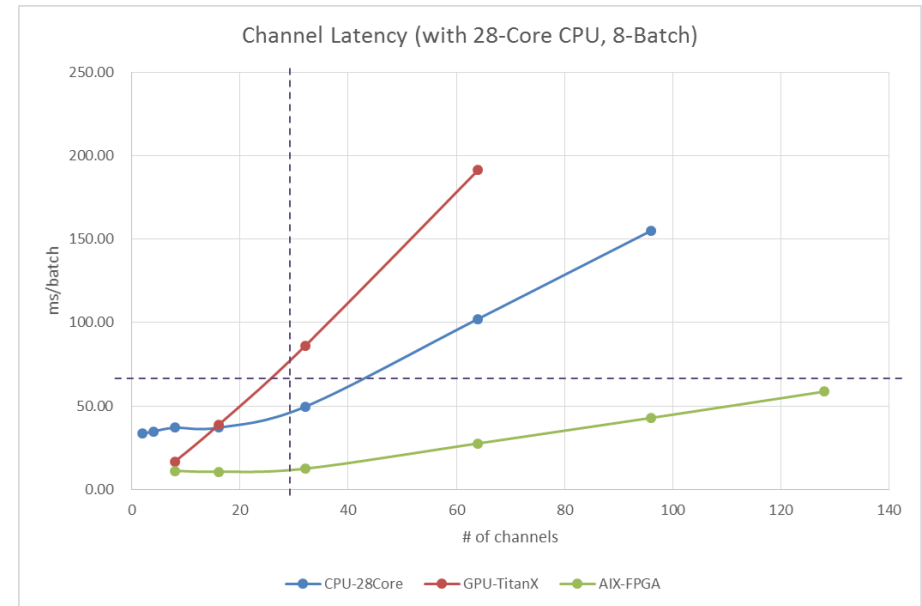
4 times performance improvement compared with existing system.



Throughput

according to the number of concurrent processing channels

Throughput becomes saturated at the number of CPU Cores



Latency

according to the number of concurrent processing channels

AXI-F has 4 times capability than CPU or GPU with real-time constraint (64msec latency limit)

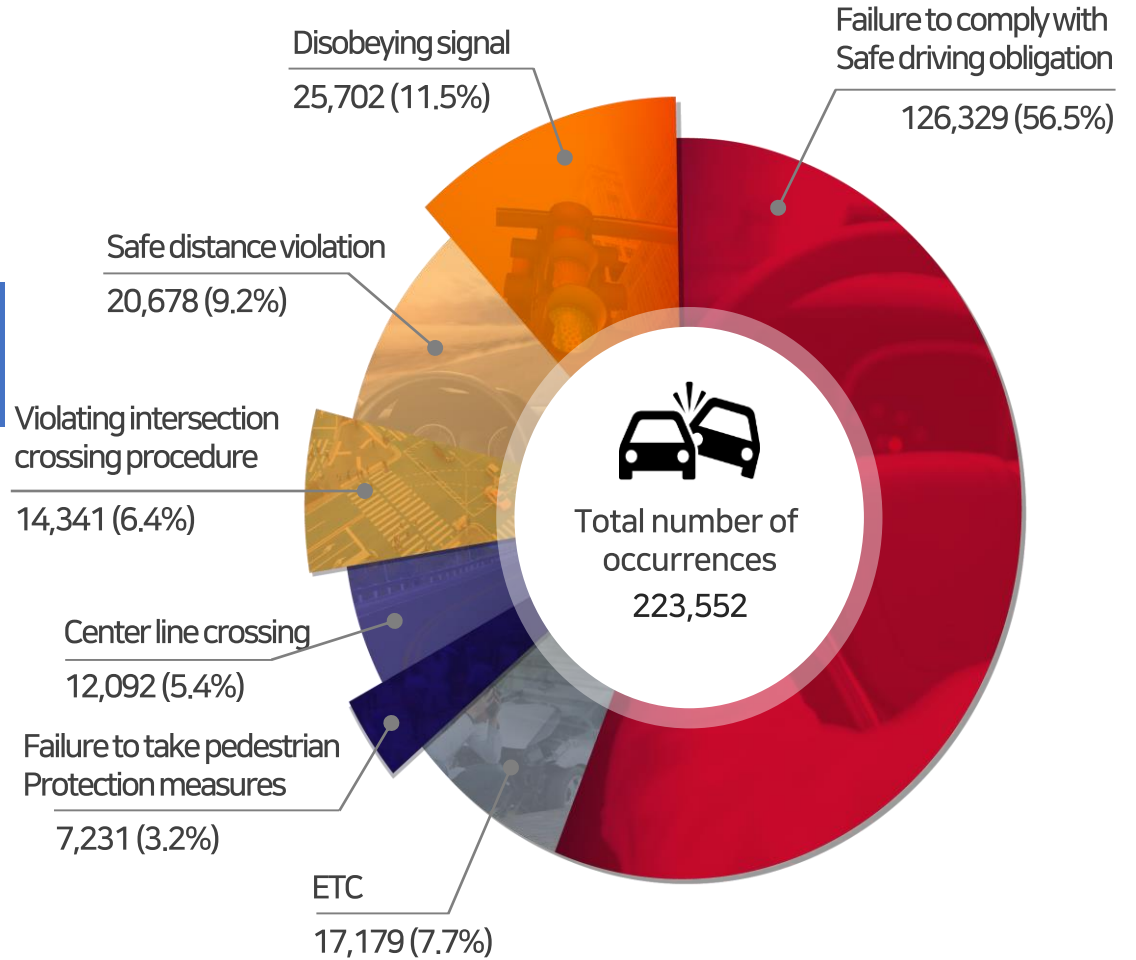
SKT's Innovation - 5G Autonomous Driving

In Korea,



Accidents

occur every year



SKT's Innovation - 5G Autonomous Driving



Autonomous Driving
with 5G and V2X

2 5 %

reduction of
accident rate

※ Source: US Department of
Transportation(US DOT)

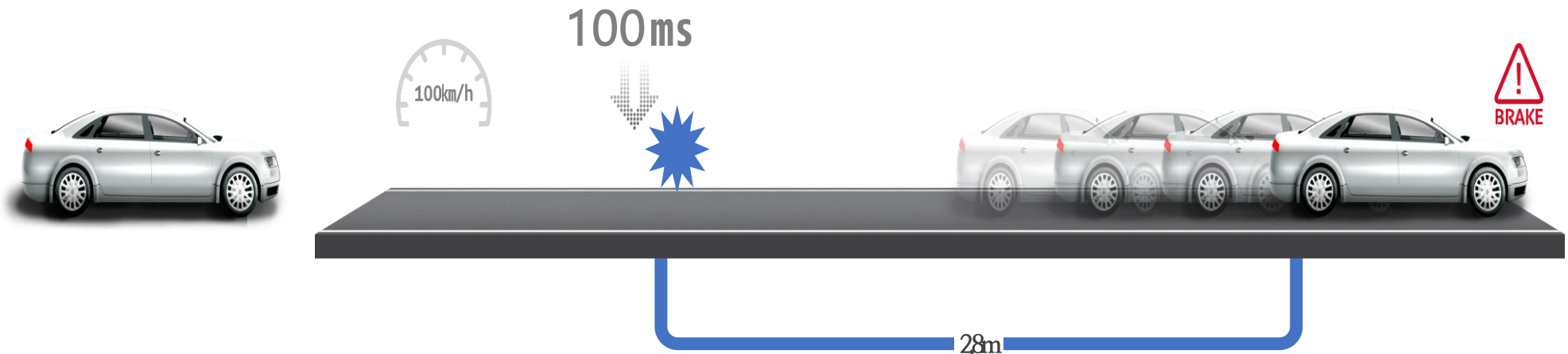
SKT's Innovation - 5G Autonomous Driving

If a vehicle traveling at 100km/h detects a hazard

After 10ms, it moves about 28cm



After 100ms, it moves about 2.8m



SKT's Innovation - 5G Autonomous Driving

1. Stability

2. Safety



SKT's Innovation - 5G Autonomous Driving

5G Network

Much Faster

Speed: max 20Gbps

Much Lower

Latency of radio 1ms, E2E 10ms

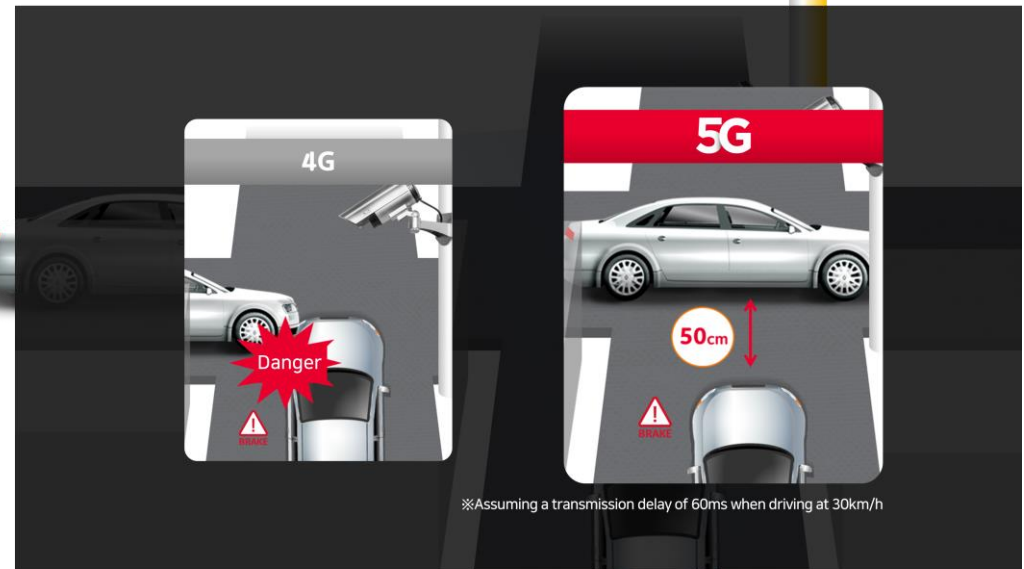
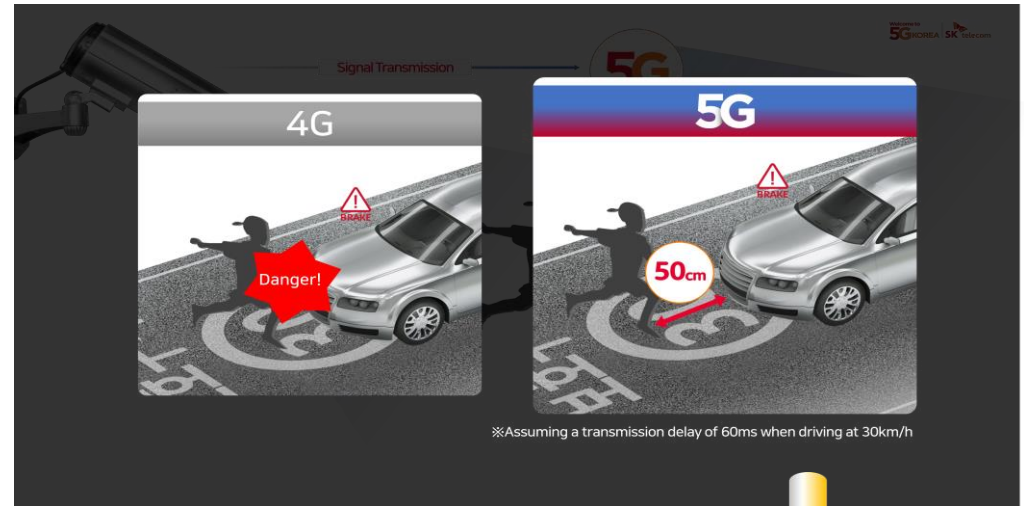
Many More Devices

Thousands of connections per Cell

With Optimized QoS

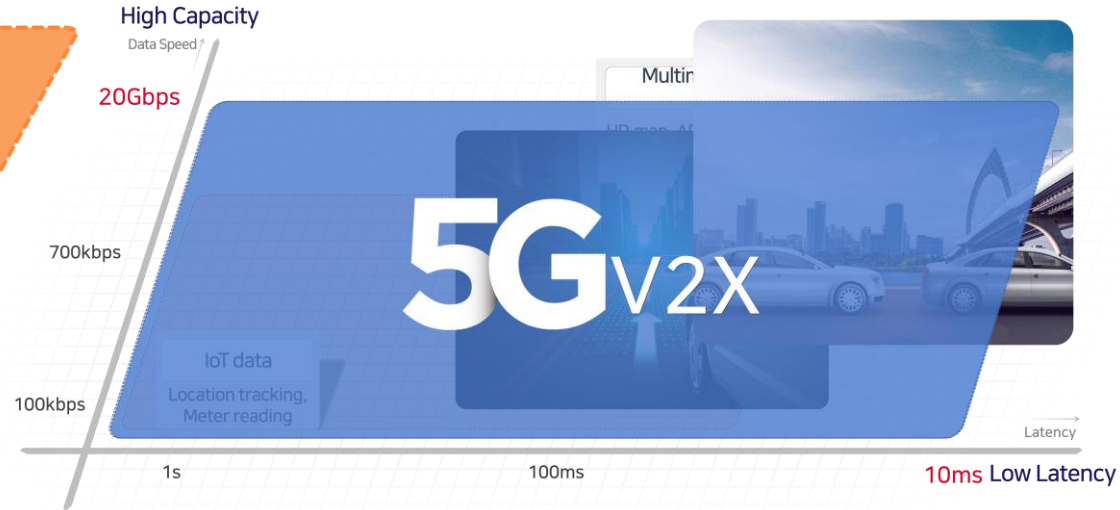
N/W separation by service (Slicing)

Provides
V2X Core Services



SKT's Innovation - 5G HD Map Update

SKT HD MAP



HD Map is a live self updating map

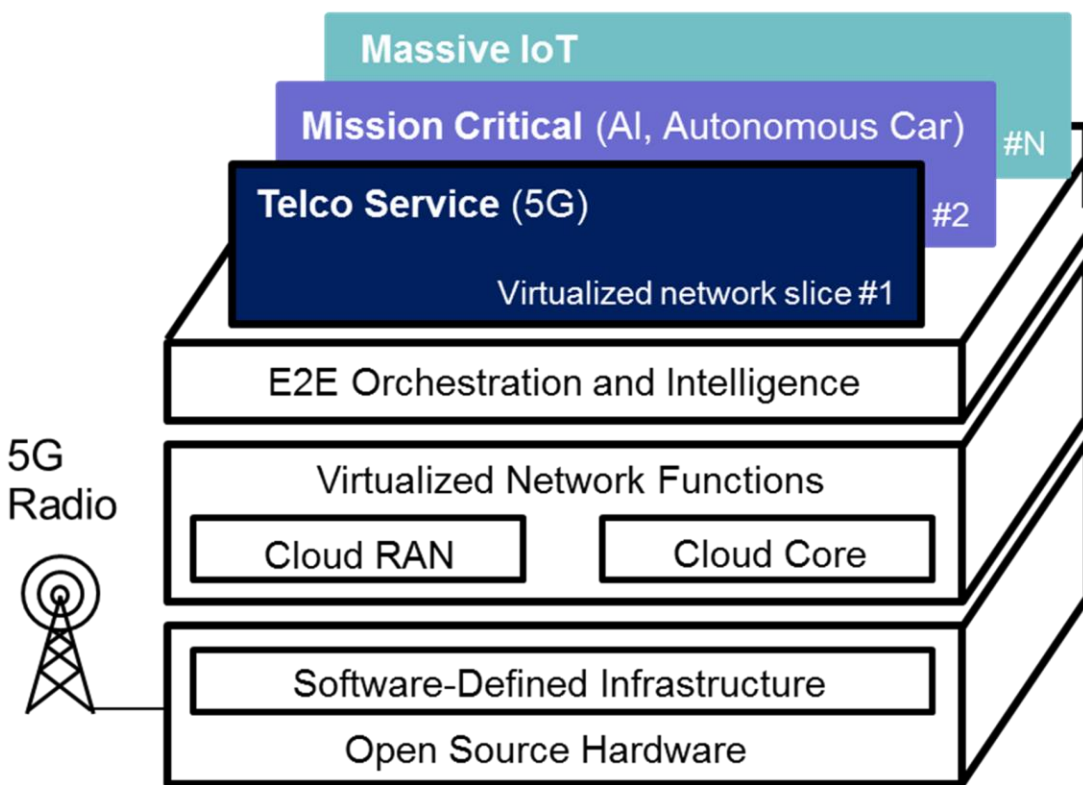
Establishment of 5G network in major regions to enable 5G autonomous driving in 2019



SKT's Innovation – AR/VR



5G Evolution to Open Infrastructure



SKT Services

- Ultra High Data Rate
- Mission Critical Service
- Massive Connectivity

ATSCALE

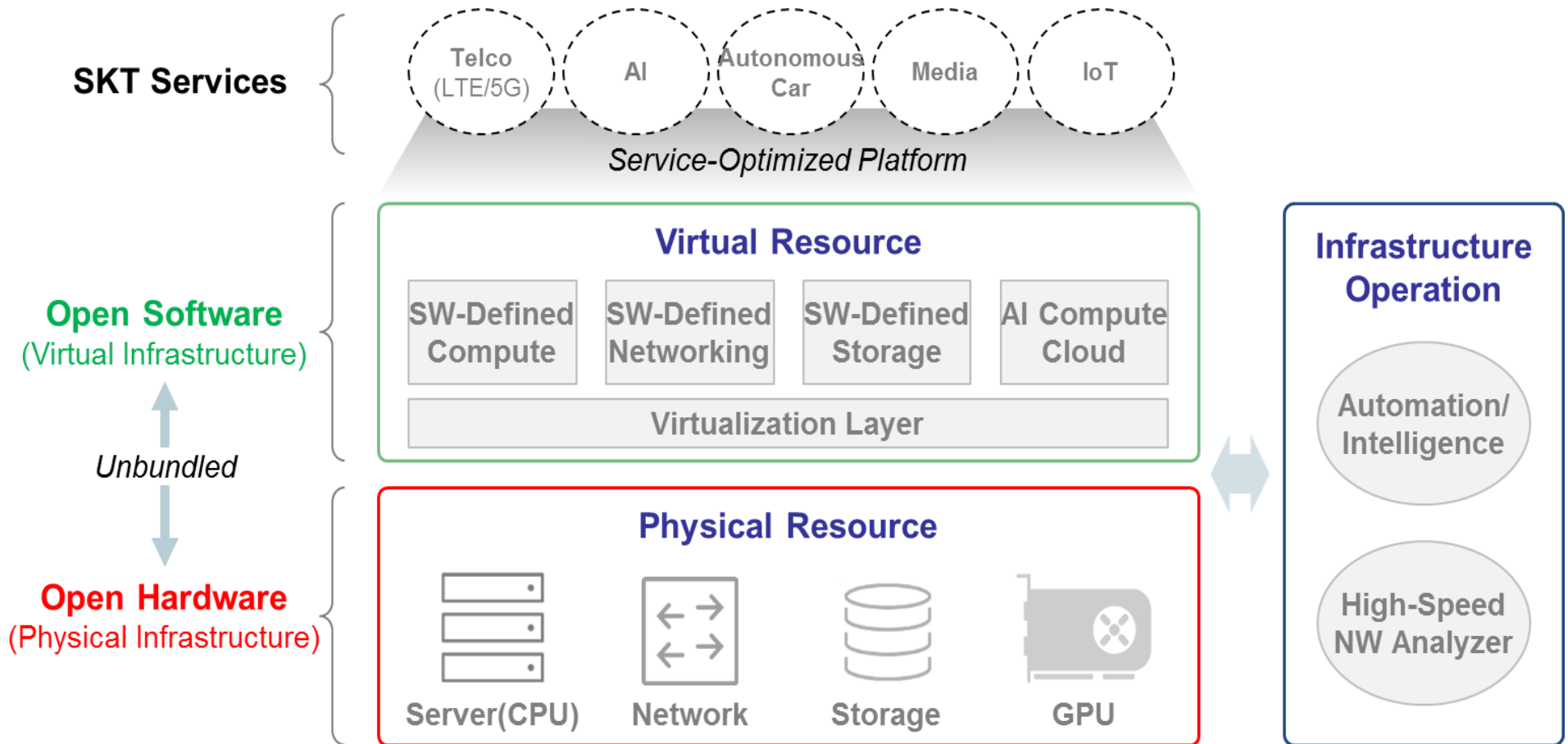
- Virtualized Network Functions
- Network & Service Slicing
- Next-Generation OSS (TANGO)

COSMOS

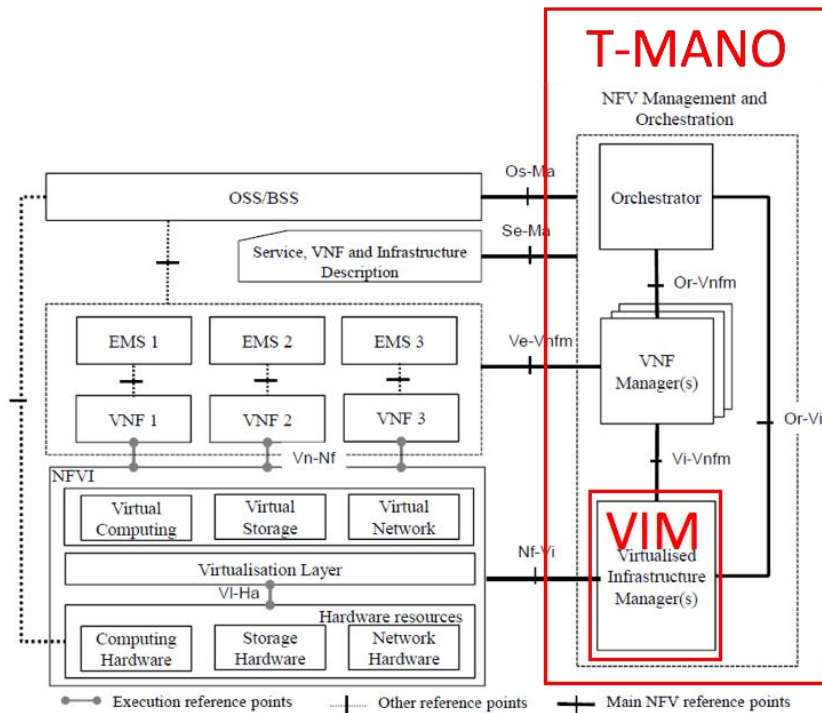
- Software-Defined Infrastructure
- Open Hardware and Software
- Telco & Mission Critical Services

COSMOS Vision

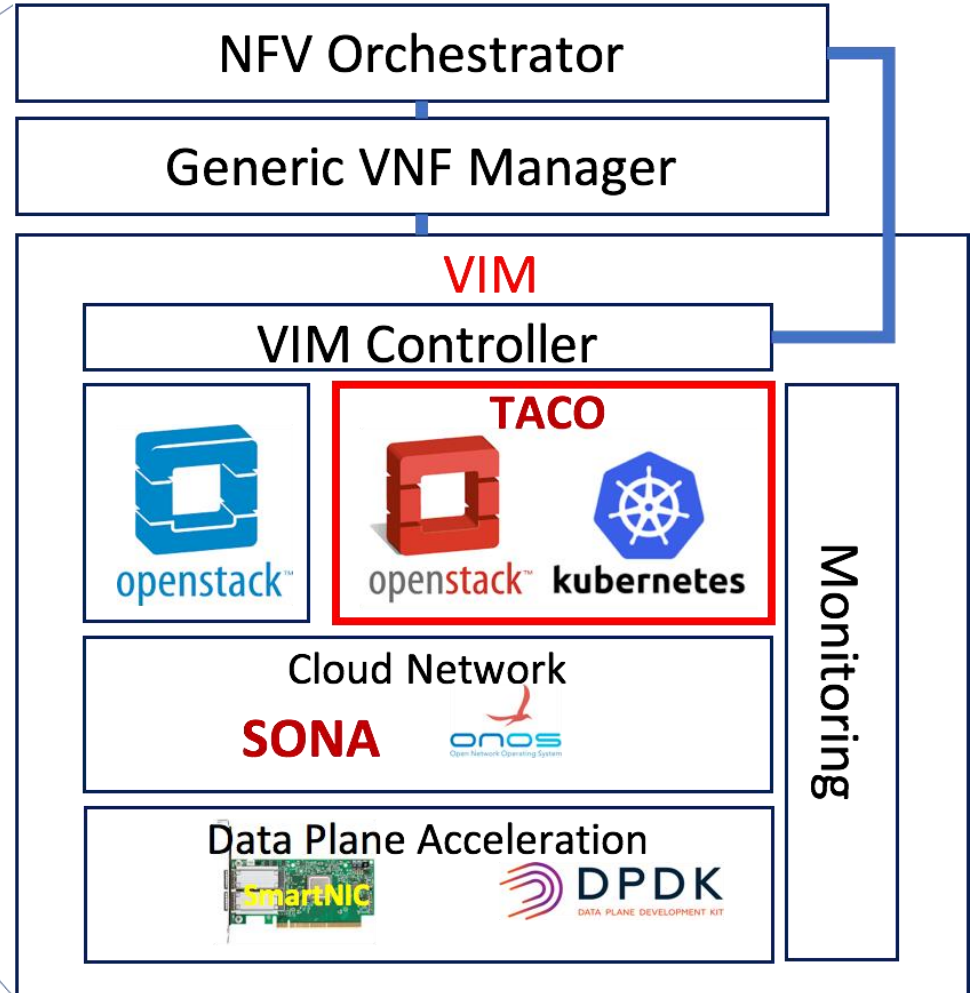
- **C**omposable, **O**pen, **S**calable with **O**pen **S**oftware and Hardware
- **M**ission Critical Services (5G, AI, Autonomous Car, etc.)



Cloud VIM(Virtualized Infrastructure Manager)



ETSI NFV Architecture

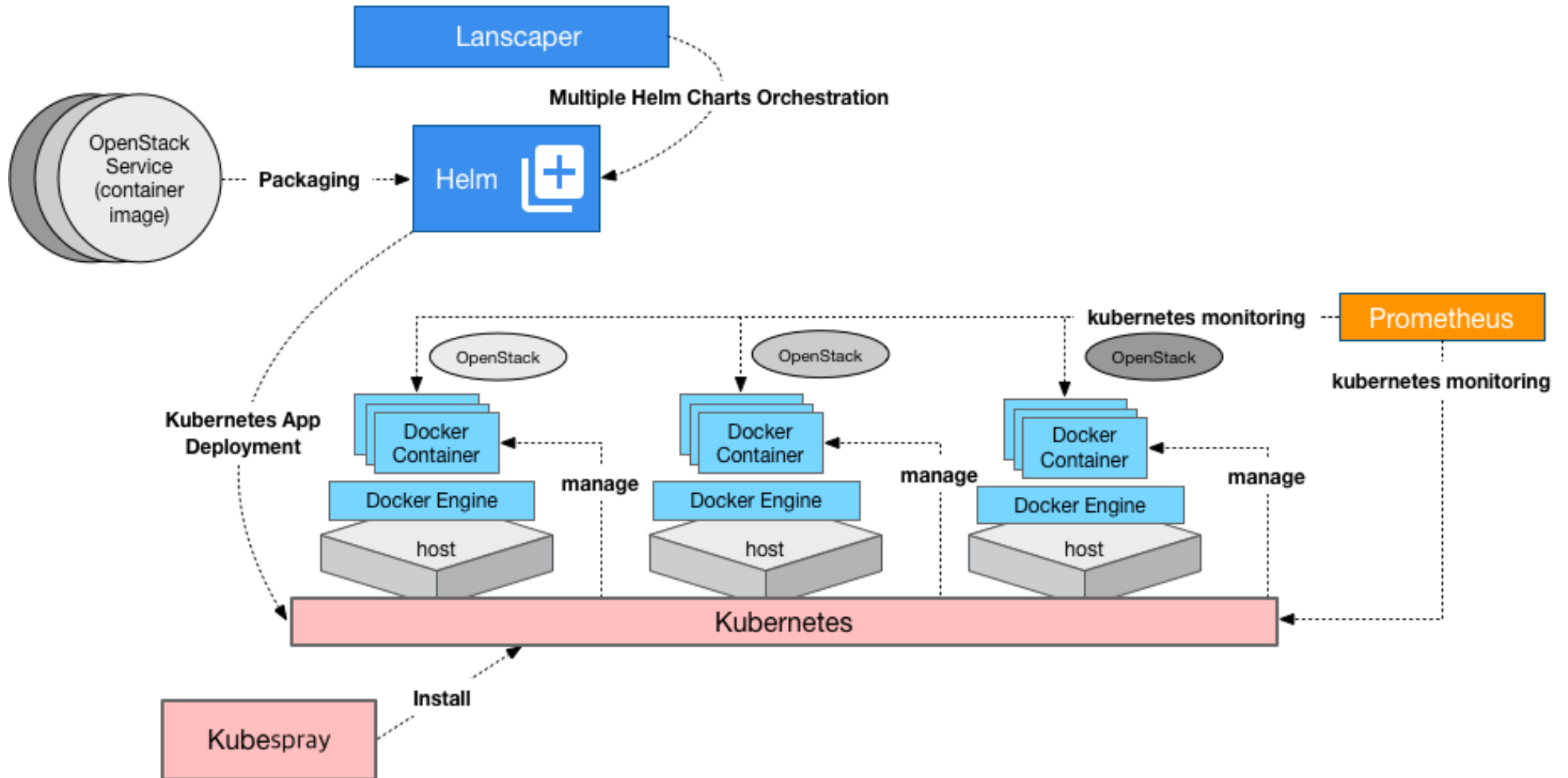


TACO (SKT All Container OpenStack)



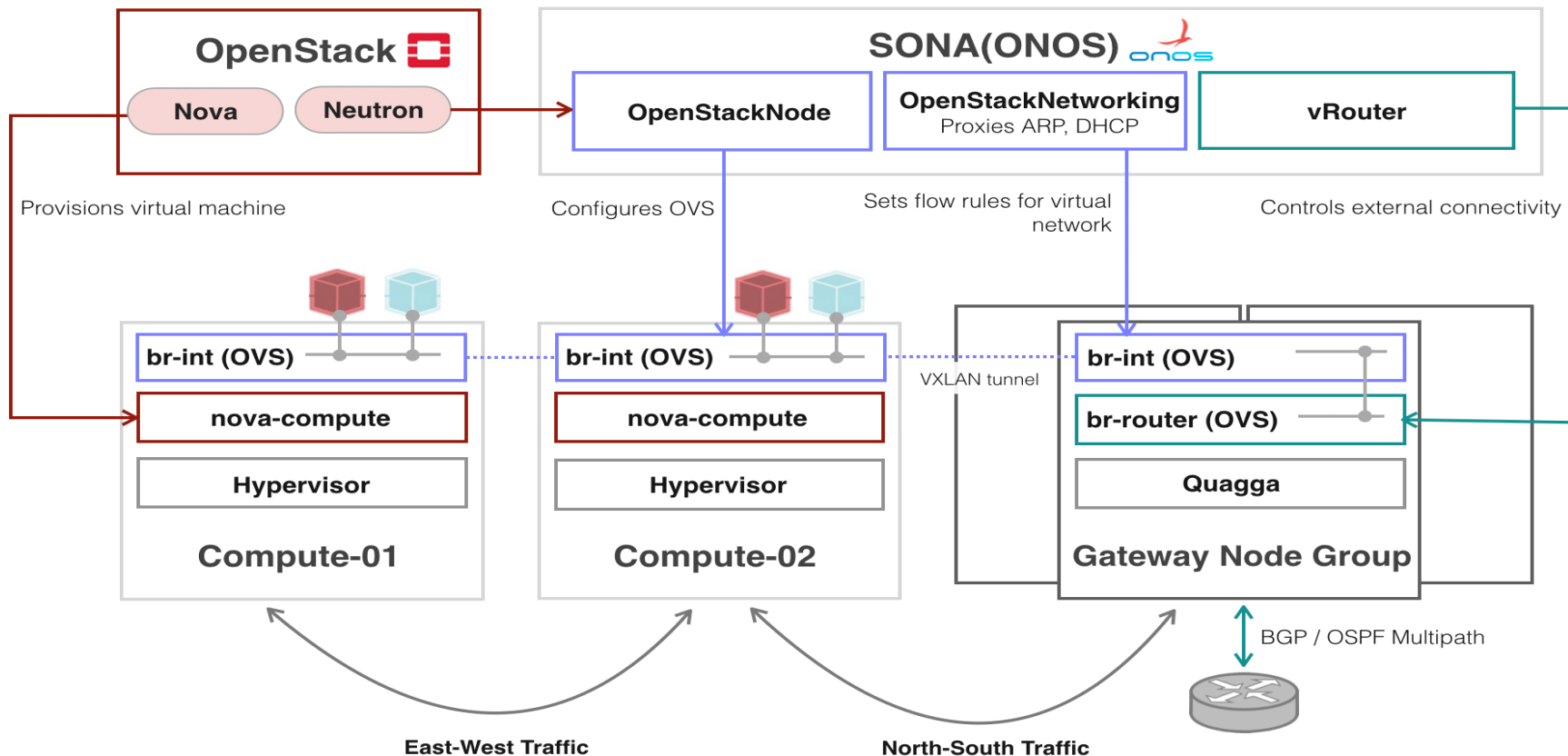
- Developed by **SK Telecom**, leveraging **Container and Kubernetes**
- **Community Version with Continuous Integration / Delivery System**

TACO Open SW Components



SONA (Simplified Overlay Networking Architecture)

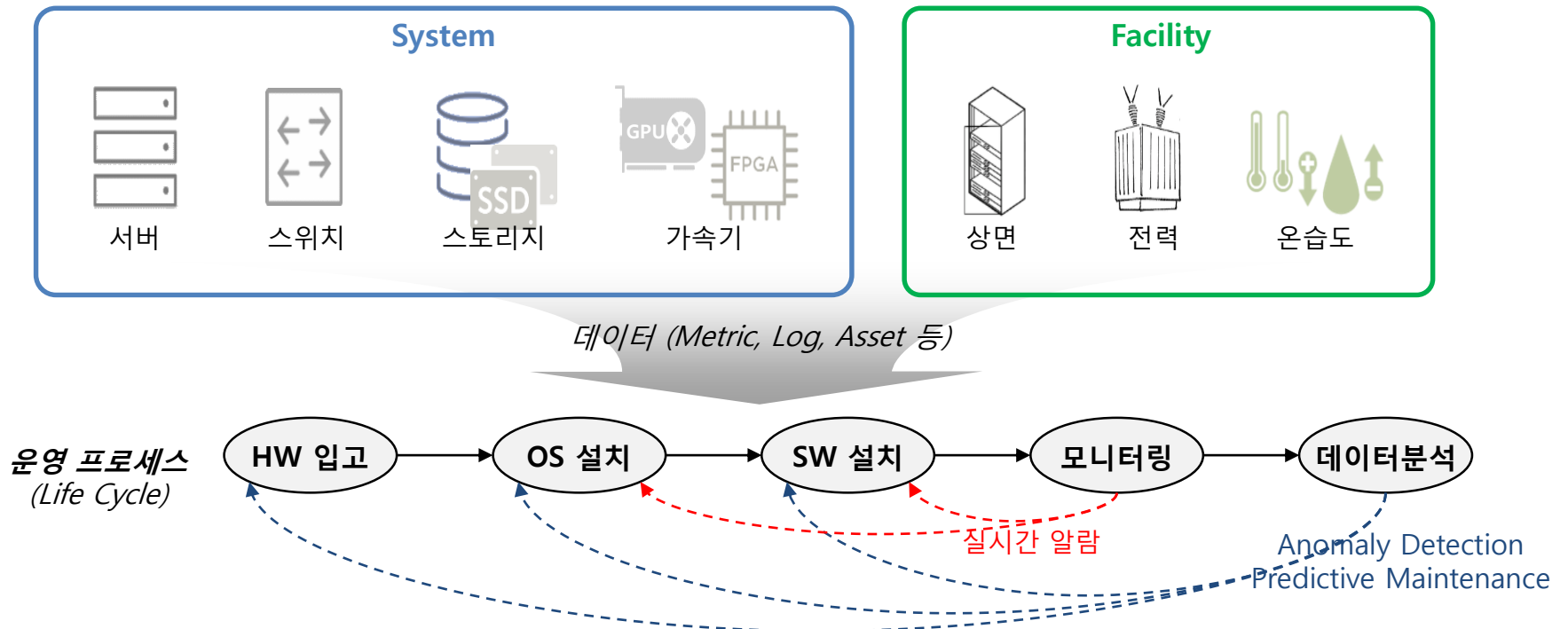
- ONOS based **Virtual Network Management** solution
- **Multi-Tenancy** support with **VxLAN** and VLAN
- **Scalable Gateway**, Full Compatible with **OpenStack**



T-CORE (데이터센터 운영 자동화/지능화 솔루션)

“데이터 기반 Infra 운용 솔루션”

- 데이터센터에서 발생하는 수많은 데이터를 활용 (System & Facility)
- 운영 전체 프로세스에 필요한 모든 기능을 통합적으로 제공
- Big Data 및 Deep Learning에 기반한 운영 가시성/효율성을 향상



T-CORE 주요 기능

1



Monitoring & Real-time Alarm

- 자산/시스템/App. 통합 데이터 플랫폼
- 통합 모니터링 및 실시간 알람 발생
- 데이터 Discovery, 통계 및 추세 분석

3



Management & Control Automation

- 물리/가상 시스템 및 설비(상면, 전력, 온도 등) 조회/이력 관리
- 원격 작업 및 히스토리 관리

2



AI/ML-Based Intelligence & Visualization

- Anomaly 및 Engineering 진단/예측
- Predictive Maintenance
- UI 기반의 Alarm 대응 자동화

4



OS Provisioning & SW Provisioning

- 대규모 장비 대상 OS/SW Provisioning
- 시스템 도입 전 과정 자동화 (Zero Touch Deployment)

TINA (고속 네트워크 분석 솔루션)

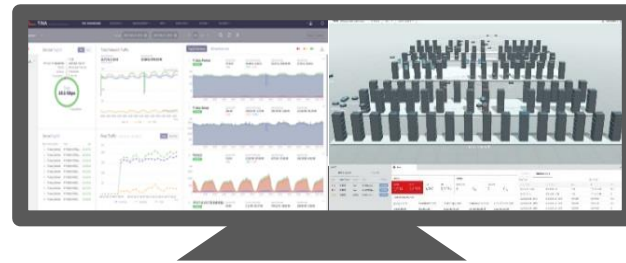
Single Pane of Glass



“망은 점점 복잡해지고 트래픽은 늘어나는데...”

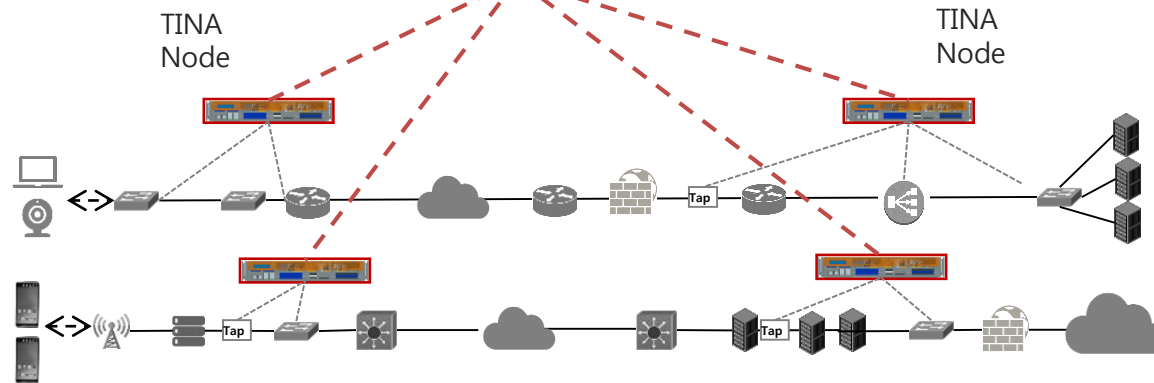


“네트워크는 너무 어려워...”



- Network Monitoring
- Service Monitoring
- In-depth Analysis

TINA
(SKT Integrated Network Analyzer)



Physical Network

Virtual Network

Telco Network

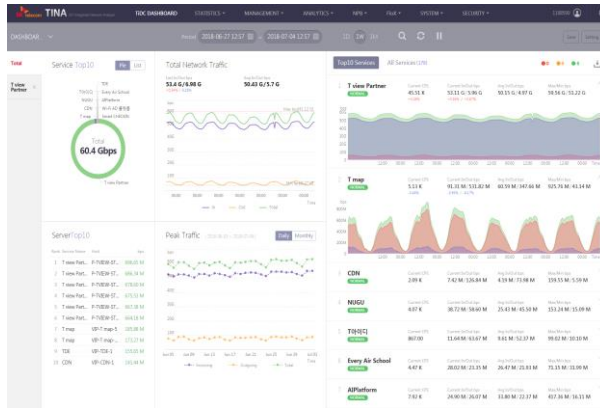
Hybrid Cloud

TINA 주요 기능

TINA는 패킷 분석, 세션 분석, 트래픽 모니터링, Trouble Shooting 등 데이터센터/네트워크 운용에 반드시 필요한 시스템과 도구를 포함하는 통합 솔루션

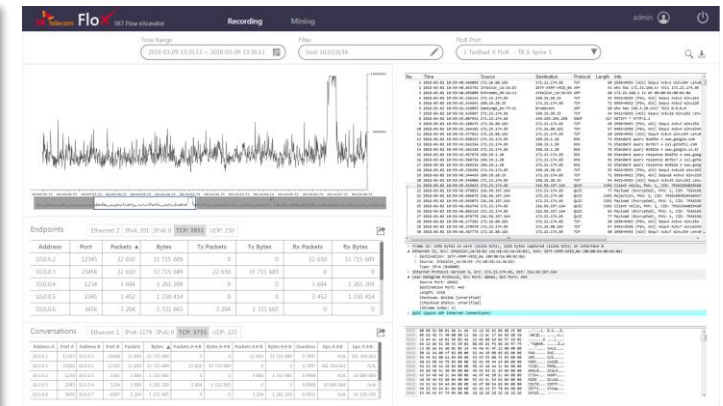
1

실시간 서비스
모니터링



3

고성능 패킷
저장 및 분석



2

TCP/
HTTP 세션
분석

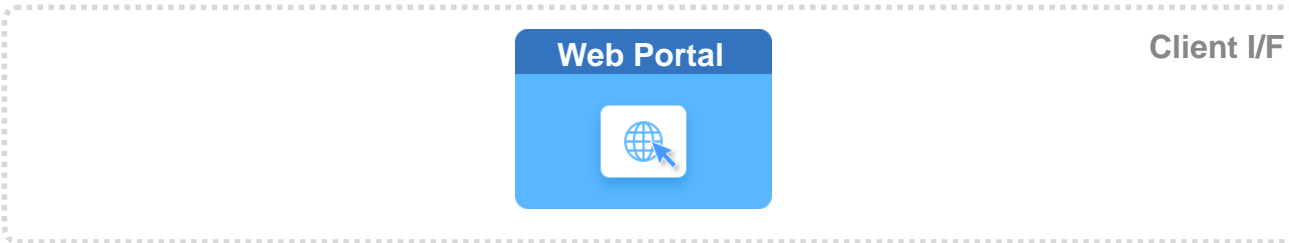


4

3D
Visualization

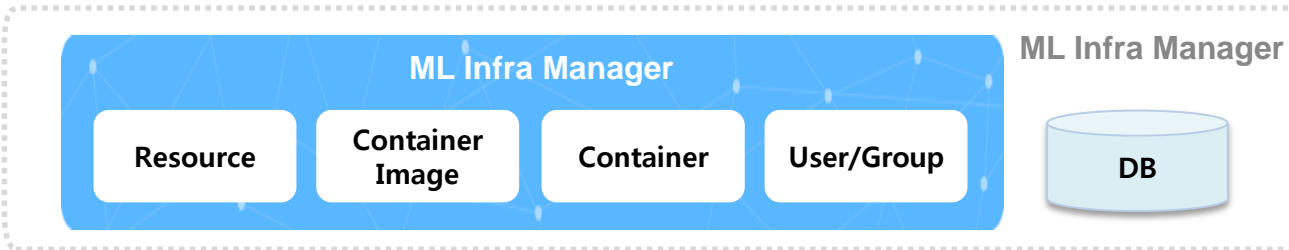


AI Compute Cloud



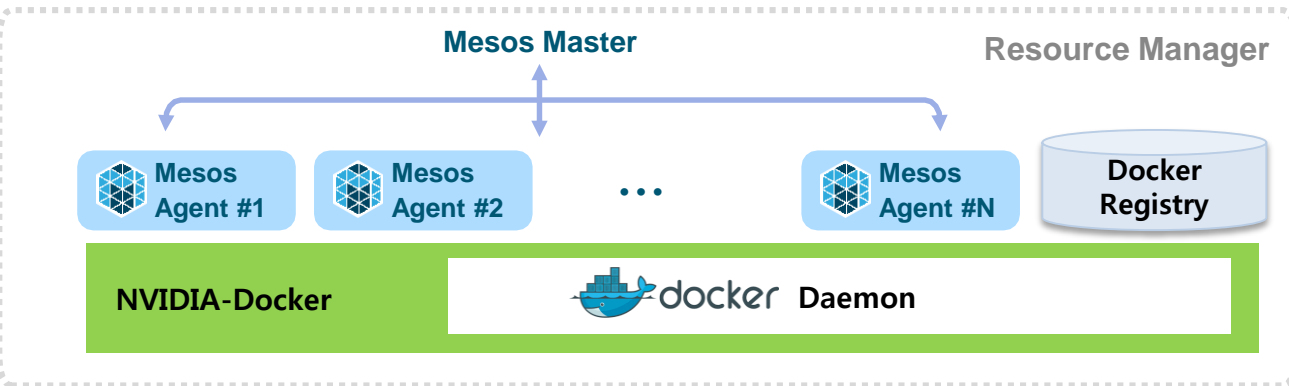
Client I/F

- 웹 포탈 인터페이스
 - 사용자 - IaaS 생성 요청/접속 정보 제공
 - 팀운영자 - 팀 서버/컨테이너 관리
 - 관리자 - 시스템 현황/사용자 관리/Q&A



ML Infra Manager

- Frontend API Server
 - 인프라 & ML Framework 요구 스케줄러 전송
 - 컨테이너-고속 스토리지(AF-NAS 등) 설정
 - 팀별 보유 서버 관리



Resource Manager

- Resource / Container Management
 - ML Framework 관리 도구(이미지) 저장
 - Mesos 기반 자원 관리
 - NVIDIA-Docker 기반 GPU 컨테이너 생성

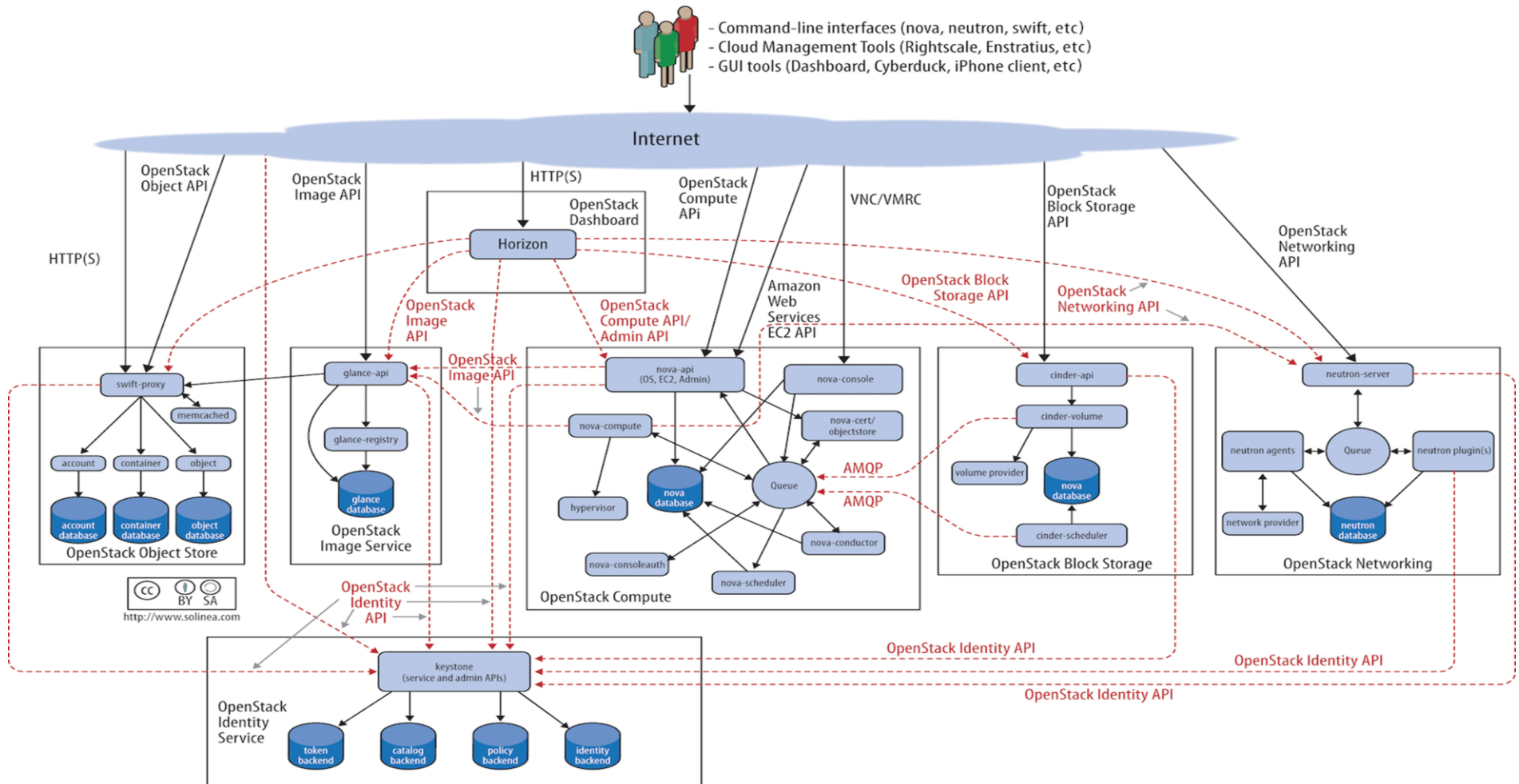


TiDC- GPU Server

- Data Center (TiDC) 내 ML Infra 서버 구축

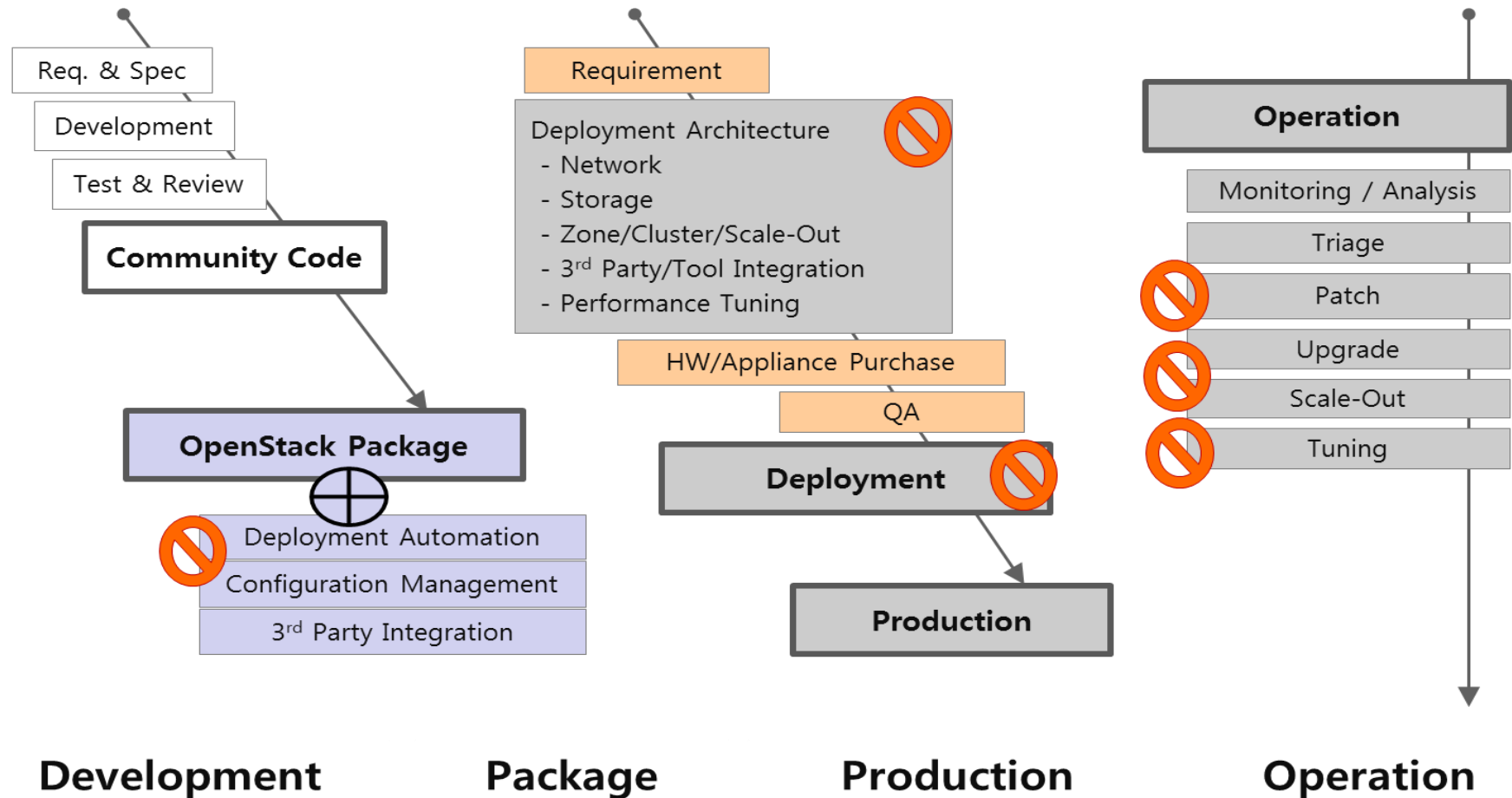
Challenges

- OpenStack is a very **complicated system to deploy and manage**



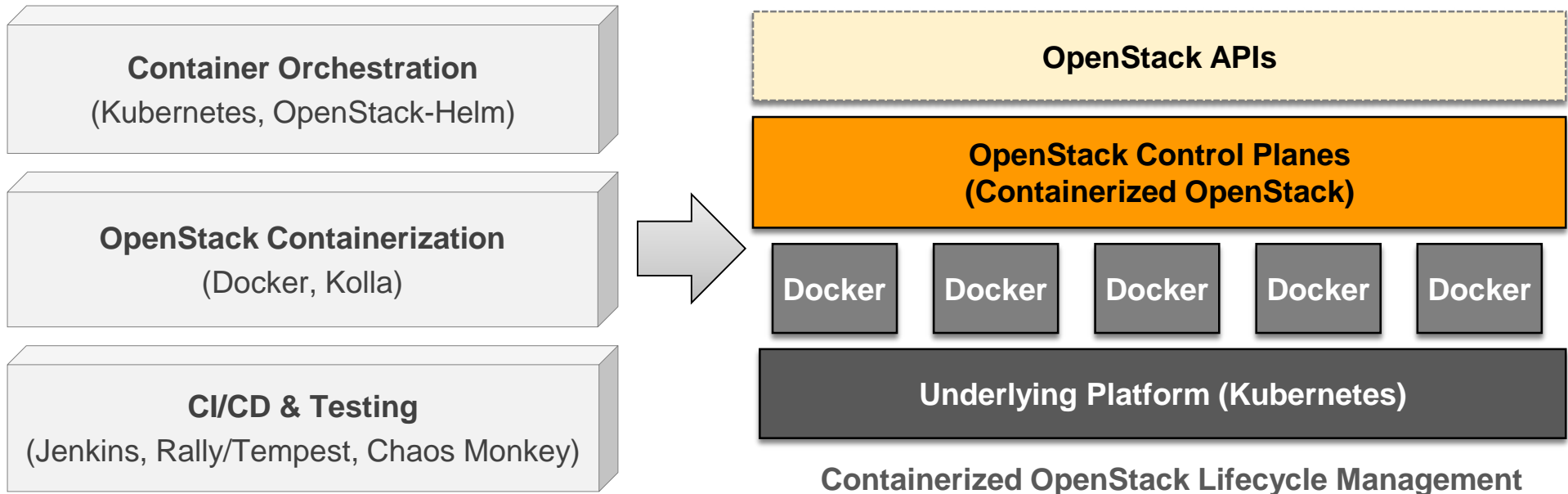
Challenges

- OpenStack is a very **complicated system to deploy and manage**
- Current way of **automating** OpenStack still has lots of **challenges**



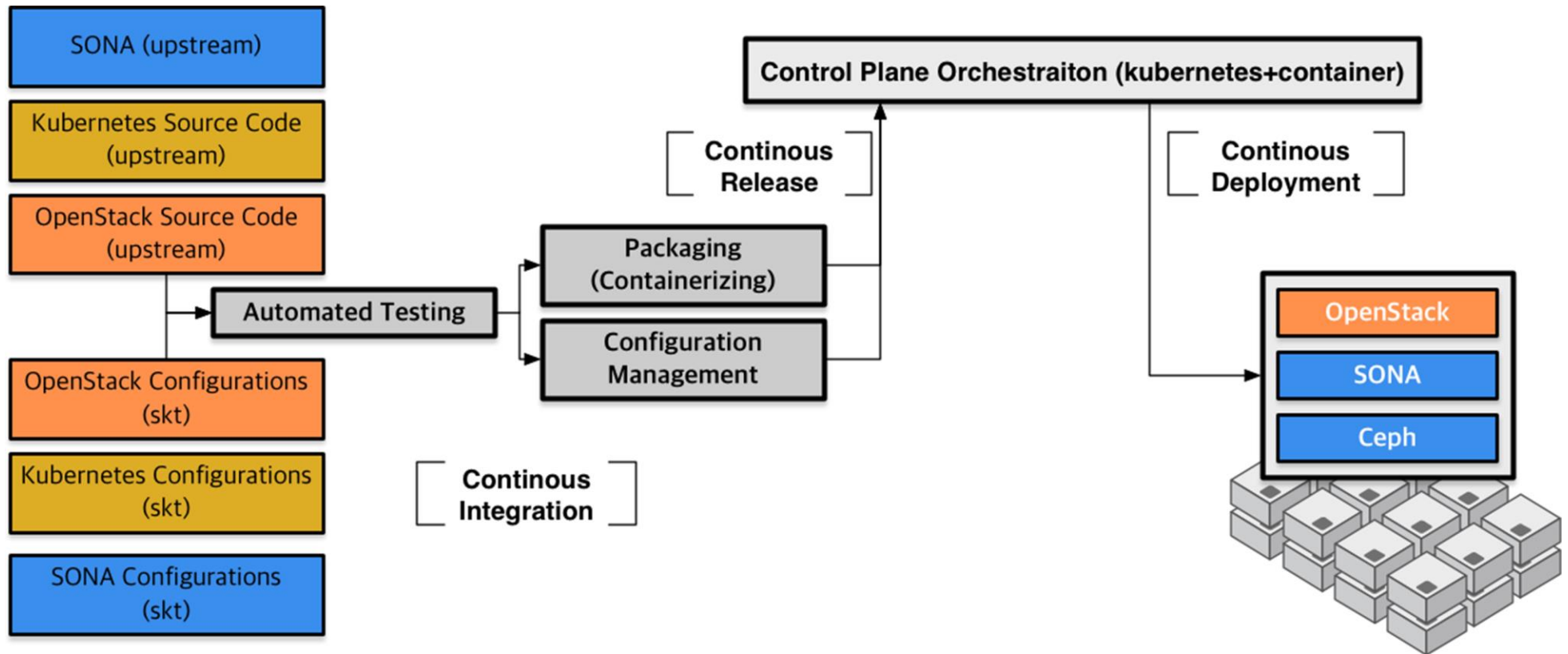
TACO Architecture

- Developed by **SK Telecom**, leveraging **Container and Kubernetes**
- Enhanced OpenStack Lifecycle Management: **Self-Healing, Upgrade w/o Service Interruption, Simple and Easy Deployment, Highly Flexible Customization**

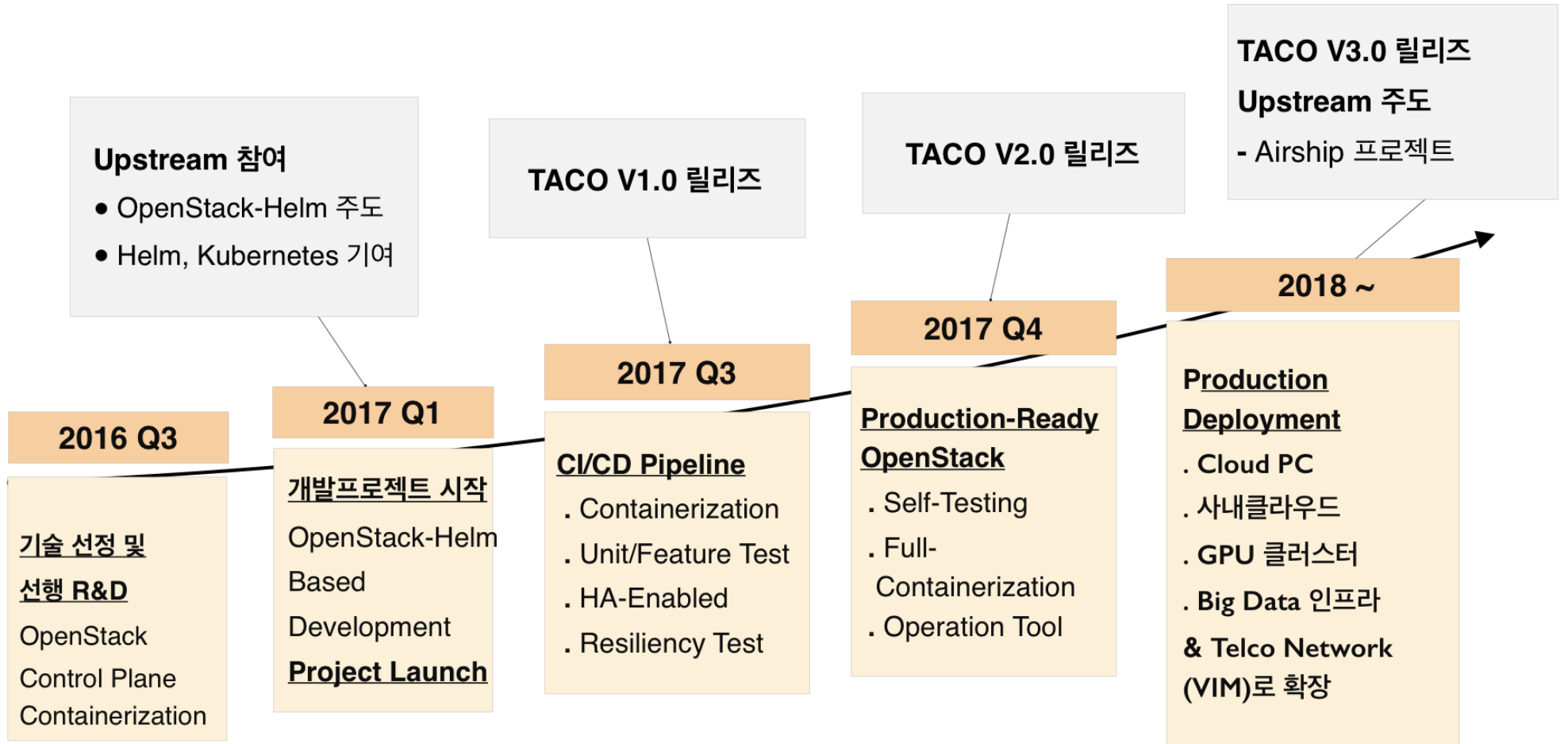


TACO SW Delivery

- **Automated Continuous Integration** Pipeline w/ Various Tests (100% sync to Upstream Code)
- **Standardized Packaging, Versioning, Release** Process and Tool Sets

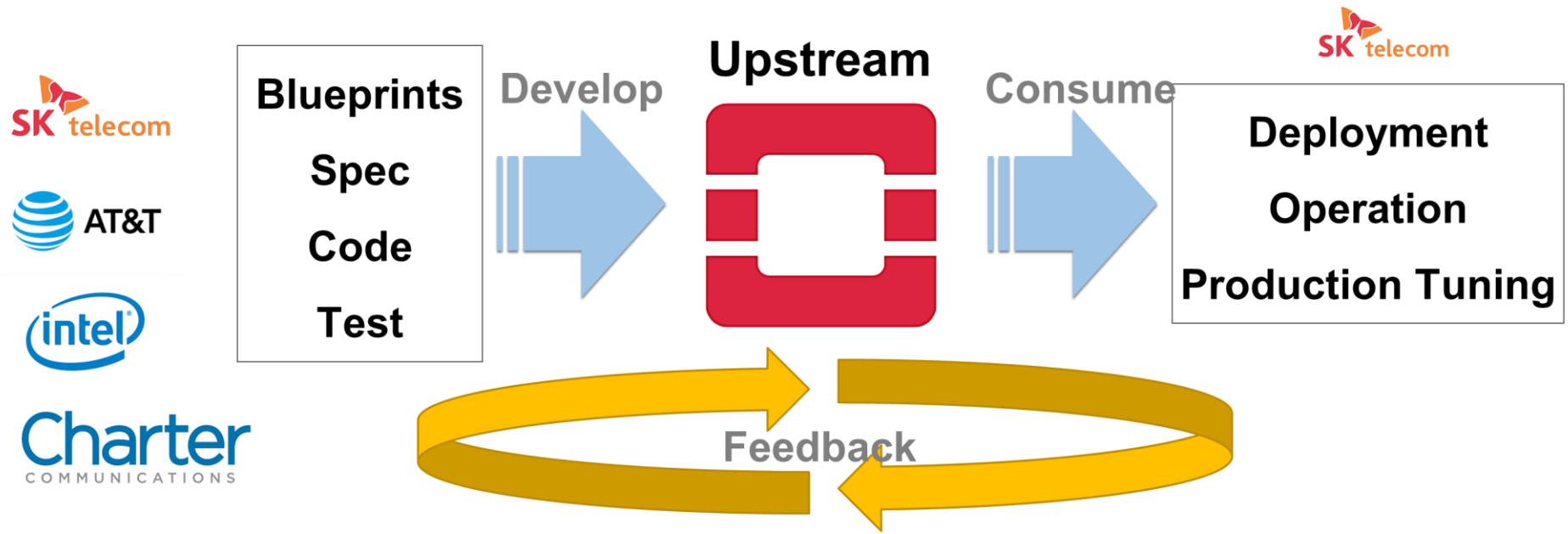


TACO Status



Upstream First Philosophy

- **Upstream First:** Develop on upstream; Consume directly from the upstream
- **Benefits:** Zero silo code, Strong ecosystem (Your code are used everywhere), Efficient development effort (Loosely coupled co-development with various community partners)



Upstream First Philosophy – TACO Helm

Contribution by companies

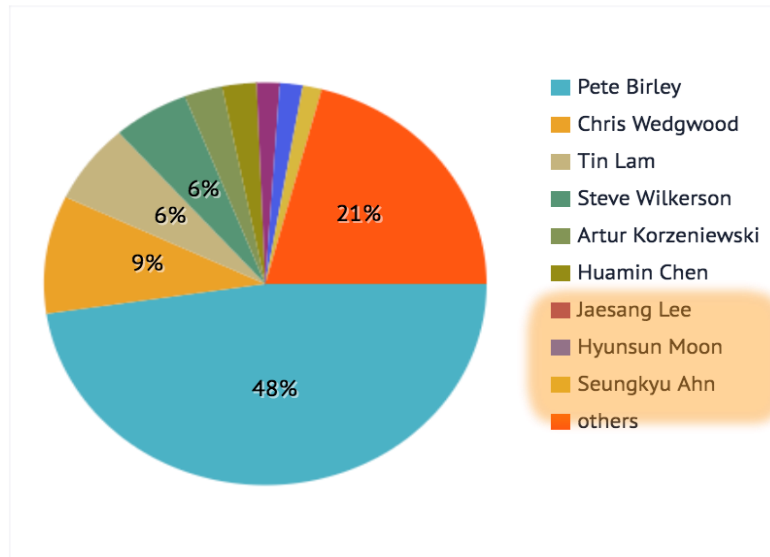


Show 10

#	
1	AT
2	SI
3	In
4	Re
	*i
5	Cl
6	Ea
7	M
8	Sl
9	N

Showing 1 to

Contribution by contributors



Show 10 entries

Search:

#	Contributor	Commits
1	Pete Birley *	171
2	Chris Wedgwood *	34
3	Tin Lam *	23
4	Steve Wilkerson *	20
5	Artur Korzeniewski	10
6	Huamin Chen	9
7	Jaesang Lee	6
8	Hyunsun Moon	6
9	Seungkyu Ahn	5
10	Matt McEuen *	5

Showing 1 to 10 of 49 entries

Openstack helm



Pete Birley (AT&T)

25 Feb 2018 19:44:25 UTC in **openstack-helm**

Commit "OSD: remove redundant DMCRYPT setup"

This PS removes the redundant dmcrypt setup from the OSD scripts.

Change-Id: [I40b0c0a0be8a32340d992dc690a76980a129ca90](#)

Commit date: 25 Feb 2018 01:13:33 UTC

+2 - 27



Pete Birley (AT&T)

25 Feb 2018 19:41:17 UTC in **openstack-helm**

Commit "Ceph: remove unrequired keyrings from pods"

This PS removes unrequired keyrings from being mounted into ceph pods.

Change-Id: [If224796a4579cde195954ab806c20be7a1974ecd](#)

Commit date: 25 Feb 2018 01:05:36 UTC

+0 - 117



Pete Birley (AT&T)

24 Feb 2018 20:04:31 UTC in **openstack-helm**

Commit "dependencies: move static dependencies under a 'static' key"

This PS moves static dependencies under a 'static' key to allow expansion to cover dynamic dependencies.

Change-Id: [I38990b93aa79fa1f70af6f2c78e5e5c61c63f32c](#)

Commit date: 23 Feb 2018 18:14:20 UTC

+1474 - 1450



Pete Birley (AT&T)

23 Feb 2018 18:44:13 UTC in **openstack-helm**

Commit "Postgresql: Update chart to match current OSH format"

This PS updates the Postgresql chart to match the current OSH format.

Change-Id: [Ifadb473043b51ccc10405886ae7a0954ce119a22](#)

Commit date: 23 Feb 2018 03:18:40 UTC

+115 - 25



Pete Birley (AT&T)

23 Feb 2018 18:20:57 UTC in **openstack-helm**

Commit "Etcd: update chart to match current format"

This PS spring cleans the etcd chart to match the current format used in OSH.

Change-Id: [I5f8802b662f7aac9f7a72d91e4d3aa2206099c92](#)

Commit date: 23 Feb 2018 02:51:48 UTC

+103 - 22

Upstream First Philosophy – SONA Upstream

Browser address bar: <https://wiki.onosproject.org/display/ONOS/SONA%3A+DC+Network+Virtualization>

Browser address bar: <https://gerrit.onosproject.org/#/q/status:open>

Search for status:open

Subject	Status	Owner	Project	Branch	Updated	Size	CR	MO	RIPE	V
Parallelize probing the E-W and N-S VMs reachability		Jian Li	onos	master (sona)	12:04 PM	+16, -2	+1			✓
Supports dpdk config in OpenstackNode.		Daniel Park	onos	master (dpdk)	10:38 AM	+1238, -123				✗
Fix race to become master in P4Runtime before pipeline config set		Carmelo Cascone	onos	onos-1.14	10:30 AM	+12, -13				✗
Reset flow rules for VM(s) port		Jongsik Jung	onos	master (17060ee8502b37b6d815c15feb338df05eeb749c1)	8:18 AM	+95, -0	+1			✓
Close session files opened by components created in the tests		You Wang	OnosSystemTest	onos-1.13 (log_file_leak)	8:10 AM	+8, -0				✓
Remove NextId from internal stores when the NextObj fails		Charles Chan	onos	master (19483)	5:58 AM	+83, -67				✓
Implement CLI commands to view and delete SR internal stores		Charles Chan	onos	master	5:14 AM	+599, -81				✓
ONOS-7759 Explicitly pop VLAN while editing hash group buckets		Charles Chan	onos	onos-1.14 (19536)	3:19 AM	+30, -11				✓
Probing must verify all old location on host move		Daniel Ginsburg	onos	onos-1.12 (cblos-22060)	2:53 AM	+4, -1				✓
Refactor: extract interfaces for a set of simple fabric classes		Jian Li	onos	master (sona)	Aug 23	+1486, -745				✓
UI for server device driver		Georgios Katsikas	onos	master (srv-dr-ui)	Aug 23	+2386, -0				✓
Optimized NIC rule deletion		Georgios Katsikas	onos	master (srv-dr-flow-rem)	Aug 23	+76, -26				✓
Refactor: extract static values to Constants class, split packages		Jian Li	onos	master (sona)	Aug 23	+255, -127				✓
Refactor: split api from SONA simple fabric		Jian Li	onos	master (sona)	Aug 23	+116, -62				✓
[ONOS-7772] Add dropped packets/bytes to toString for meter cli		HoYeon Kim	onos	master (ONOS-7772)	Aug 23	+19, -2				✓
Upgrade to Atomix 3.0.1		Jordan Halterman	onos	master (atomix-3.0.1)	Aug 23	+67, -67				✗
Make leadership/mastership failover timeouts configurable		Jordan Halterman	onos	master (mastership-election-timeout)	Aug 23	+3, -0	+1			✓
Implement destroy() method for certain primitives to preserve backwards ...		Jordan Halterman	onos	master (primitive-deletes)	Aug 23	+15, -0				✗
SSL/TLS support for OVSDb Southbound API		Debanshu Rout	onos	master (ovsdbTls)	Aug 21	+195, -32	✗	✗		✓
[ONOS-7732] Automating switch workflow(part 4): sample workflow & small fix	Merge Conflict	Jaegon Kim	onos	master (workflow)	Aug 21	+308, -0				✓
[ONOS-7732] Automating switch workflow(part 3): app & implementation classes ...	Merge Conflict	Jaegon Kim	onos	master (workflow)	Aug 21	+2934, -16				✓
[ONOS-7732] Automating switch workflow(part 2): interface & abstract class ...	Merge Conflict	Jaegon Kim	onos	master (workflow)	Aug 21	+2355, -0				✓
[ONOS-7732] Automating switch workflow: interface, & abstract class commit	Merge Conflict	Jaegon Kim	onos	master (workflow)	Aug 21	+1771, -0				✓
ONOS-6092 Create a gRPC Northbound for core services		zhiyong ke	onos	master	Aug 21	+315, -0				✓
removing non-required fields for delete op message		Minh Pham	onos	master (onos7610)	Aug 21	+90, -27				✓
Fixes OpenstackNetworking just sends warn msg when unsupported ovs-based ...		Daniel Park	onos	master (sriov)	Aug 21	+17, -28				✓
[ONOS-7765] Run SRMulticast test case 1 on Flex POD		You Wang	OnosSystemTest	onos-1.13 (SRMulticast-on-Flex-POD)	Aug 21	+1200, -97				✓
[ONOS-7764] Supports a creation of dpdk interface on open vSwitch via OVSDb ...		Daniel Park	onos	master (dpdk)	Aug 20	+506, -1				✓
WIP - Adding GUI2 to the Bazel build system	Merge Conflict	Sean Condon	onos	master (scBzlGui2)	Aug 19	+22, -4				✓
ONOS-7784: get login user who invoked sudo		Eric Tang	onos	master (ONOS-7784)	Aug 19	+1, -1				✓
[WIP] Implement LAG service		Charles Chan	onos	master (lACP)	Aug 16	+892, -0				✗
[WIP] Implement packet serializer and deserializer for LACP		Charles Chan	onos	master (lACP)	Aug 16	+1398, -0				✓
IEEE 802.1x EAPOL-MKA packet support.		Jayakumar Thazhath	onos	onos-1.13 (eapol-mka)	Aug 15	+1652, -9	+1	+1		✓
[ONOS-7683] New CLI Commands for StatFlowRule	Merge Conflict	Boyoung Jeong	onos	master	Aug 15	+498, -54				✓
Adding Multisc traffic drop for un-programmed trees. Pushed NDP flows to ...		Andrea Campanella	onos	onos-1.12 (onos-1.12-NDP-fix)	Aug 14	+133, -54	✗	✓		✓
sr-mcast: enable IPv6 NDP to flood on ports with same incoming vlan		Andrea Campanella	onos	onos-1.12 (onos-1.12-NDP-fix)	Aug 11	+254, -106	-1	-1		✓
Augmenting double tagged host with vlan type parameters	Merge Conflict	Andrea Campanella	routing	master	Aug 10	+345, -17				✓
Flows not removed on device removal status		Junyeong Seo	onos	master (change)	Aug 10	+9, -2	-1	-1		✓
Upgrade to Ubuntu 18.04		Charles Chan	routing	master	Aug 9	+1, -2				✓

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The screenshot shows a web browser window displaying the T-Hub community page. The page title is "Spark2.0 New Features(2) Structured Streaming - 1편" by user "jerryjung" on 2018.08.28. The page content includes a section on "Structured Streaming" with a detailed explanation of its architecture and a code snippet for a word count application.

Structured Streaming

Structured Streaming은 Spark2.X에서 새롭게 나온 Spark SQL엔진 위에 구축된 Stream Processing Framework이다. Structured Streaming은 기존에 Spark APIs(DataFrames, Datasets, SQL)등의 Structured API를 이용하여 End-to-End Streaming Application을 손쉽게 만들 수 있다. 또한 input data에 대한 Streaming데이터 처리 후 checkpointing과 write-ahead logs를 통한 exactly-once하고 fault-tolerance한 프로세싱을 지원한다. 또한, 늦게 오는 데이터에 대해 처리가 가능하며 Continuous Processing Mode로 1ms미만의 latency를 제공한다. 각각에 대해서는 개별 글을 통해 공유해 보도록 하겠다.

Structured Streaming의 주요한 아이디어 중 하나는 input으로 들어오는 stream데이터에 대해 table형식으로 append를 할 수 있다는 점이다. 즉, DataFrame을 통해 streaming으로 들어오는 데이터를 질의하거나 집계하거나 변경하는 작업들이 가능하다. 출처 - <https://spark.apache.org/docs/2.3.0/structured-streaming-programming-guide.html/#caption>

그럼 우선 Spark Streaming에 대해 간략하게 알아보자. 실시간 Streaming Framework에 있어서 Spark Streaming의 position은 micro-batch 영역이다. in-stream으로 들어오는 데이터에 대해 작은 batch로 만들어서 RDD연산을 수행한다.

출처 - <https://spark.apache.org/docs/2.3.0/streaming-programming-guide.html/#caption>

위와 같이 작은 batch는 spark engine을 통해 처리되고 external system(HDFS, NoSQL 등)에 최종 결과가 write된다. 다음은 <https://spark.apache.org/docs/2.3.0/streaming-programming-guide.html> 에서 가이드하는 streaming application code example이다. 아래의 예제에서 Spark Streaming의 socket stream을 receiver로 만들고 9999 port로 socket을 binding하는 application이다. input stream으로 들어온 socket data를 1초 단위의 small batch로 처리하게 되어 있는데 flatMap을 이용하여 입력 받은 데이터를 공백 단위로 split한다. 여기까지 읽었다면 대충 감이 올 것이다. big data 계의 hello world같은 word count예제이다. split된 데이터는 각 word를 count하여 pairs로 만들고 최종적으로는 reduceByKey를 통해 입력받은 문장의 tokenizing한 word를 count하게 된다.

예를 들면 1초 내 input 이 hello world hello word라면 최종 결과 값의 최종 RDD는 (hello,2) (world,1) (word,1)이런식으로 생성된다.

```

1. import org.apache.spark._
2. import org.apache.spark.streaming._
3. import org.apache.spark.streaming.StreamingContext._ // not necessary since Spark 1.3
4.
5. // Create a local StreamingContext with two working thread and batch interval of 1 second.
6. // The master requires 2 cores to prevent from a starvation scenario.
7.
8. val conf = new SparkConf().setMaster("local[2]").setAppName("NetworkWordCount")
9. val ssc = new StreamingContext(conf, Seconds(1))
10.
11.
12. // Create a DStream that will connect to hostname:port, like localhost:9999
13. val lines = ssc.socketTextStream("localhost", 9999)
14.
15. // Split each line into words
16. val words = lines.flatMap(split(" "))
17.
18. import org.apache.spark.streaming.StreamingContext._ // not necessary since Spark 1.3
19. // Count each word in each batch

```

Conclusion

- 오픈소스 소프트웨어는 당사 뿐 아니라 ICT 생태계 전체를 변화시키는 혁신의 동인으로 작용하고 있음.
- 당사는 오픈소스 생태계에 적극 참여 및 활용 활용하여 소프트웨어 기반 혁신 기술을 지속적으로 개발할 예정이며,
- 오픈소스 발전 및 활용을 위해 국내/외 오픈소스 커뮤니티에 적극적으로 참여하고 리딩해 나갈 예정임.