電子情報通信学会
第三十回 ネットワーク仮想化特別研究専門委員会 招待講演

5G 時代におけるネットワーク・エッジの変革に向けた市場動向とシスコの取り組み

Rev.1.0

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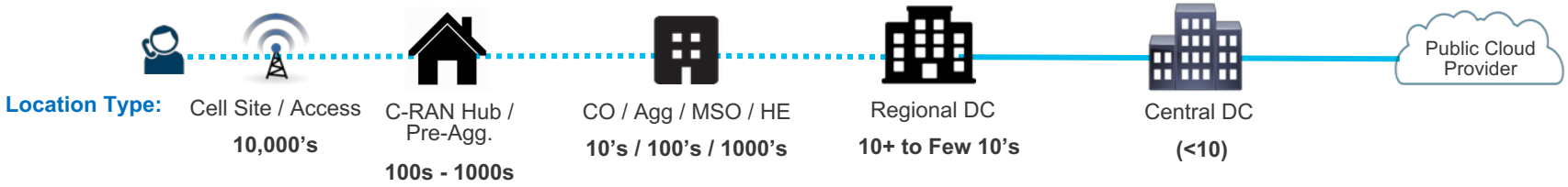
Feb 28, 2019

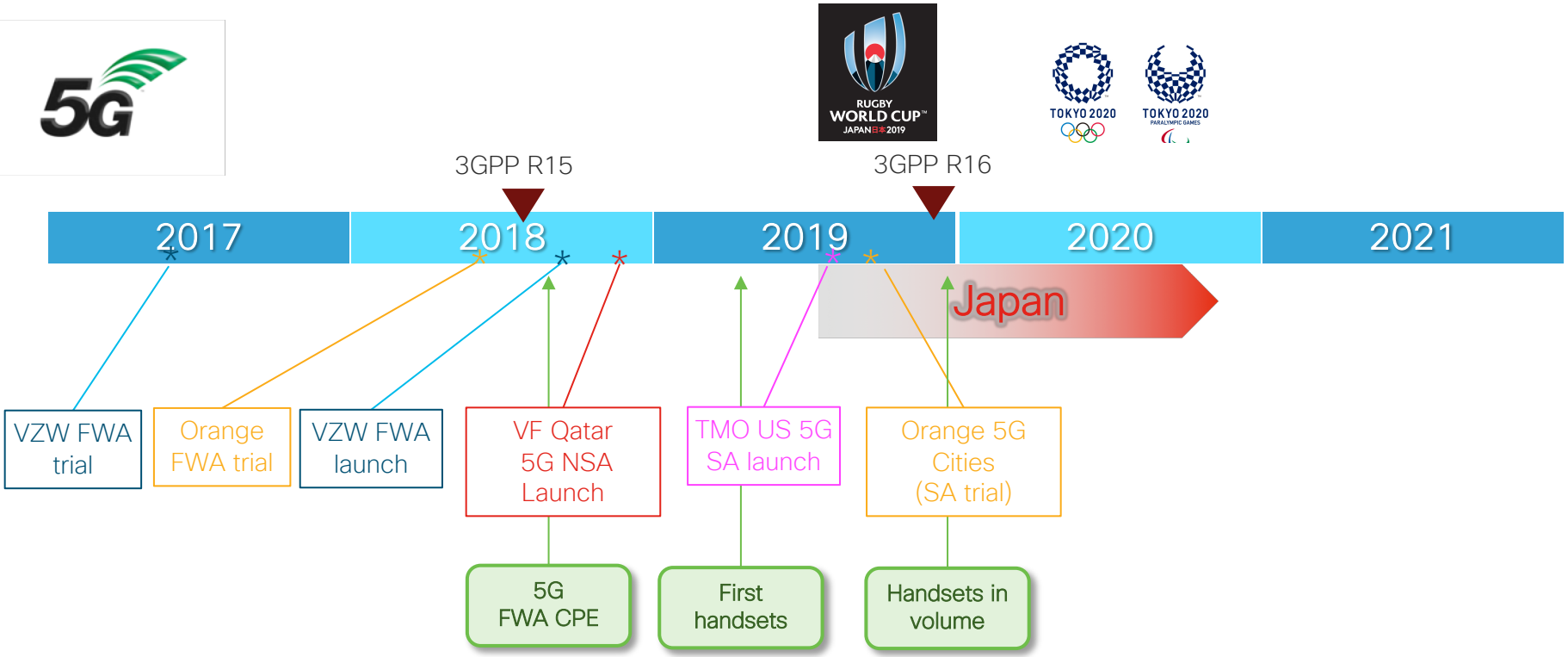
Terminology for Service Edge
「エッジ」とは何を指しているか



Terminology from a Services Edge or Applications Placement Perspective

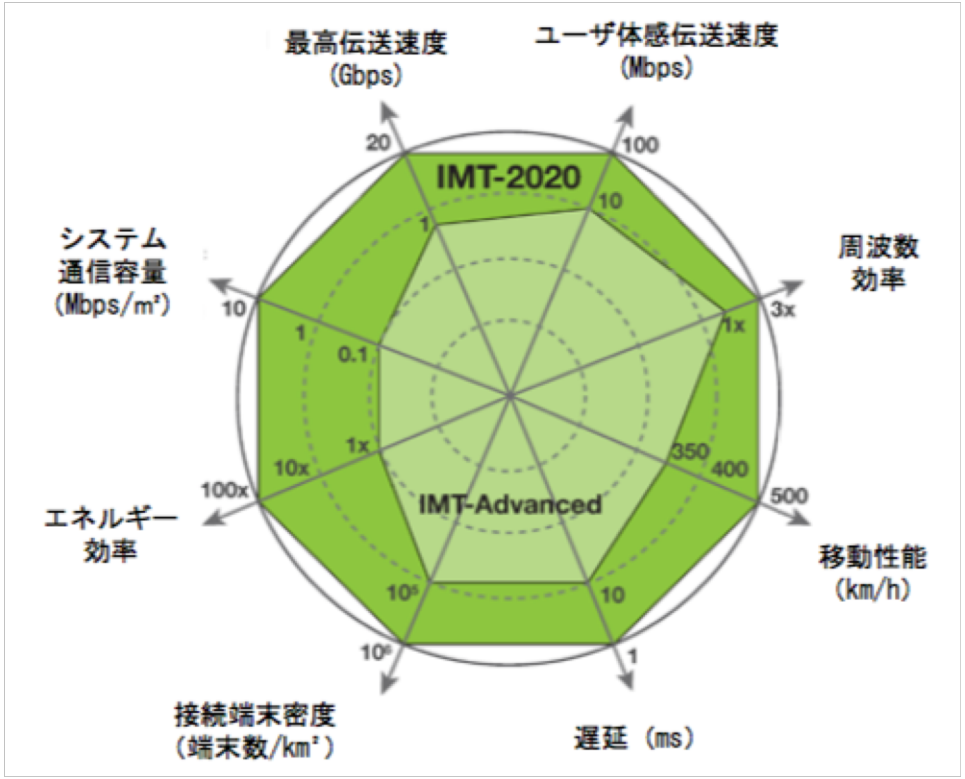
Cisco's Terminology	Far Edge		Edge	Regional DC	Central DC	Public Cloud
Customer Terminology	EMEA APJ		Frontend Data Center	Backend Data Center		
	US	Cloud Platform – Deep Edge	Cloud Platform – Far Edge	Cloud Platform - Edge	Cloud Platform - Core	

5G's coming



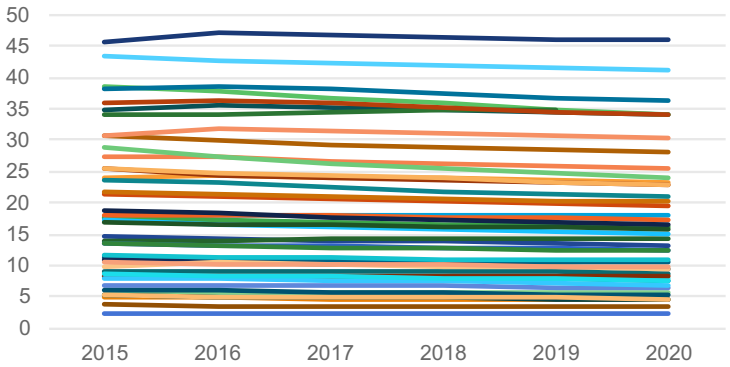
5G – 超高速・多数接続・超低遅延を実現するテクノロジとそれらに基づく次世代の新サービス

総務省 電波政策2020懇談会 報告書より (2016.7)

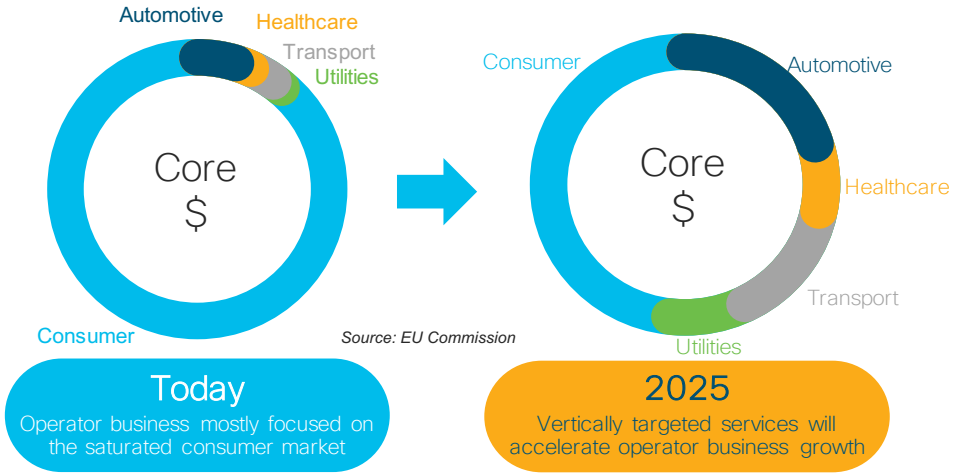


ITU-R M.2083-0 (2015.9)

ビジネス視点: 新たな収益源となるべき B2B 領域
特に低遅延を活かしたサービスの創出がビジネスの鍵に



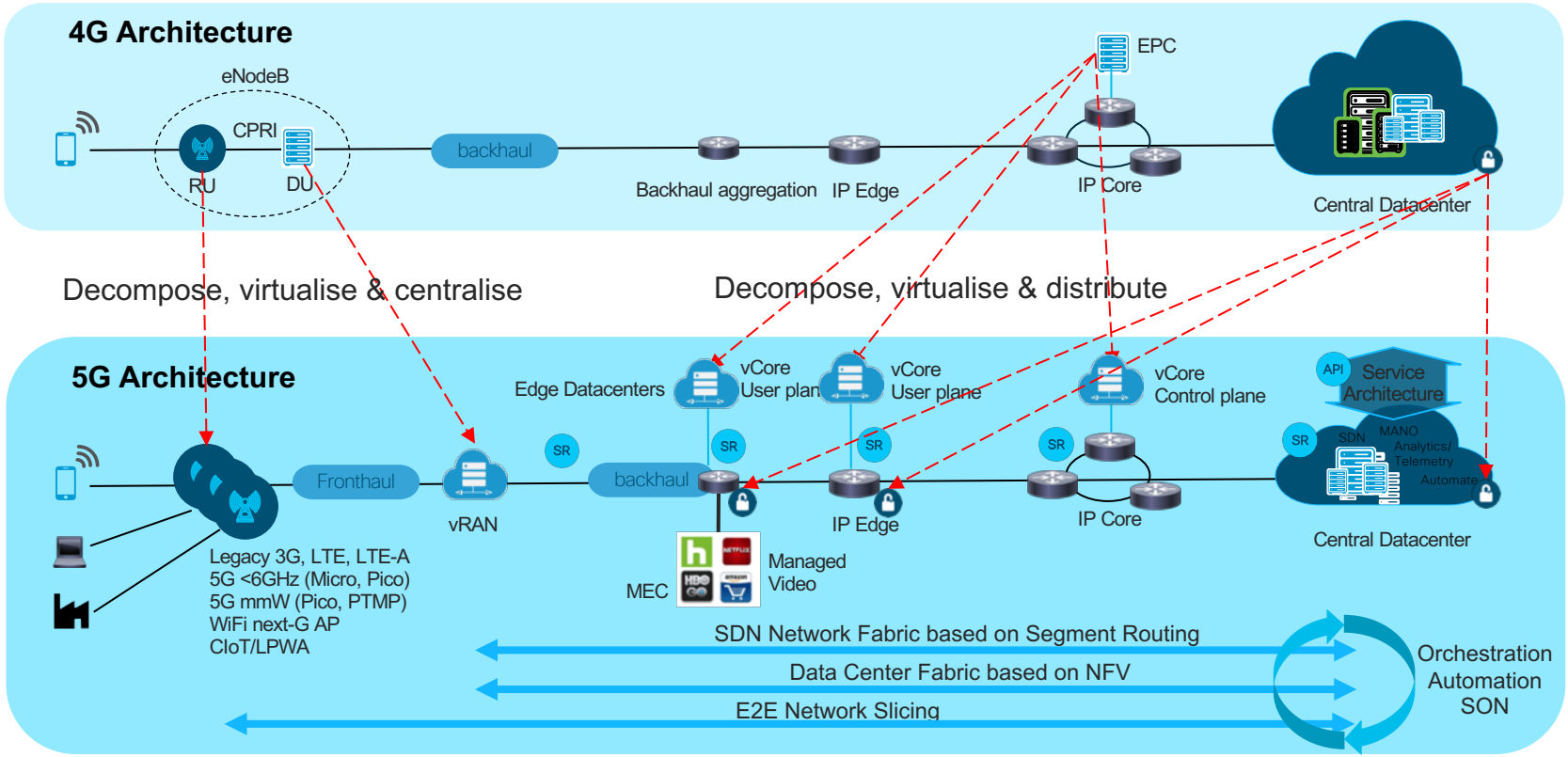
Consumer ARPUs are Declining or Flat



B2B or B2B2x Market Has Future Growth

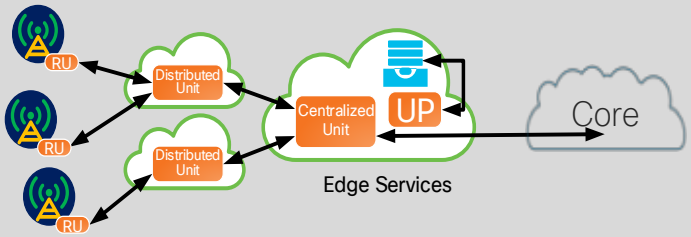
Low Latency for better QOE
and to Enable New Applications,
Customer Experience Transformation

5G ではネットワークアーキテクチャに大きな変革
エッジはインフラとして必須 かつ 新規ビジネスへの活用のチャンスに

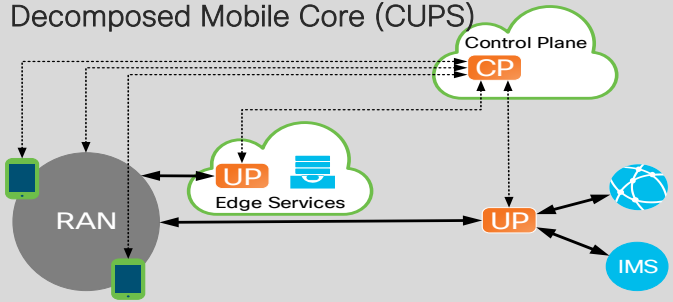


SP インフラとしてのエッジの利用例

(Open) Virtualized RAN

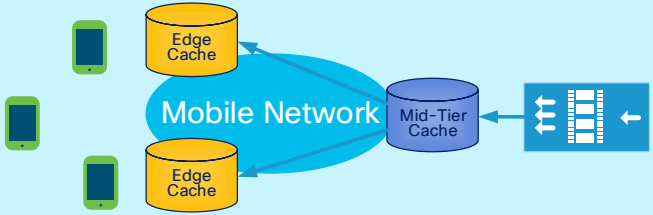


Decomposed Mobile Core (CUPS)

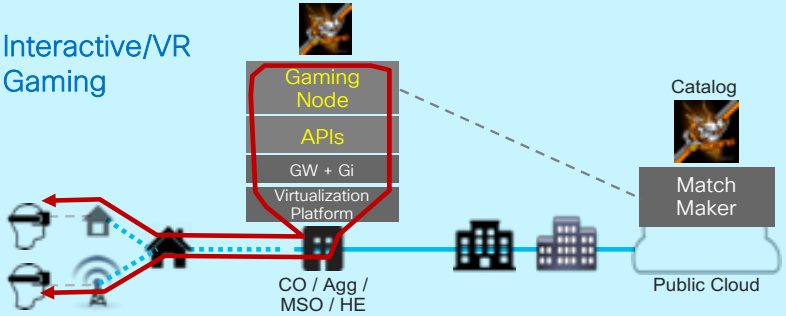


B2B サービスのためのエッジの利用例

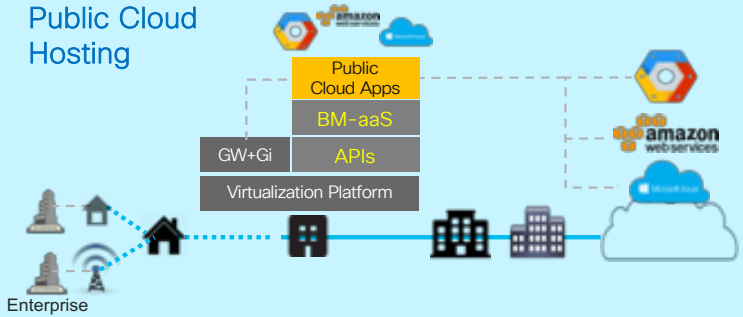
Edge CDN for (Mobile) Video



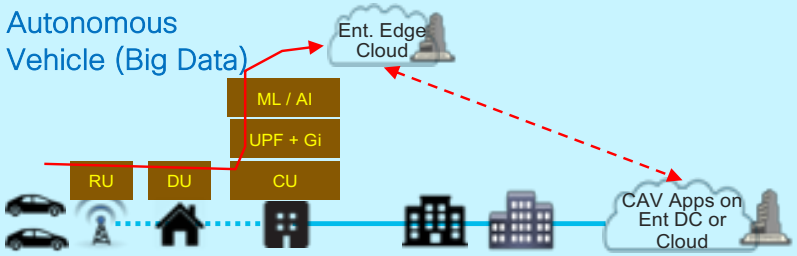
Interactive/VR Gaming



Public Cloud Hosting



Connected Autonomous Vehicle (Big Data)



エッジへの投資にあたって

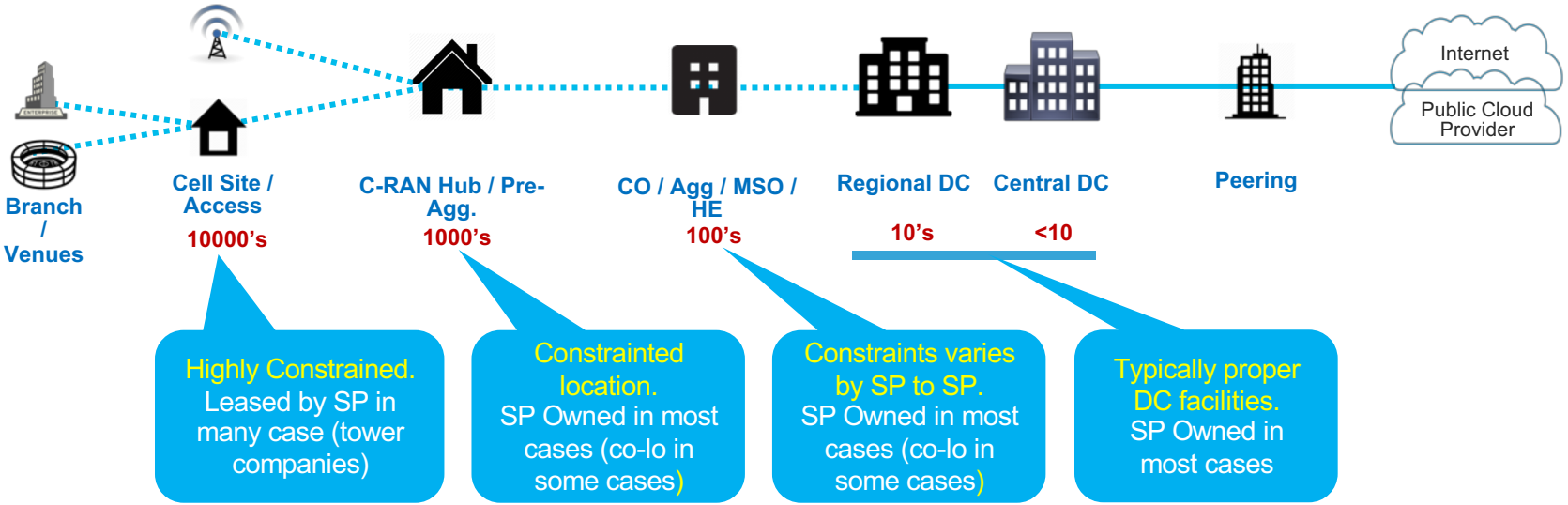
考慮点1: アプリケーションの遅延要件

Use Case / Function	Latency	Notes
vRAN with Option 7 Split	~250us	End-to-end latency, Including RU symbol buffering, for transport typically 100us delay budget is ok
Mobile Video	~75ms (One way Delay), will depend on PLR	Including ~25ms of buffering. This recommendation is derived from considering typical PLR in radio and its impact to the performance of TCP congestion control. It implies maximum OWD between streaming server and RAN node must be $< 35\ ms$ for LTE and $< 40\ ms$ for 5G.
Mobile Augmented Reality	10ms (One Way Delay)	Network-based inference will not result in viable mobile AR in LTE since the air interface budget ($30\ ms$) exhausts the smallest possible lag ($20\ ms$). In 5G, the AR inference capability likely requires an edge host adjacent to the RAN node.
Mobile Virtual Reality, Interactive Gaming	20ms (One Way), 50ms (One Way)	For VR, Based on a $40\ ms$ RTT requirement for maximum lag, we see the maximum One Way Delay between the VR server and the RAN node must be $< 5\ ms$ for LTE and $< 10\ ms$ for 5G.
VoIP	200ms (One Way Delay)	Note that the number implies VoIP can be supported over longer distances with no measurable impact on delay. **This suggests IMS APN should remain centralized**
Other Low Latency / uRLLC Use Cases (More likely to be deployed in later phases)		
Factory Automation	$0.25\ -10\ ms$	Real-time control of machines and systems in production lines
Intelligent Transportation	$0\ -100\ ms$	Autonomous driving and optimization of road traffic (platooning and overtaking)
Robotics and telepresence	$10\ -100\ ms$	Remote control with synchronous visual-haptic feedback
Health care	$1\ -10\ ms$	Medial Bio-Telemetry, Tele-diagnosis, tele-surgery
Smart Grid	$100\ ms$	Switching on/off electrical sources to compensate for demand fluctuations

エッジへの投資にあたって

考慮点2: エッジでのインフラ構築には多くの制約と課題

場所, 現状, 所有者, 諸所の制約事項



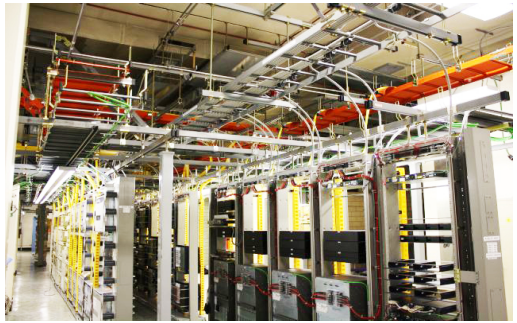
US の場合: Central Office

A CO is not a data center

- Some operators have very specific requirements on DC equipage
- Power is -48 VDC in the CO and grid voltage in the DC
- COs typically have concrete floors vs raised floors in data centers
- Power dissipation in COs is limited to < 4.5 kW per cabinet whereas no such limit exists in DC rack (~12 kW)
- In COs, equipment depth is ~12 in (600 mm) vs 800-900 mm in DCs

Many Operators have empty space at CO

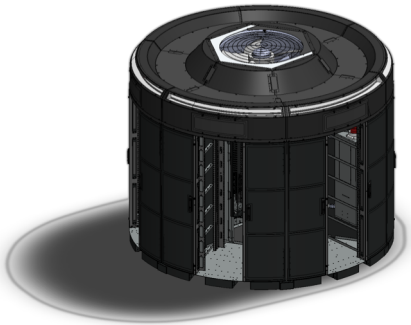
- How to use it - sell or sell & lease back or keep?
- Adapt to the constraints or resdesign the facility as a data center?



Adapt to exisiting Constraints?

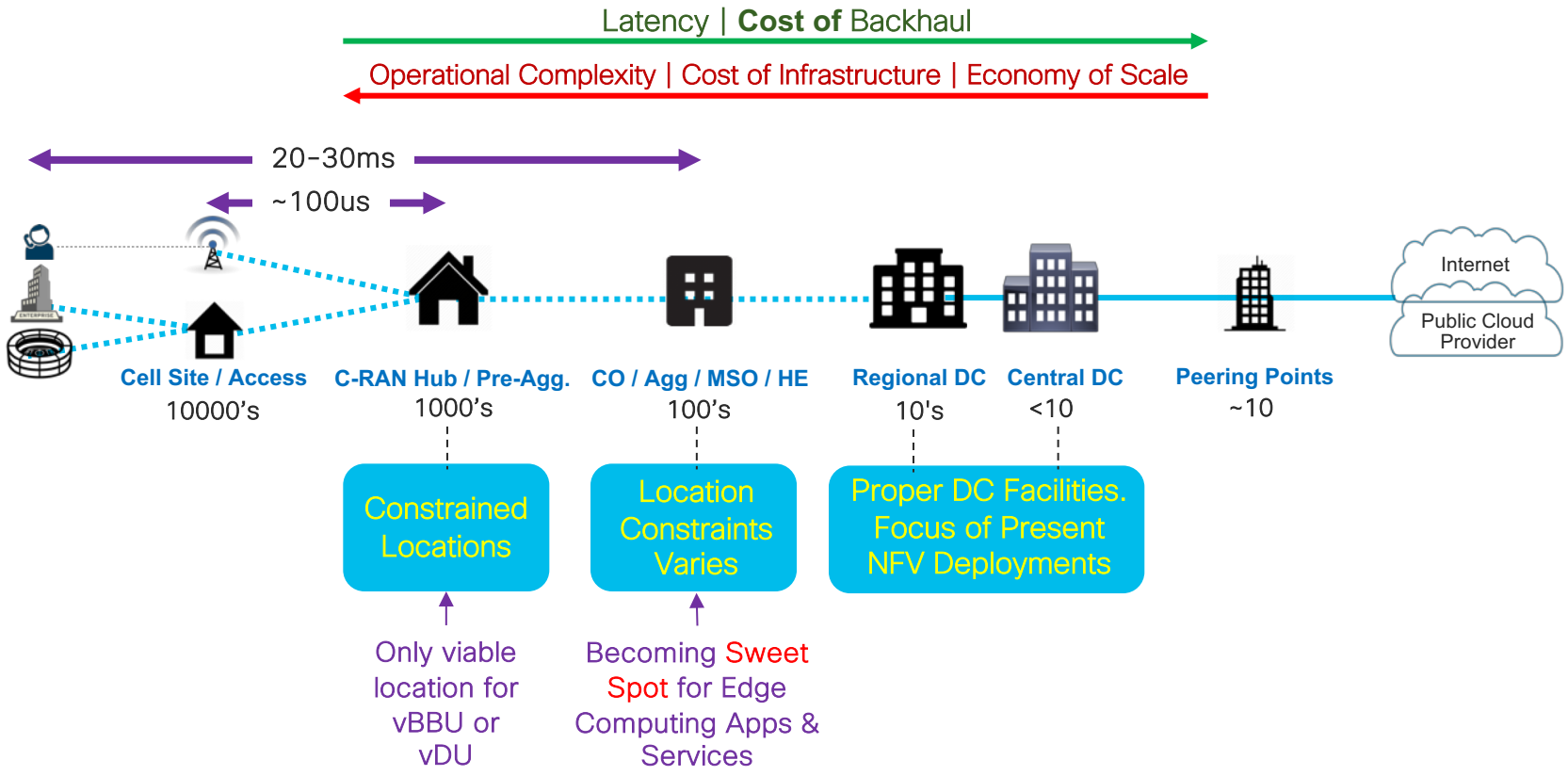
Tear-down and rebuild?

Convert to raised floors, filtered air, and advanced AC?

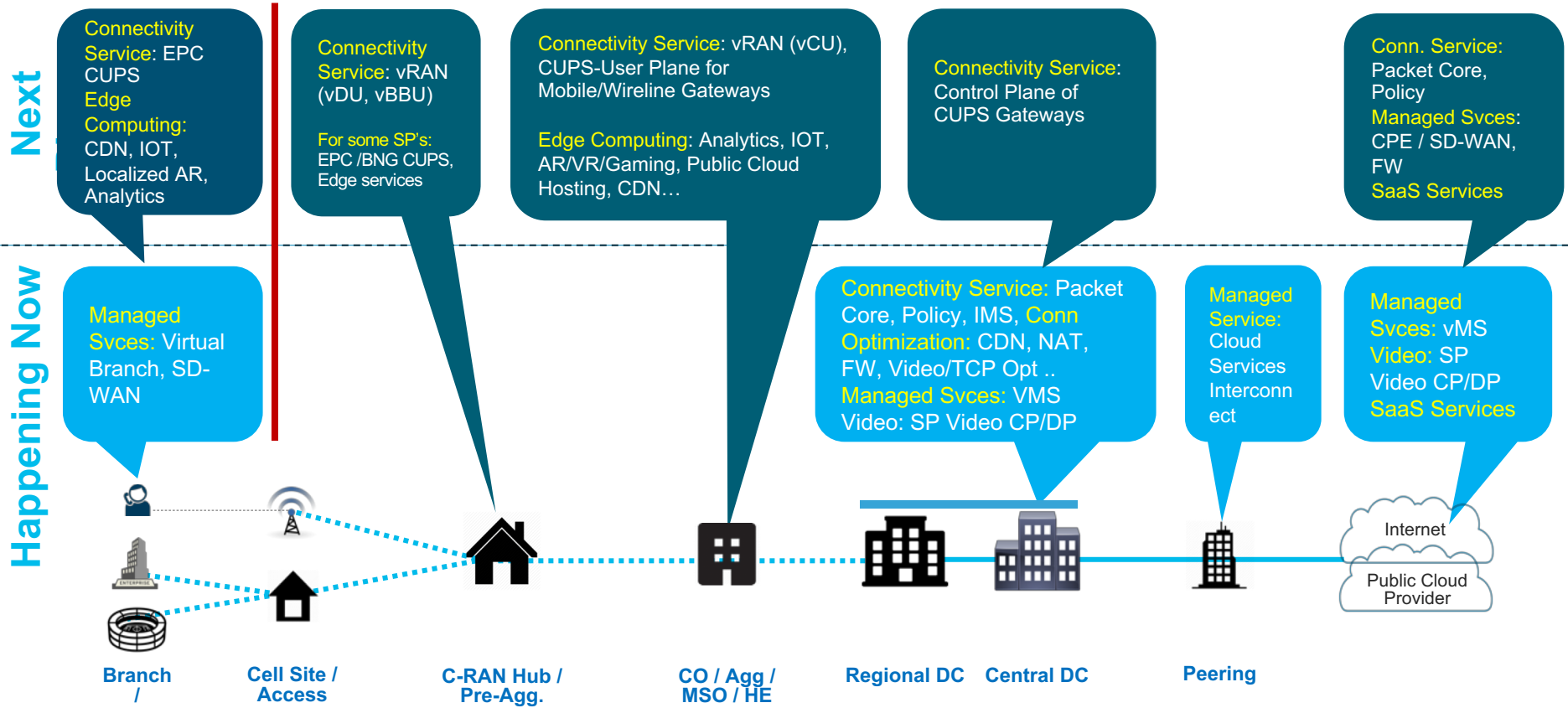


Data Center in a POD?

最適な配置とビジネス性を見据えたエッジへの設備投資



アプリケーションの配置の例:
アプリケーションの特性と要件に応じて最適なエッジへ配置ができるインフラを構築することが重要



エッジの変革に向けたシスコの取り組み

- Cloud Native Network Functions
  - Network Function の仮想化・Cloud Native 化への開発投資
  - Mobie EPC, Cloud CMTS, Cloud Native BNG, and more…
- Virtualization & Container Platform
  - エッジまで拡張できる仮想基盤・コンテナ基盤への開発投資
- Cloud Native Performance
  - エッジ上で仮想化・Cloud Native 化された Network Function での高性能パケット処理のための開発投資

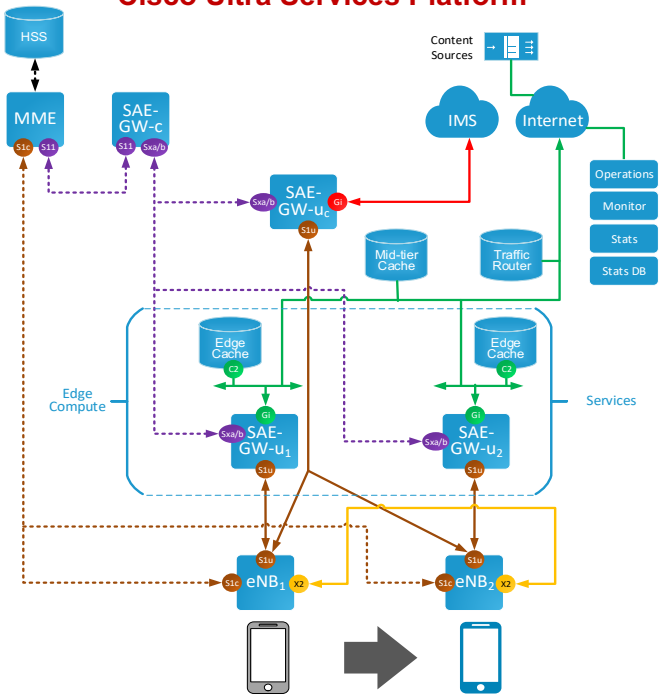
エッジ変革に向けて シスコが開発する 製品＆テクノロジー

- Cloud Native Network Functions

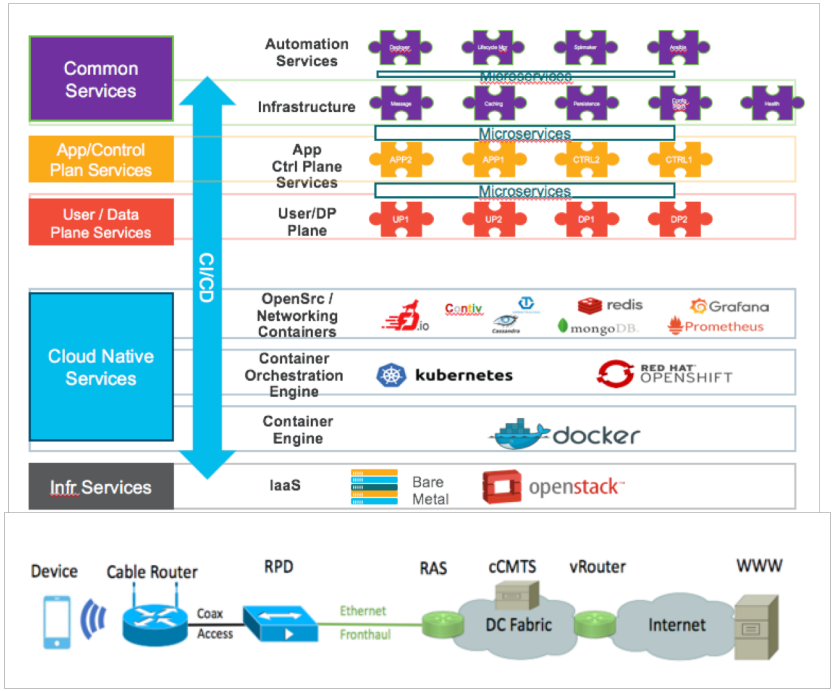
シスコは Network Function の Cloud Native 化を推進

Decomposition, Virtualization to Cloud Native

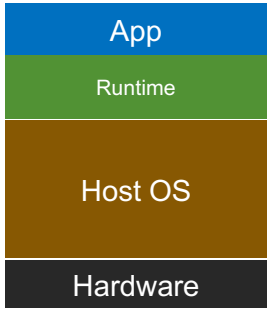
Decomposed Mobile core with
Cisco Ultra Services Platform



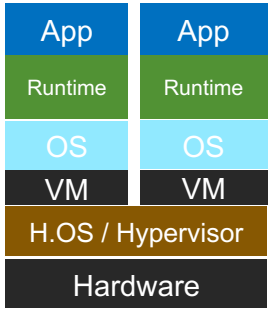
Cisco Cloud CMTS (cCMTS)



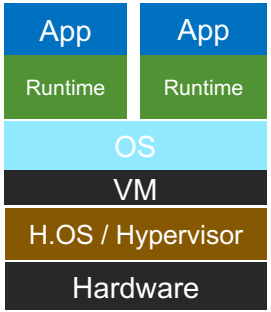
Cloud Native に向かう背景: アプリケーションの進化
専用アプライアンスから仮想マシン・そしてコンテナへ



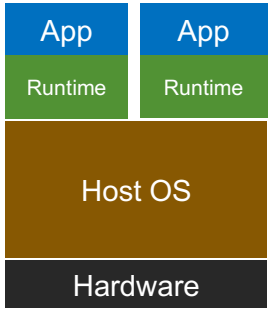
Bare Metal / Dedicated



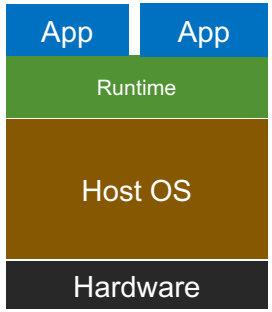
Virtual Machine



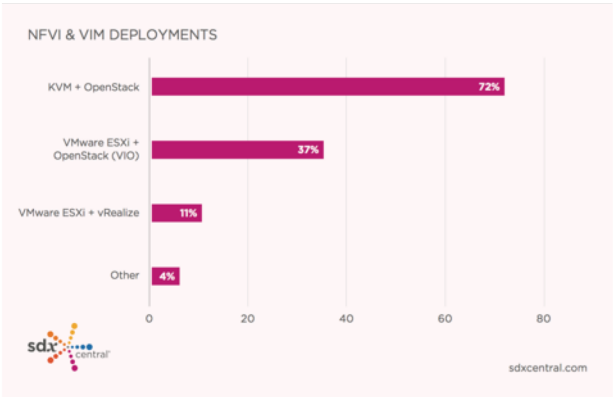
Containers in VM

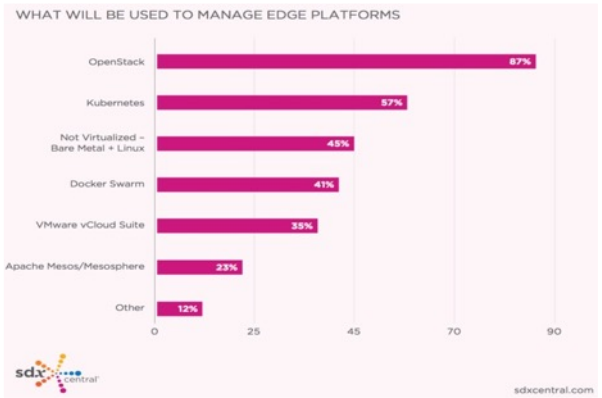


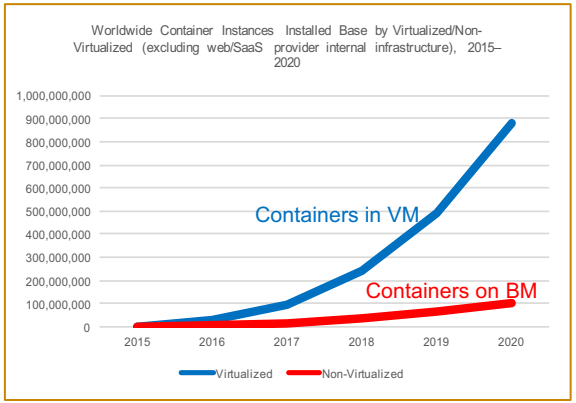
Containers (on BM)

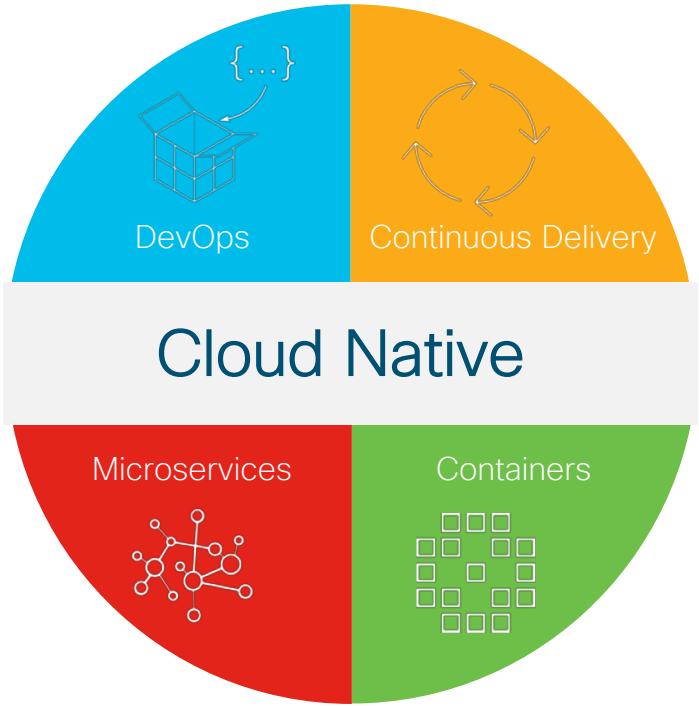


Function-as-a-Service









Microservices

- Modular, loosely coupled software services
- Individually deployed and lifecycle managed

Containers

- Virtualization and management of Microservices
- Highly portable to different deployment targets

Continuous Delivery

- Automated continuous integration, validation and availability of containers

DevOps

- Automate and manage rapid deployments
- Isolate production changes and deploy once validated

Cloud Native 化のアプリケーションにとっての利点
NFV に期待されていた真のメリットを実現

Lifecycle Automation	Automated instantiation and placement, upgrade, scale and recovery.
Multi-Cloud Portability	Mobile core disaggregation to the edge across public, private, and hybrid clouds.
Lightweight and Fast	Extremely fast startup times improves recovery and scaling event handling.
High Performance	Bypass the hypervisor overhead when deployed on bare metal. VPP based forwarding plane and vswitch.
Stateless Application Services	State services are separated from the application processing to simplify manageability.

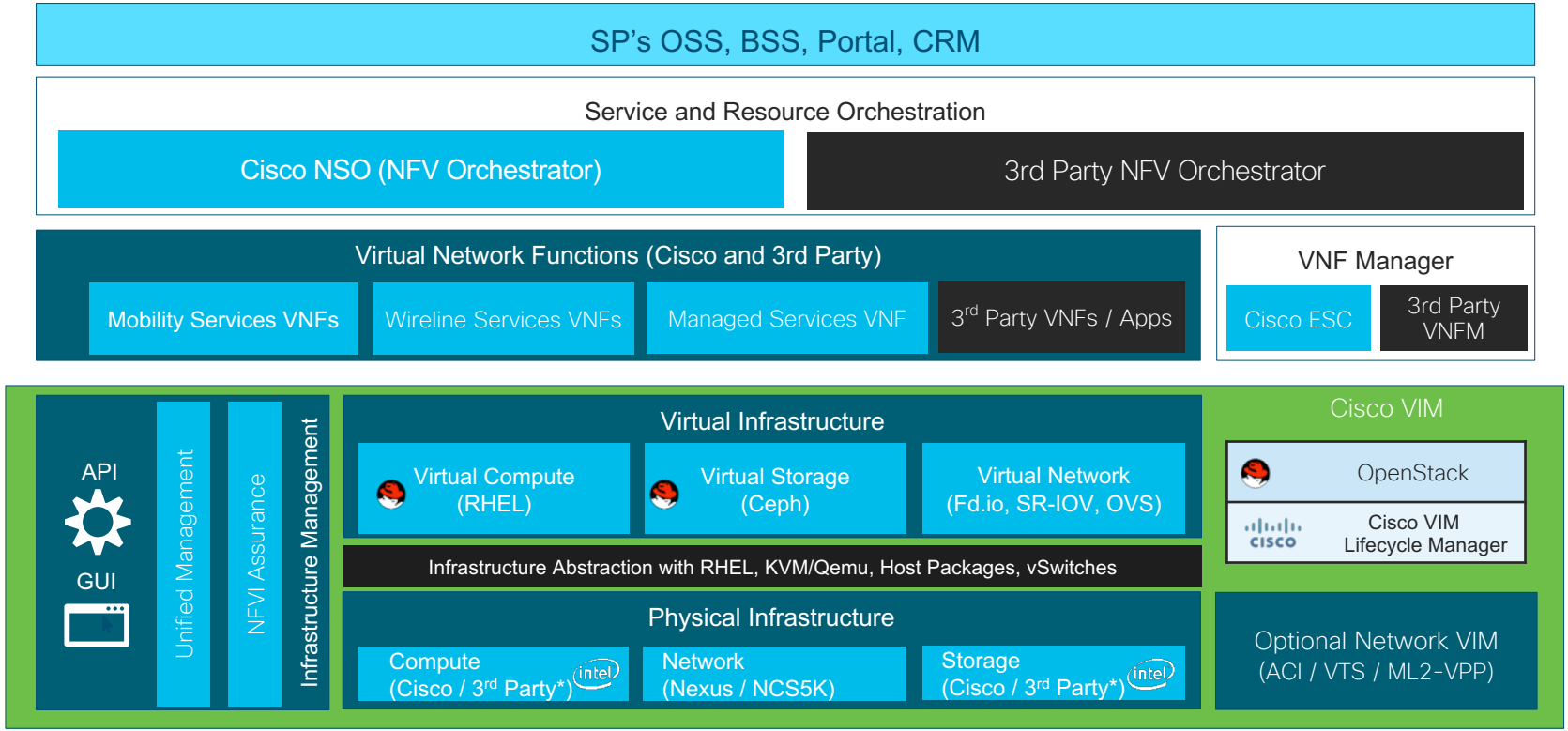
kubernetes

エッジ変革に向けて シスコが開発する 製品＆テクノロジー

- Cisco VIM
- Cisco Container Platform
- Virtual Packet Processor

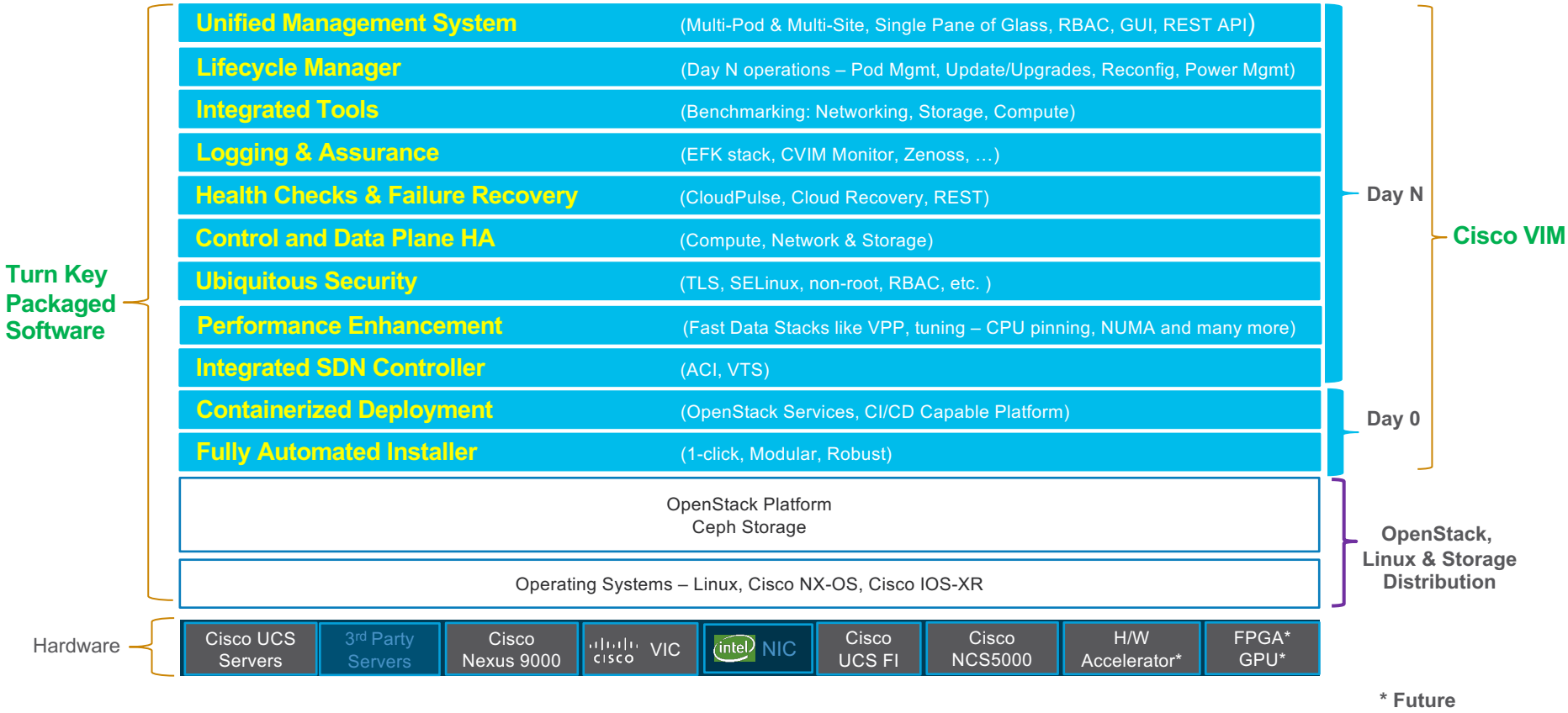
Cisco SP Virtualization Platform Today

With Cisco VIM, Cisco UCS Servers, Cisco Switching and MANO stack

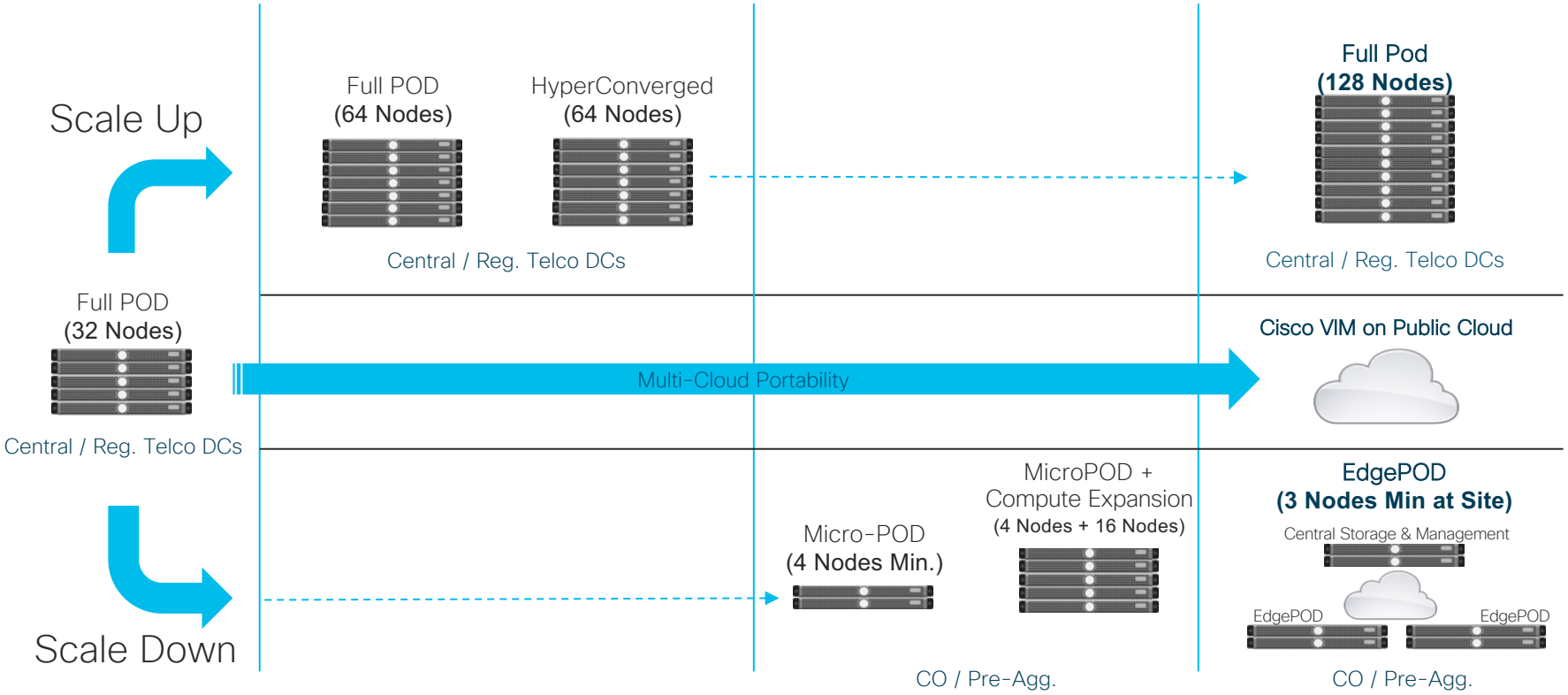


VIM: Virtual Infrastructure Manager

Cisco VIM
Carrier Grade NFV Platform



Expand Virtualization Platform to the Edge
CVIM Deployment Models



Cisco Container Platform

ターンキー ソリューションでの
製品レベルのコンテナ環境

ネイティブ Kubernetes（100 % アップストリーム）
オープン ソース コミュニティでの更新やベスト プラクティスを直接適用

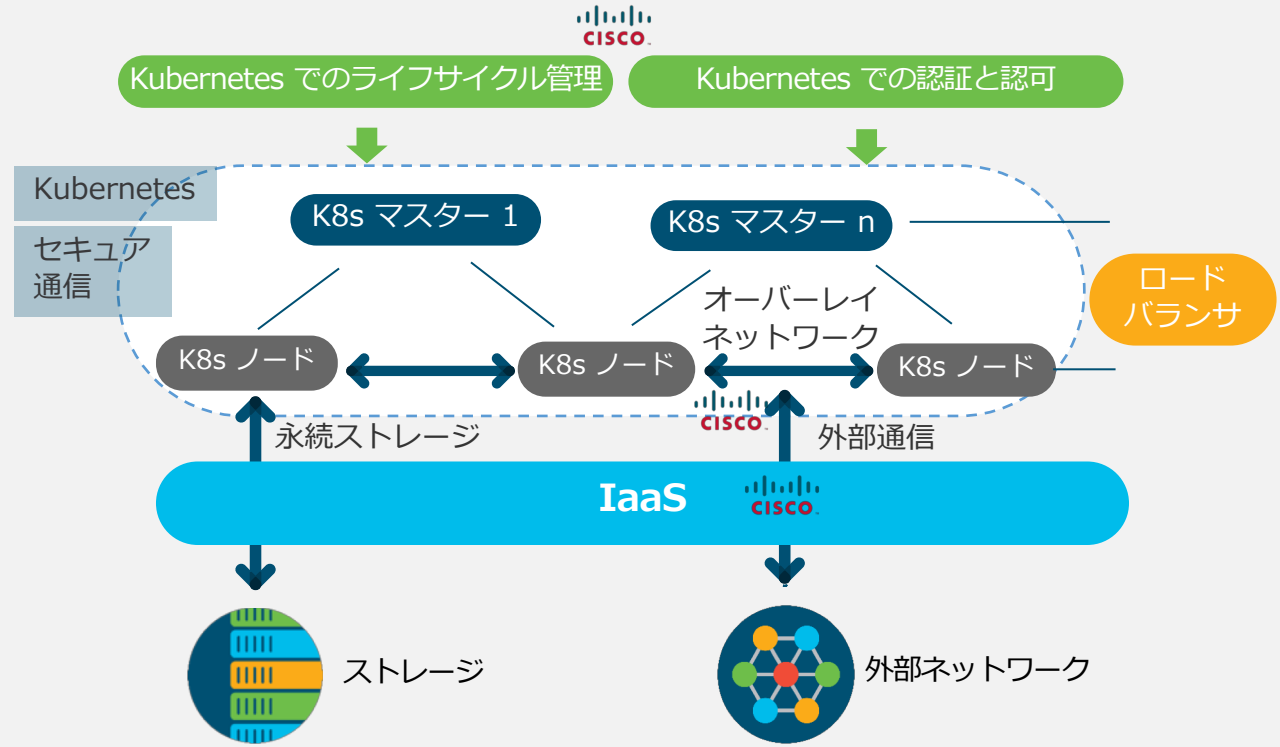
ハイブリッド クラウドの最適化
例：Google 等

統合
ネットワーク | 管理 | セキュリティ | 分析

柔軟な導入モデル
VM | ベア メタル ←→ HX、ACI | パブリック クラウド

容易な導入、展開、管理 | オープンでありながら一貫性を維持 | 拡張可能なプラットフォーム | 世界レベルのアドバイザリとサポート

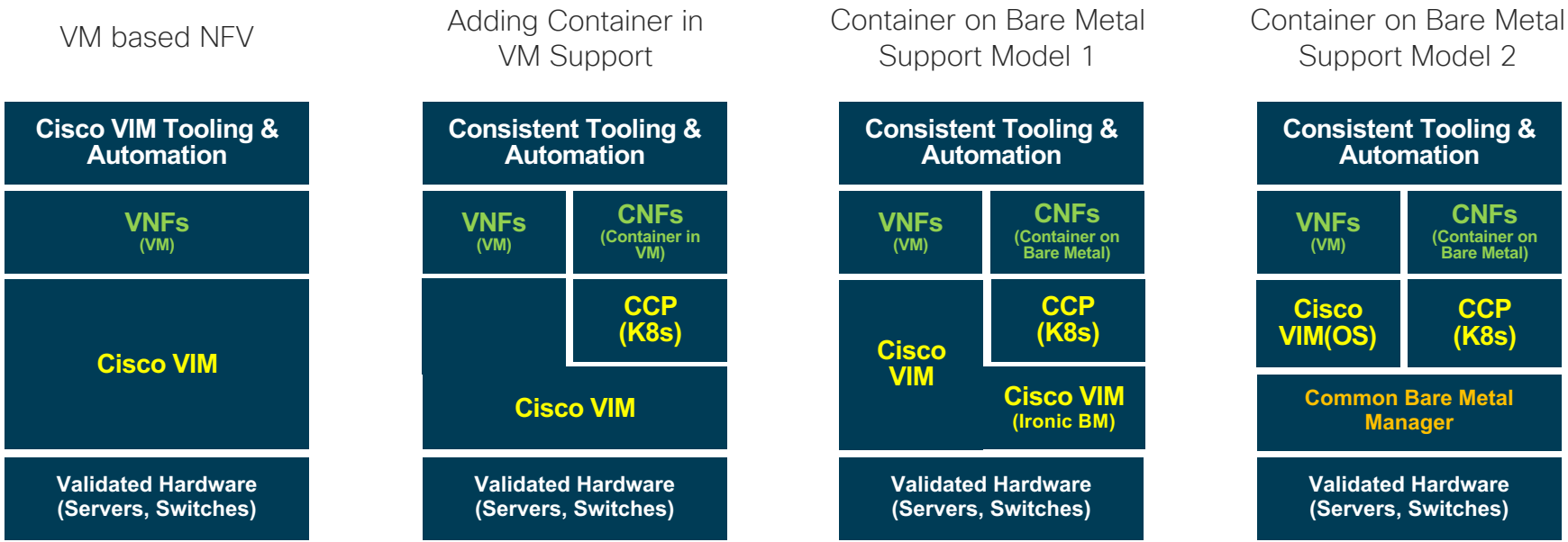
Cisco Container Platform



技術面での差別化要因

- ✓ 高度な自動化、キュレーション
- ✓ アップストリームの Kubernetes 上で 100 % 動作
- ✓ シームレスなコンテナネットワーキング
- ✓ 組み込みでのセキュリティとロード バランシング（L4/L7）
- ✓ エンタープライズ クラスの永続ストレージ
- ✓ 統合されたモニタリングとロギング

Virtualization Platform – Cisco VIM Evolution
toward container support



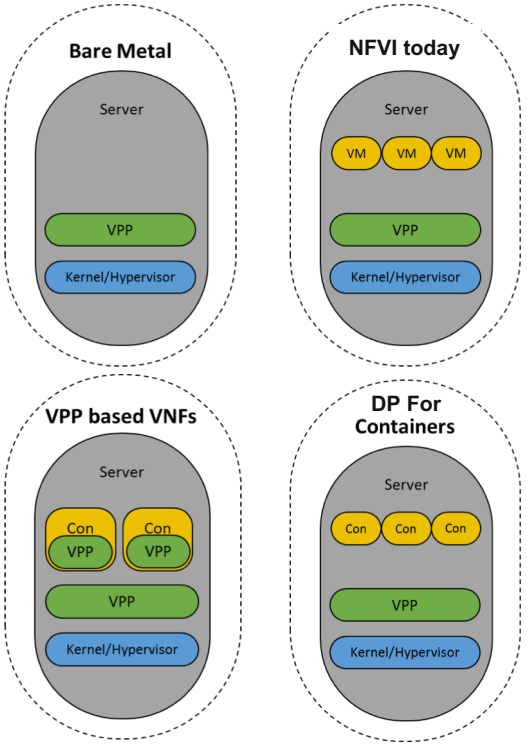
VPP (Vector Packet Processing)

Virtual Networking Data Plane – For Containers, VMs, and VNF's Data Plane

https://fd.io/

- Project at Linux Foundation: Open & Wide Adoption
- VPP / Fd.io to serve as a key foundation on our platform – Cisco is committed to it
- Becoming Universal data plane in our solution:
  - Infrastructure vSwitch
  - Data Plane for Containerized Network Functions
- Software Dataplane
  - High throughput (up to terabit on multiple cores)
  - Low and Predictable Latency & Jitter
  - Feature Rich
  - Resource Efficient
  - Bare Metal / VM / Container format
  - Multi-platform (x86, ARM…) support
  - SR and SRv6 ready

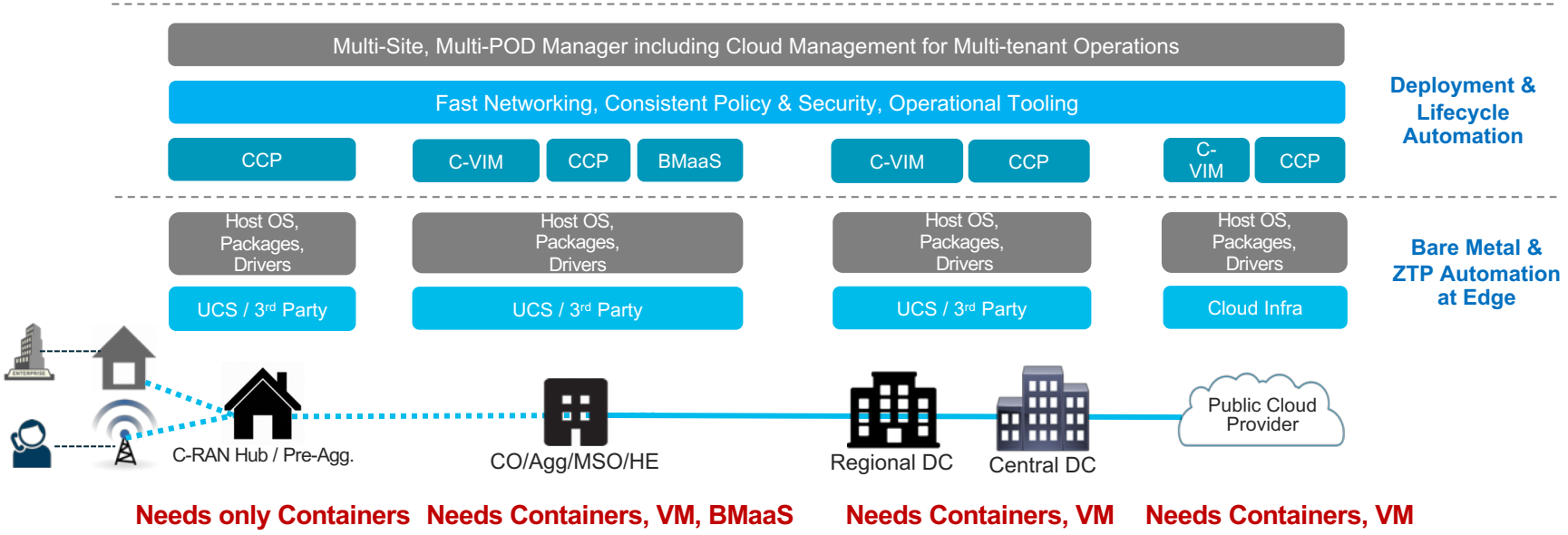
SR: Segment Routing
SRv6: Segment Routing IPv6



Multi-party: Broad Contribution

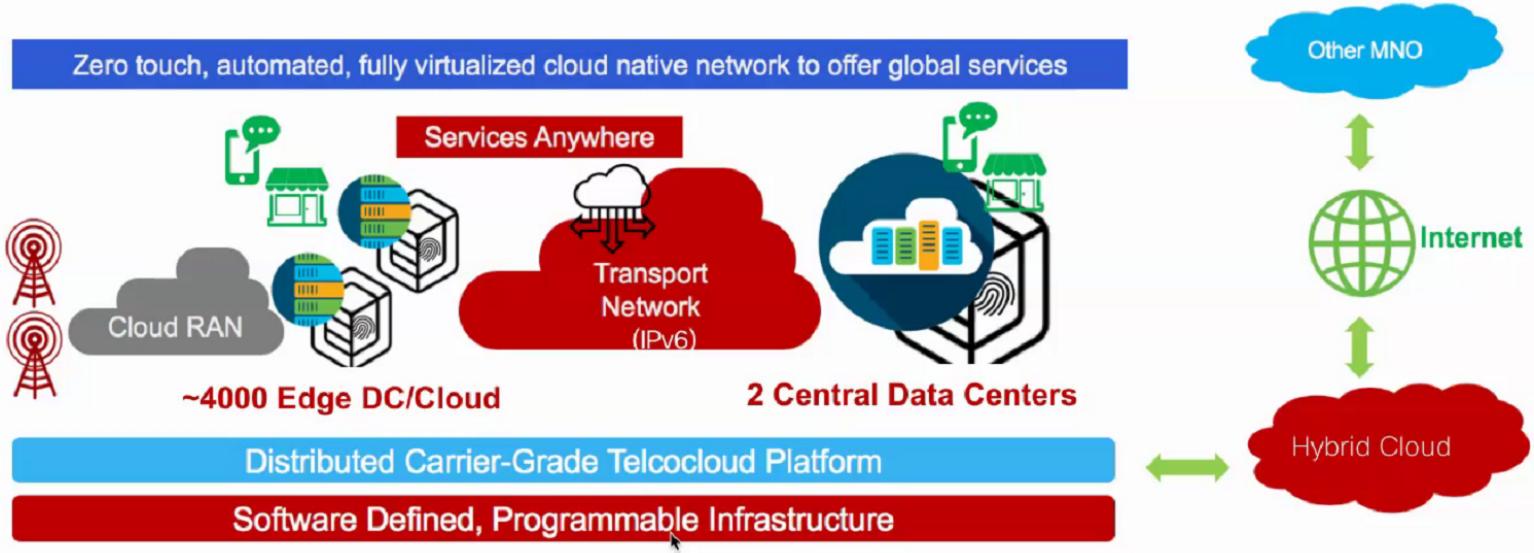
シスコの取り組みの全体像:
Evolution to Cloud Native Virtualization Platform

Modules: Cisco VIM (OpenStack) | Cisco Container Platform | BMaaS | Fast Networking (VPP) | Operational Tools



Example – Full Solution at New Disruptive MNO

Cisco is driving the Telco Cloud and Edge Computing Deployment

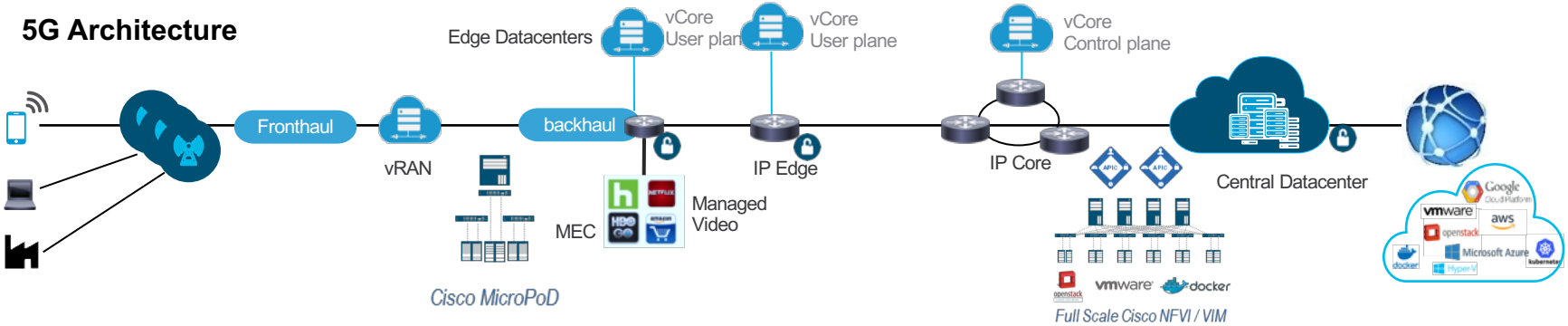


1. **Open, Virtualized** & disaggregated **RAN**
2. **Fully Virtualized** with Common & **distributed Telco Cloud**
3. **Edge Computing** – Enhanced Customer Experience & New Apps
4. New **business models**, Cross-Monetization with OTT Content
5. **Common HW SKUs** for "Any-Service, Anywhere"
6. **End-to-End** Closed Loop **Automation**

Summary

5G に向けたネットワークアーキテクチャの変革が段階的に進む
仮想化 > コンテナ化 > エッジの変革 > クラウド化

Phase 4 - Edge Service Cloud	Phase 2 - Distributed Telco Cloud	Phase 1 - Central/Regional Telco Cloud	Phase 3 - Public Cloud
• Hosting of Edge/Fog Applications (IoT, Gaming, V2X, etc.) • Micro-Services • 1000s locations • < 10 VMs	• Virtualization of User Plane (UP, MEC/CDN, vRAN, etc.) • SDN and Virtualization • Approx. 40 – 100 locations • < 100 VMs	• Virtualization of Core Functions (CP, UP, Gi-Services, IMS, CDN, etc.) • SDN Fabric and Orchestration • <10 locations • 100+ VMs	• Hosted Platforms and Applications (Device mgmt, IoT, Analytics, etc.) • Cross borders • Lab Test and Validation



Summary

- 通信事業者様のビジネスにおいて 5G がエッジ (MEC; Multi-Access Edge Computing) の変革を主導している。エッジのインフラ構築は必須、かつ、新規ビジネス創出のチャンスに
- ビジネス創出に向けた産業界や企業・アプリケーション開発者とのエコシステム構築が鍵を握る
- エッジの変革を見据えたシスコの開発投資の方向性
  - Cloud Native Network Functions:
    エッジに対応した Network Function の仮想化・Cloud Native 化への開発投資
  - Cloud Native Platforms:
    エッジまで拡張できる仮想基盤・コンテナ基盤への開発投資
  - Cloud Native Performance:
    エッジ上で仮想化・Cloud Native 化された Network Function での高性能パケット処理への開発投資 : VPP / fd.io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