Building the Internet Infrastructure of the Future!

Pranav Mehta, Sr. Principal Engineer
Today’s Discussion

- Background - Evolution of the Compute Cloud
- Challenges for Network Function Virtualization
- SDI - The Ideal End State
- Paving a path to SDI
End User Value Proposition

Business Integrity

Lower TCO

On-Demand Services
Evolution of Compute Cloud

- Standardize and instrument platforms
- Make virtualization pervasive
- Add Automation Framework
Network Virtualization

Virtual Overlay Network 1

Virtual Overlay Network 2

Virtual Overlay Network N

Physical underlay Network
SDN Evolving the Data Center

Discrete Data Center
- Compute
- Storage
- Networking
- Management
  - Control

Virtualized Data Center
- Resource Pools
- Unified Network Virtualization
  - 10Gb Ethernet
- Management
  - Control
- Orchestration

Cloud Data Center
- Network Virtualization
- Software Defined Networks
  - 10G-100G & Low Latency
- Control
What About the ‘Network Services?’

- WAN
- ISP B Router
- ISP A Router
- ISP Decision Routers
- Intrusion Detection
- Stateful Firewalls
- Web Services Firewall
- SSL Acceleration
- Local Caching...
- Back End Servers and Storage
- Mobile Clients
- External Clients
- Internet
- WAN
Telco Conventional EPC - Challenges

Constraints/Issues:
Centralized Signaling, bearer, device state management limit data plane scalability (SDN/NFV)
Backhaul + Core Network OPEX costs weigh down Telco response to market demand for data

Legend:
Backhaul: Metro Ethernet
Backbone: Giga Optical (OC3)
Internet Backbone: XGiga Optical (DWDM, ...)

INTEL CONFIDENTIAL – INTERNAL USE ONLY
4:1 Strategy: First Step in Transformation

- **Application Processing**: QuickAssist
- **Control Processing**: Crystal Forest
- **Packet Processing**: NPU/ASIC
- **Signal Processing**: DSP

Years:
- **2011**
- **2012**
- **2013**

Tools:
- **SPDK**
- **DPDK**
- **One ISA**
- **One Tool Suite**
- **Multiple Opportunities**
Leading the Network Transformation

4:1 Workload Consolidation

Virtualized Network Apps

SDN for Communications

SDN Node Common Ingredients

Application
Control
Packet
Signal

Proprietary

IA CPU
NIC Silicon
Chipset Acceleration
Switch Silicon
Data Plane Development Kit
Open Networking Software

Intel Architecture
Virtual Machine Monitor
Virtual Switch
Control Plane Appliance
Data Plane Appliance
Next Gen Services
Node
Node
Node

Orchestration
Controller

2010
2012
Future

4:1 Workload Consolidation
Virtualized Network Apps
SDN for Communications
Evolution of Compute & NFV Clouds

- Public Cloud
- Virtual Private Cloud
- Network Function Virtualization (NFV)

Types of Clouds:
- Private Cloud (non-Virtualized)
- Private Cloud (Virtualized)

Network Functions:
- Backhaul
- Backbone
- Small Cell
- Macro-Cell
- Telco EPC
- OSS
- BSS
- MSP
- PCRF
- MME
- S-GW
- P-GW
- NW IF
- NW API
Software Defined Infrastructure (SDI)
Attributes of Cloud & NFV

**Cloud**
- Reliability at the Cloud level; through software
- Scaleout the primary focus
- Performance metrics vary across SaaS and IaaS; especially private IaaS
- Latency requirements vary
- Preference for standard high volume server platform
- “Cloud Time!”

**NFV**
- Reliability at the node level; typically hw and software
- Scaleout desired; not proven yet; Perf/watt/$ still important
- Latency critical for network functions
- Accelerators deemed unavoidable
- Long design and deployment cycles → “Cloud Time”
- Still Regulated; Licensed Spectrum a key asset
Intel Objectives: SDN & NFV

Orchestrator

Enable industry leading manageability by exposing health, state, resource availability for optimal workload placement and configuration.

Controller

Promote and contribute to industry standards and open source solutions for interoperability.

Node

Enable TEMs/OEMs/ISVs to deliver industry leading performance, power, cost, security optimized solutions on virtualized “SW defined Nodes”.

Intel Value Add

Orchestration

Controller

Node
Research Opportunities

- QoS and QoE SLAs in Virtualized Infrastructure
- Platform Instrumentation and Policy Enforcement linkage
- Reliability
- Scale-out for Network Services
- Isolation between multi-tenant domains
- Troubleshooting
Summary

SDN and NFV enabling Infrastructure transformation

Intel® Architecture evolving to facilitate Transformation across Telecom, Cloud, Enterprise

Intel investing in software, silicon, and reference designs for the New Infrastructure

Need Industry and Academia Collaboration to turn the SDI Vision into a Reality!
Backup
Q&A
INFORMATION IN THIS DOCUMENT IS PROVIDED IN CONNECTION WITH INTEL PRODUCTS. NO LICENSE, EXPRESS OR IMPLIED, BY
ESTOPPEL OR OTHERWISE, TO ANY INTELLECTUAL PROPERTY RIGHTS IS GRANTED BY THIS DOCUMENT. EXCEPT AS PROVIDED
IN INTEL’S TERMS AND CONDITIONS OF SALE FOR SUCH PRODUCTS, INTEL ASSUMES NO LIABILITY WHATSOEVER AND INTEL
DISCLAIMS ANY EXPRESS OR IMPLIED WARRANTY, RELATING TO SALE AND/OR USE OF INTEL PRODUCTS INCLUDING LIABILITY OR
WARRANTIES RELATING TO FITNESS FOR A PARTICULAR PURPOSE, MERCHANTABILITY, OR INFRINGEMENT OF ANY PATENT,
COPYRIGHT OR OTHER INTELLECTUAL PROPERTY RIGHT.

• A “Mission Critical Application” is any application in which failure of the Intel Product could result, directly or indirectly, in personal injury or
death. SHOULD YOU PURCHASE OR USE INTEL’S PRODUCTS FOR ANY SUCH MISSION CRITICAL APPLICATION, YOU SHALL
INDEMNIFY AND HOLD INTEL AND ITS SUBSIDIARIES, SUBCONTRACTORS AND AFFILIATES, AND THE DIRECTORS, OFFICERS, AND
EMPLOYEES OF EACH, HARMLESS AGAINST ALL CLAIMS COSTS, DAMAGES, AND EXPENSES AND REASONABLE ATTORNEYS’
FEES ARISING OUT OF, DIRECTLY OR INDIRECTLY, ANY CLAIM OF PRODUCT LIABILITY, PERSONAL INJURY, OR DEATH ARISING IN
ANY WAY OUT OF SUCH MISSION CRITICAL APPLICATION, WHETHER OR NOT INTEL OR ITS SUBCONTRACTOR WAS NEGLIGENT
IN THE DESIGN, MANUFACTURE, OR WARNING OF THE INTEL PRODUCT OR ANY OF ITS PARTS.

• Intel may make changes to specifications and product descriptions at any time, without notice. Designers must not rely on the absence or
characteristics of any features or instructions marked "reserved" or "undefined". Intel reserves these for future definition and shall have no
responsibility whatsoever for conflicts or incompatibilities arising from future changes to them. The information here is subject to change
without notice. Do not finalize a design with this information.

• The products described in this document may contain design defects or errors known as errata which may cause the product to deviate from
published specifications. Current characterized errata are available on request.

• Intel processor numbers are not a measure of performance. Processor numbers differentiate features within each processor family, not across

• Contact your local Intel sales office or your distributor to obtain the latest specifications and before placing your product
order.

• Copies of documents which have an order number and are referenced in this document, or other Intel literature, may be obtained by calling 1-800-548-4725, or go to: http://www.intel.com/design/literature.htm

• [Add any code names from previous pages] and other code names featured are used internally within Intel to identify products that are in
development and not yet publicly announced for release. Customers, licensees and other third parties are not authorized by Intel to use code
names in advertising, promotion or marketing of any product or services and any such use of Intel's internal code names is at the sole risk of
the user

• Intel, [Add words with TM or R from previous pages..ie Xeon, Core, etc] and the Intel logo are trademarks of Intel Corporation in the United
States and other countries.

• Other names and brands may be claimed as the property of others.

Copyright ©2012 Intel Corporation.

THIS PAGE IS REQUIRED DO NOT DELETE
Risk Factors

The above statements and any others in this document that refer to plans and expectations for the first quarter, the year and the future are forward-looking statements that involve a number of risks and uncertainties. Words such as "anticipates," "expects," "intends," "plans," "believes," "seeks," "estimates," "may," "will," "should" and their variations identify forward-looking statements. Statements that refer to or are based on projections, uncertain events or assumptions also identify forward-looking statements. Many factors could affect Intel's actual results, and variances from Intel's current expectations regarding such factors could cause actual results to differ materially from those expressed in these forward-looking statements. Intel presently considers the following to be the important factors that could cause actual results to differ materially from the company's expectations. Demand could be different from Intel's expectations due to factors including changes in business and economic conditions, including supply constraints and other disruptions affecting customers; customer acceptance of Intel's and competitors' products; changes in customer order patterns including order cancellations; and changes in the level of inventory at customers. Uncertainty in global economic and financial conditions poses a risk that consumers and businesses may defer purchases in response to negative financial events, which could negatively affect product demand and other related matters. Intel operates in intensely competitive industries that are characterized by a high percentage of costs that are fixed or difficult to reduce in the short term and product demand that is highly variable and difficult to forecast. Revenue and the gross margin percentage are affected by the timing of Intel product introductions and the demand for and market acceptance of Intel's products; actions taken by Intel's competitors, including product offerings and introductions, marketing programs and pricing pressures and Intel's response to such actions; and Intel's ability to respond quickly to technological developments and to incorporate new features into its products. Intel is in the process of transitioning to its next generation of products on 22nm process technology, and there could be execution and timing issues associated with these changes, including products defects and errata and lower than anticipated manufacturing yields. The gross margin percentage could vary significantly from expectations based on capacity utilization; variations in inventory valuation, including variations related to the timing of qualifying products for sale; changes in revenue levels; product mix and pricing; the timing and execution of the manufacturing ramp and associated costs; start-up costs; excess or obsolete inventory; changes in unit costs; defects or disruptions in the supply of materials or resources; product manufacturing quality/yields; and impairments of long-lived assets, including manufacturing, assembly/test and intangible assets. The majority of Intel's non-marketable equity investment portfolio balance is concentrated in companies in the flash memory market segment, and declines in this market segment or changes in management's plans with respect to Intel's investments in this market segment could result in significant impairment charges. Impacting restructuring charges as well as gains/losses on equity investments and interest and other. Intel's results could be affected by adverse economic, social, political and physical/infrastructure conditions in countries where Intel, its customers or its suppliers operate, including military conflict and other security risks, natural disasters, infrastructure disruptions, health concerns and fluctuations in currency exchange rates. Expenses, particularly certain marketing and compensation expenses, as well as restructuring and asset impairment charges, vary depending on the level of demand for Intel's products and the level of revenue and profits. Intel's results could be affected by the timing of closing of acquisitions and dispositions. Intel's results could be affected by adverse effects associated with product defects and errata (deviations from published specifications), and by litigation or regulatory matters involving intellectual property, stockholder, consumer, antitrust and other issues, such as the litigation and regulatory matters described in Intel's SEC reports. An unfavorable ruling could include monetary damages or an injunction prohibiting us from manufacturing or selling one or more products, precluding particular business practices, impacting Intel's ability to design its products, or requiring other remedies such as compulsory licensing of intellectual property. A detailed discussion of these and other factors that could affect Intel's results is included in Intel's SEC filings, including the report on Form 10-Q for the quarter ended Oct. 1, 2011.
Back-Up Materials