IP Networks & Applications

Creating Value Through IP/Optical Networks

Basil Alwan
President, IP/Optical Networks
**Business Group vision**
- Terascale capacity at lowest TCO for all networks
- Dynamic cloud-optimized smart network (DC → WAN → Access)
- ‘Infinite’ network/path programmability & slicing

**Current Portfolio Focus**
- Terabit IP edge & core routing
- Terabit Optical networking
- Converged adaptive core
- Seamless DC & WAN SDN
- Cloud-based optimized service delivery solutions

---

**Digital Value Platforms**
- ANP, CSP, ICP, Vertical apps
- External data sources

**Augmented Cognition Systems**
- Analytics
- Machine learning

**Programmable Network OS**
- Dynamic customer services
  - Management & Orchestration
  - SDN
  - NFV
- Dynamic network optimization
- Multi-operator federation
- Access agnostic converged core
- Modular, decomposed network functions

**Universal Adaptive Core**
- Access agnostic converged core
- Self-optimized coverage & capacity
- Common data layer

**Smart Network Fabric**
- Converged Edge Cloud
- Software defined, end-end

**Dynamic Data Security**
- New trust framework
- Ecosystem sharing
- Mass edge monitoring

---

**IP & Optical Networks**

---
IP / Optical Networks at a glance

€28bn
IP/Optical Primary Market

€13bn
IP Routing

#2
Global Service Provider Edge Routers
Source: Dell’Oro, 2Q16 4q rolling

€10bn
Optical Transport

#3
Optical Global Optical Transport
Source: Infonetics, 2Q16 4q rolling

€5bn
Services

1,000+
Service Provider Customers

Source: Nokia estimate
IP Routing and Optical complement each other

One of only 2 players globally with full IP Routing + optical solution sets

Service Providers
- Globe
- China Telecom
- Telenor
- América Móvil
- Singtel

Utilities & Transport
- DB
- UPMC

Large Enterprise
- Customer
Solution areas

- Edge Routing
- Core Routing
- Packet Core and carrier ethernet
- Optical
- Services

IP/Optical Networks
Primary market outlook

Source: Nokia estimate
Market Dynamics
Carrier-Grade IP/Optical Networking

40% Peak Traffic Growth

YoY growth in busy hour traffic (%)

2011 2016 2021

Analysys Mason, August 2016

Shifting Traffic Hand-off

ICP Network Buildouts:
QoE drives hand-off closer to consumer
IP Routing and Optical Cycles

For illustrative purposes only
Foundation: Technology Depth & Innovation

**Silicon**
- Routing application specific integrated circuit (ASIC)
- Coherent digital signal processor
- Optical transport network switching ASIC

**Software**
- Service Routing OS
- Virtualization
- Software Defined Networks

**Systems**
- Purpose built platforms for each customer segment
Network Function Virtualization has begun

The (gradual) journey toward router virtualization

Targeted at full-featured, carrier-grade Service Edges
- Starts small <100 Gb/s throughput

Must still pass business case hurdles
- Amount of compute, space and power to deliver application performance matters

Customer Edge
Access/Aggregation
IP Service Edge (Gateway)
IP Core
Dynamic Service Gateways
Common software (all services) and flexible deployment (virtual & physical)

- Unified services across any access: fixed & mobile, licensed & unlicensed
- Foundation for converged 5G services
- Optimized architecture for IoT
Software Defined Networks
Programmable end-to-end network OS

SD-WAN

Datacenter SDN

Carrier SDN

Network Services Platform

nuagenetworks

Public Cloud

Private Cloud

BT

MynRepublic

Santander

UPMC

Globe

China Telecom
### IP/Optical Networks market

**High-scale, mission critical networks**

<table>
<thead>
<tr>
<th>Primary market</th>
<th>Attractive adjacencies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Communication service providers</td>
<td>Public Sector &amp; Verticals</td>
</tr>
</tbody>
</table>

- Communication service providers
- Public Sector & Verticals
- Internet Content Providers
- Technological Extra Large Enterprise
IP/Optical Networks
Market outlook for attractive adjacencies

Solution areas
- Mission Critical WAN
- Data Center Interconnect
- Data Center SDN & SD-WAN
- IP Video

Source: Nokia estimate
IP/Optical Networks: Higher returns through focused growth

Required investments already factored into long-term Networks guidance

**Disciplined expansion and diversification**

- **Primary market**
  - €28bn in 2016
  - 5-year CAGR 1.3%

- **Attractive adjacencies**
  - €6bn in 2016
  - 5-year CAGR 4.7%

**Strong long-term business model**

- **Net sales**
  - Grow faster than the primary market

- **Long-term operating margin**
  - Expand to double digits
IP/Optical Networks

Nokia will achieve the EUR 1.2 billion cost savings target

- Adopt Nokia Business System
- Streamline costs in packet core
- Operational efficiencies with scale
Looking forward

**2016**
- Optical100G Backbone Upgrades
- Growing leadership in virtualization & SDN
- Converging packet core portfolios, ePDG/seGW
- Transition from IP resale to own product
- cDVR trends

**2017**
- Mainstream 100G Regional/Metro builds
- Mainstream deployments of virtualization & SDN begin
- IP/Optical Optimization with SDN trends
- Continued high design activity/growth in adjacent markets including webscale

**2018**
- Smart Fabric, Dynamic Converged Edge
- 400G/Terabit backbones begin
- IP/”OTT” technology disrupting business services (as with video)
It should be noted that Nokia and its business are exposed to various risks and uncertainties, and certain statements herein that are not historical facts are forward-looking statements, including, without limitation, those regarding future business and the financial performance of Nokia and its industry and statements preceded by “believe,” “expect,” “anticipate,” “foresee,” “sees,” “target,” “estimate,” “designed,” “aim,” “plans,” “intends,” “focus,” “continue,” “will” or similar expressions. These statements are based on management’s best assumptions and beliefs in light of the information currently available to it. Because they involve risks and uncertainties, actual results may differ materially from the results that we currently expect. Factors, including risks and uncertainties that could cause such differences can be both external, such as general, economic and industry conditions, as well as internal operating factors. We have identified these in more detail on pages 69 to 87 of Nokia’s annual report on Form 20-F for the year ended December 31, 2015 under “Operating and Financial Review and Prospects—Risk Factors”, our other filings with the U.S. Securities and Exchange Commission and in our interim report issued on May 10, 2016, our half year financial report issued on August 4, 2016, our interim report issued on October 27, 2016 and our stock exchange release covering our Capital Market Day issued on November 15, 2016. Other unknown or unpredictable factors or underlying assumptions subsequently proven to be incorrect could cause actual results to differ materially from those in the forward-looking statements. Nokia does not undertake any obligation to publicly update or revise forward-looking statements, whether as a result of new information, future events or otherwise, except to the extent legally required.

In addition to information on our reported IFRS results, we provide certain information on a non-IFRS, or underlying business performance, basis. Non-IFRS results exclude costs related to the Alcatel-Lucent transaction and related integration, goodwill impairment charges, intangible asset amortization and purchase price related items, restructuring related costs, and certain other items that may not be indicative of Nokia’s underlying business performance. We believe that our non-IFRS financial measures provide meaningful supplemental information to both management and investors regarding Nokia’s underlying business performance by excluding the aforementioned items that may not be indicative of Nokia’s business operating results. These non-IFRS financial measures should not be viewed in isolation or as substitutes to the equivalent IFRS measure(s), but should be used in conjunction with the most directly comparable IFRS measure(s) in the reported results. A detailed explanation of the content of the non-IFRS information and a reconciliation between the non-IFRS and the reported information for historical periods can be found in Nokia’s respective results reports. Please see our issued interim reports for more information on our results and financial performance for the indicated periods as well as our operating and reporting structure. Nokia is a registered trademark of Nokia Corporation. Other product and company names mentioned herein may be trademarks or trade names of their respective owners.