Reliability Challenges for Emerging Technologies Based Networks
A Long Road to Standardization

Presentation to:

IEEE CQR 2014
Emergency Technologies
Reliability Roundtable

May 12, 2014

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Assurance, Trust, Confidence

The Issue

Growing concern from the telecom community about the reliability/availability of emerging technologies based (e.g., SDN, NFV, Cloud Computing) networks, including the services provided under failure conditions
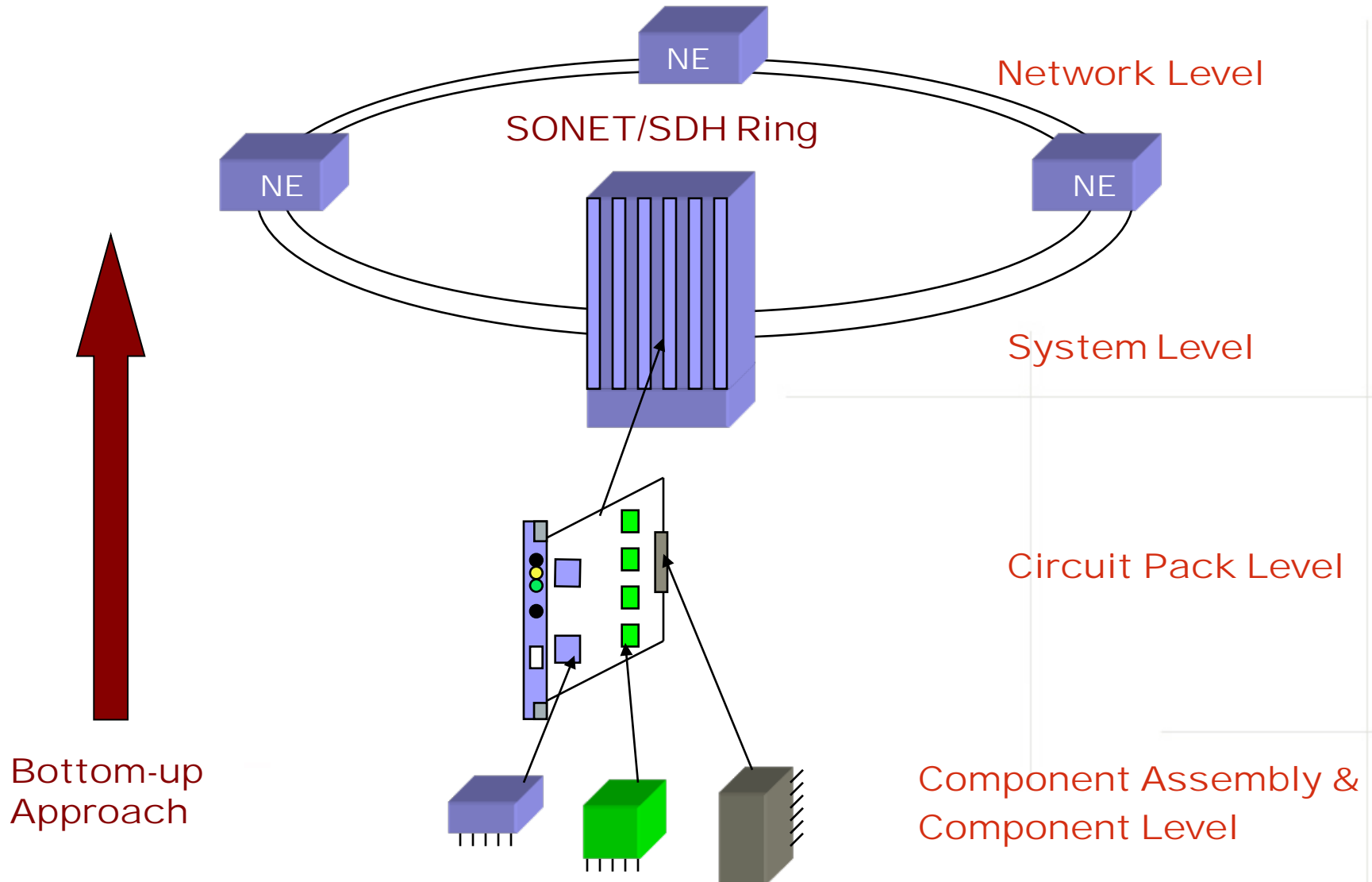
The Challenge

Design and operate emerging technologies based telecommunications networks to meet users' expectations regarding network reliability and service availability
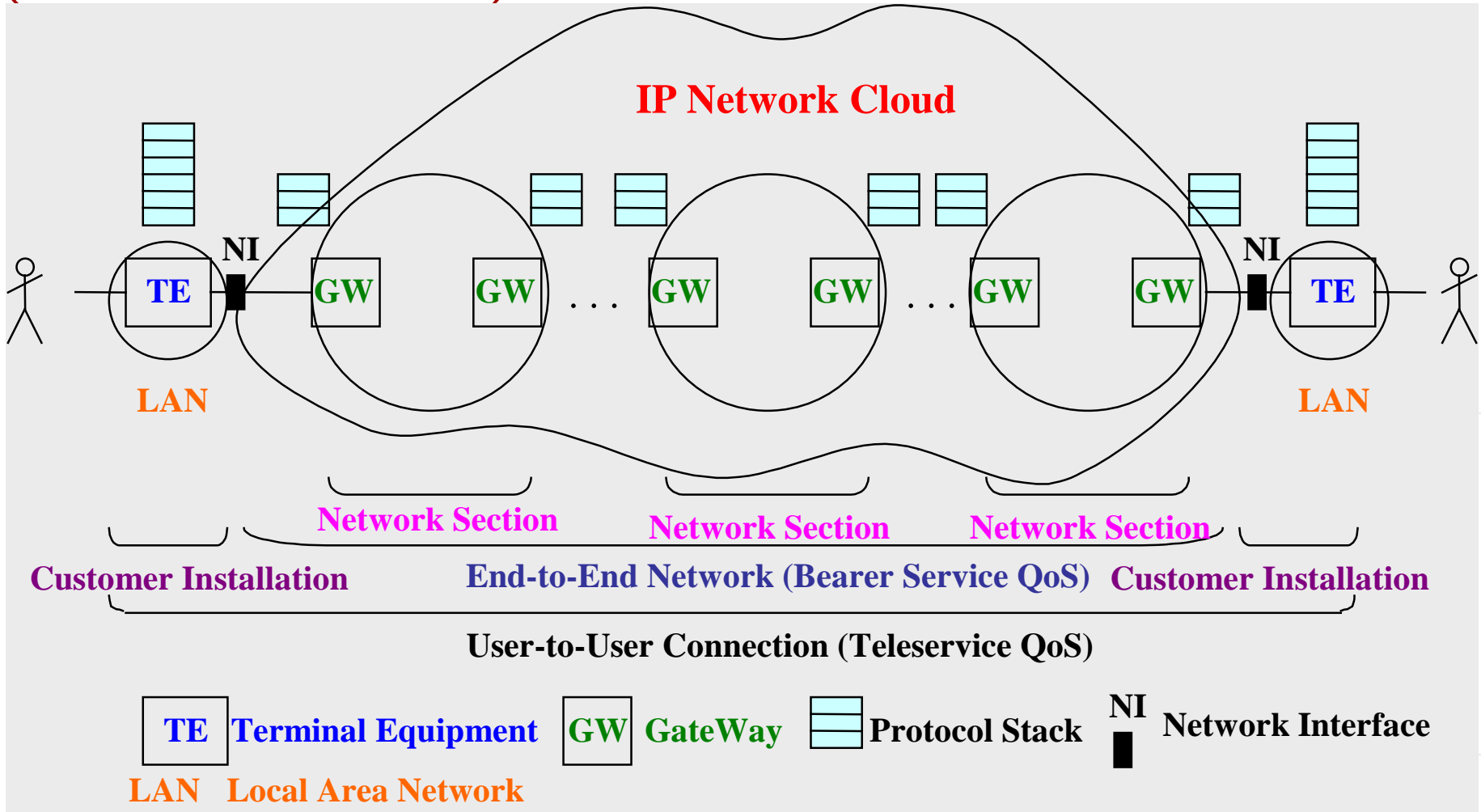
Old Reliability Roadmap
## Example 1: "Reliability Food Chain"

NE

NE

NE

SONET/SDH Ring

Network Level

System Level

Circuit Pack Level

Component Assembly &
Component Level

Bottom-up
Approach

Old Reliability Roadmap (Cont.)
Example 2: User-to-User Connection on an IP Network (ITU-T Rec. Y.1541)

IP Network Cloud

NI — TE — GW — GW ... GW — GW ... GW — GW — NI — TE

LAN   LAN

Network Section   Network Section   Network Section

Customer Installation   End-to-End Network (Bearer Service QoS)   Customer Installation

User-to-User Connection (Teleservice QoS)

TE Terminal Equipment   GW GateWay   Protocol Stack   NI Network Interface

LAN Local Area Network

**The "IP Network Cloud" will take care of any resilience issues!
Use a "cut-through" path to estimate end-to-end Network Reliability!**
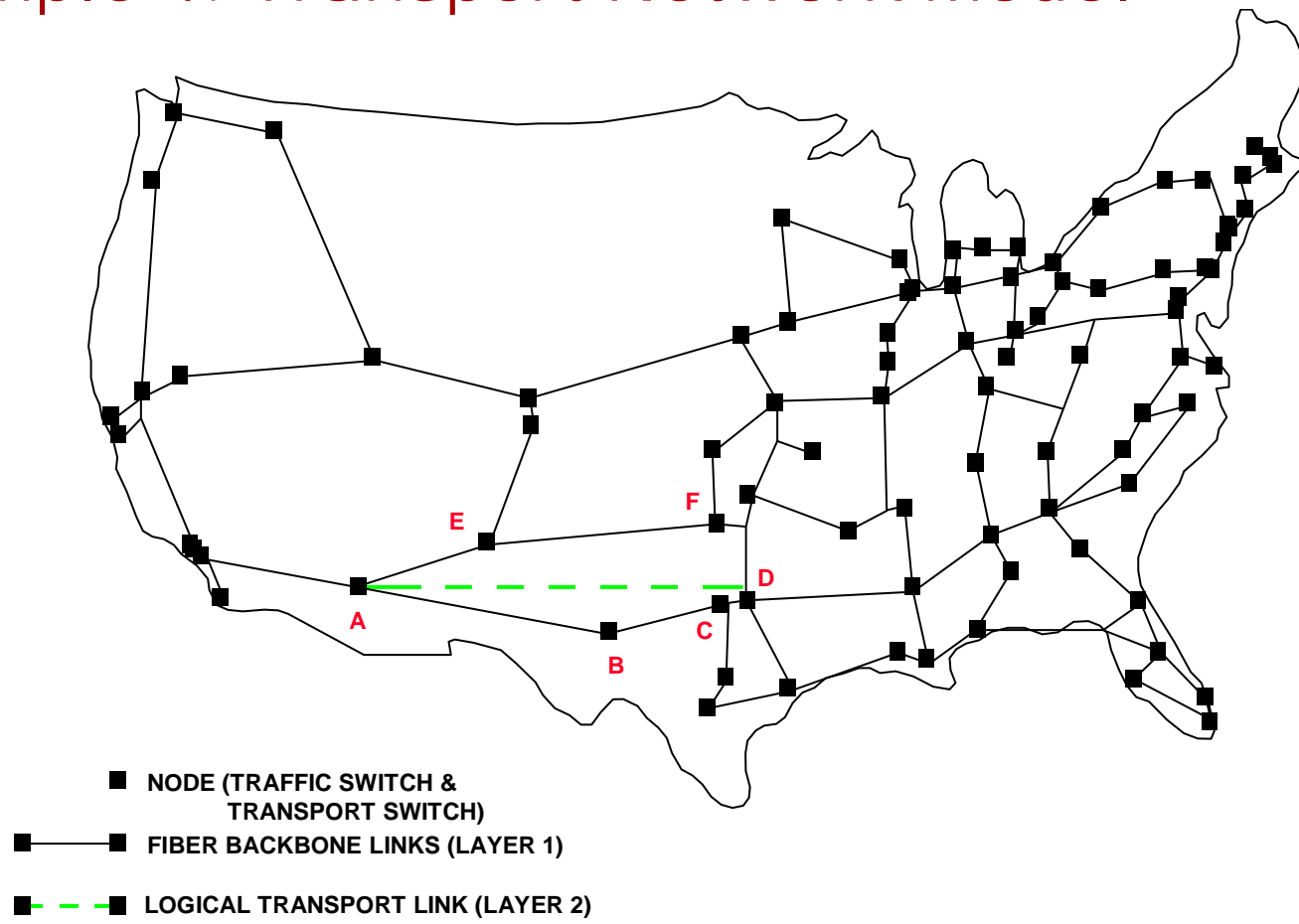
Old Reliability Roadmap (Cont.)
Example 3: Role of IP Nodes in a Network Section
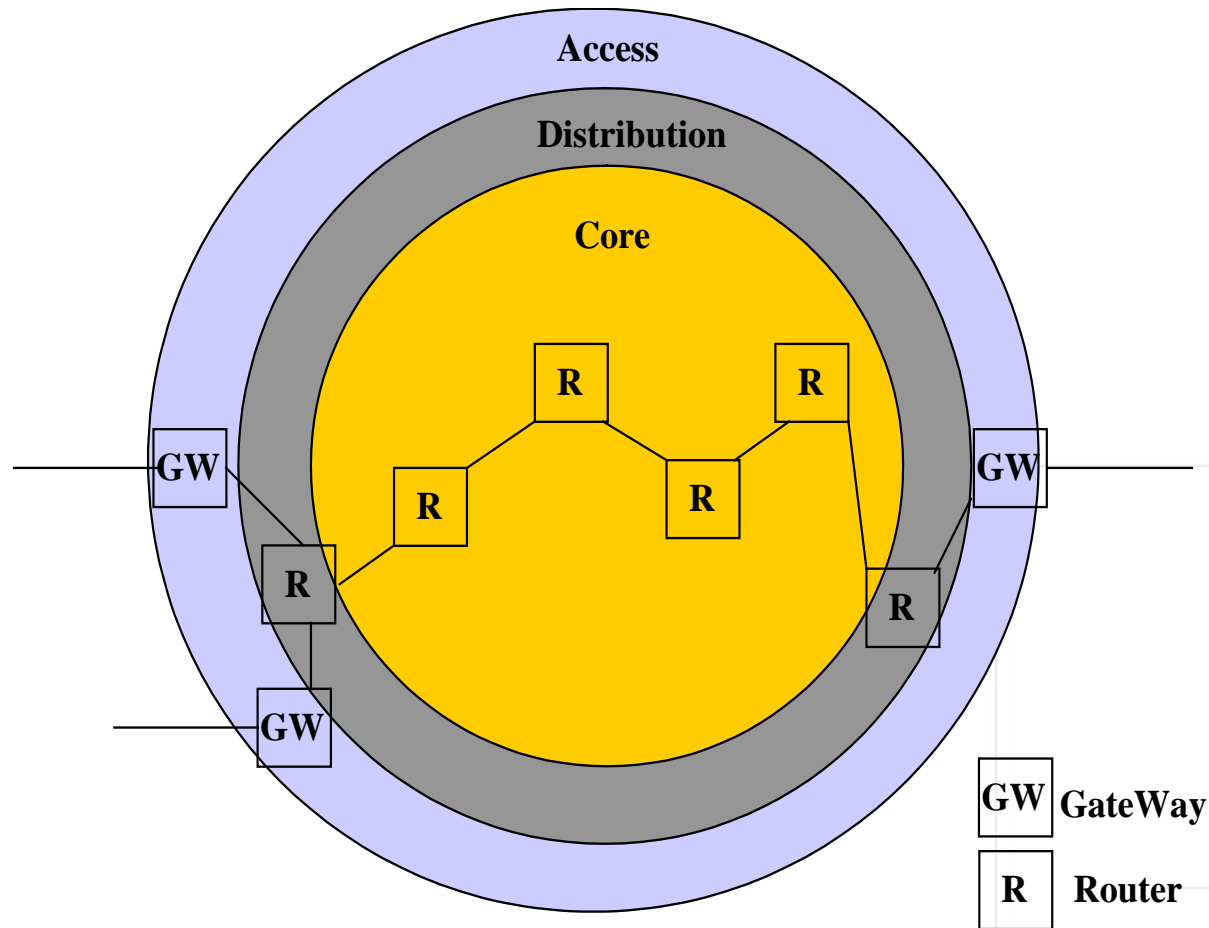
Strict system-level reliability requirements, based on the system's role, were met by redundant processors, power units, etc.

Old Reliability Roadmap (Cont.)
Example 4: Transport Network Model

NODE (TRAFFIC SWITCH & TRANSPORT SWITCH)

FIBER BACKBONE LINKS (LAYER 1)

LOGICAL TRANSPORT LINK (LAYER 2)

Network Resilience was based on route diversity and system redundancy
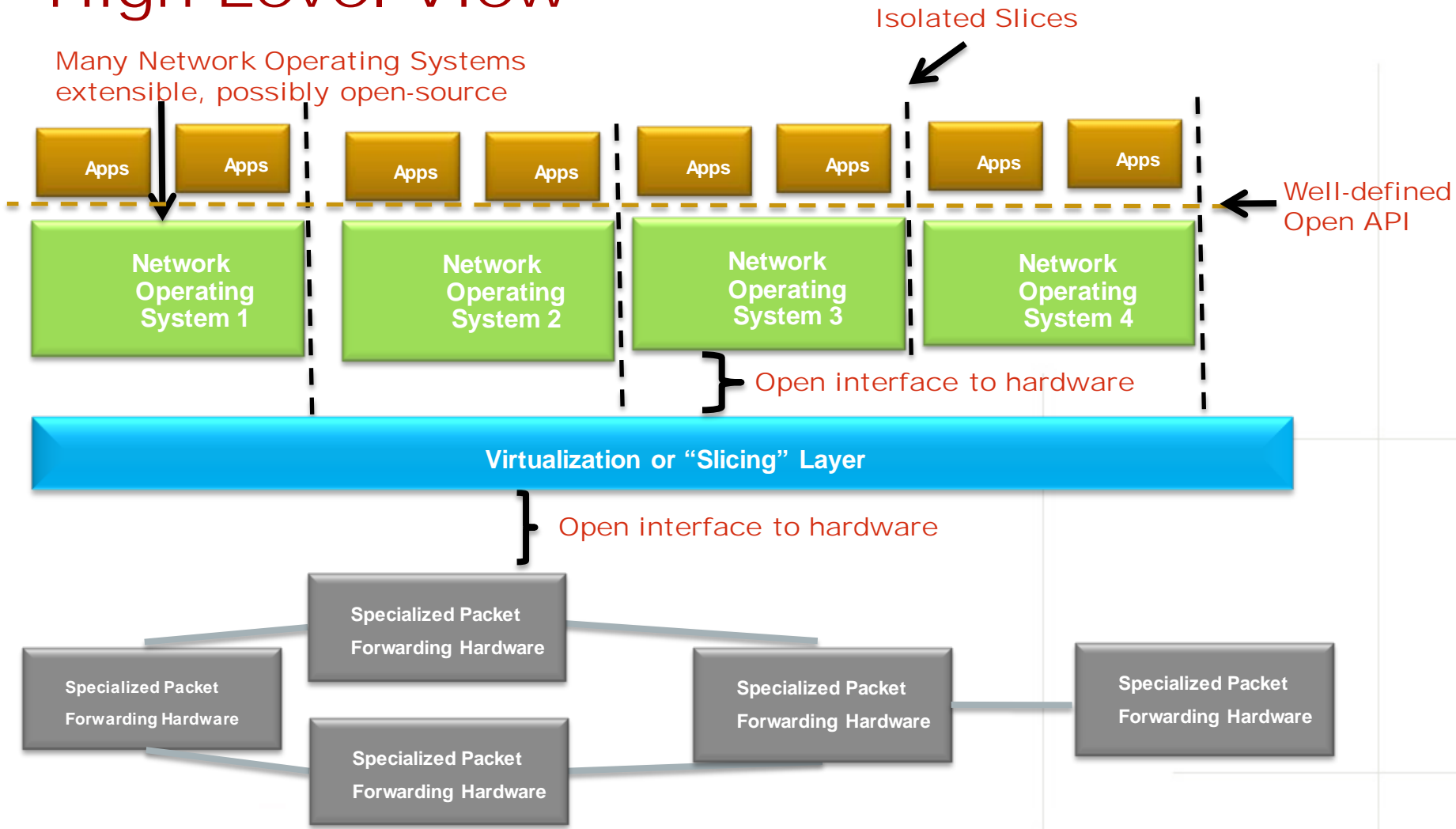
BEFORE Software Defined Networking
Status Quo: Closed Boxes, Fully-Distributed Protocols

- Fragmented non-commodity hardware
- Physical install per system per site
- Hardware development large barrier to entry for new vendors, constraining innovation & competition
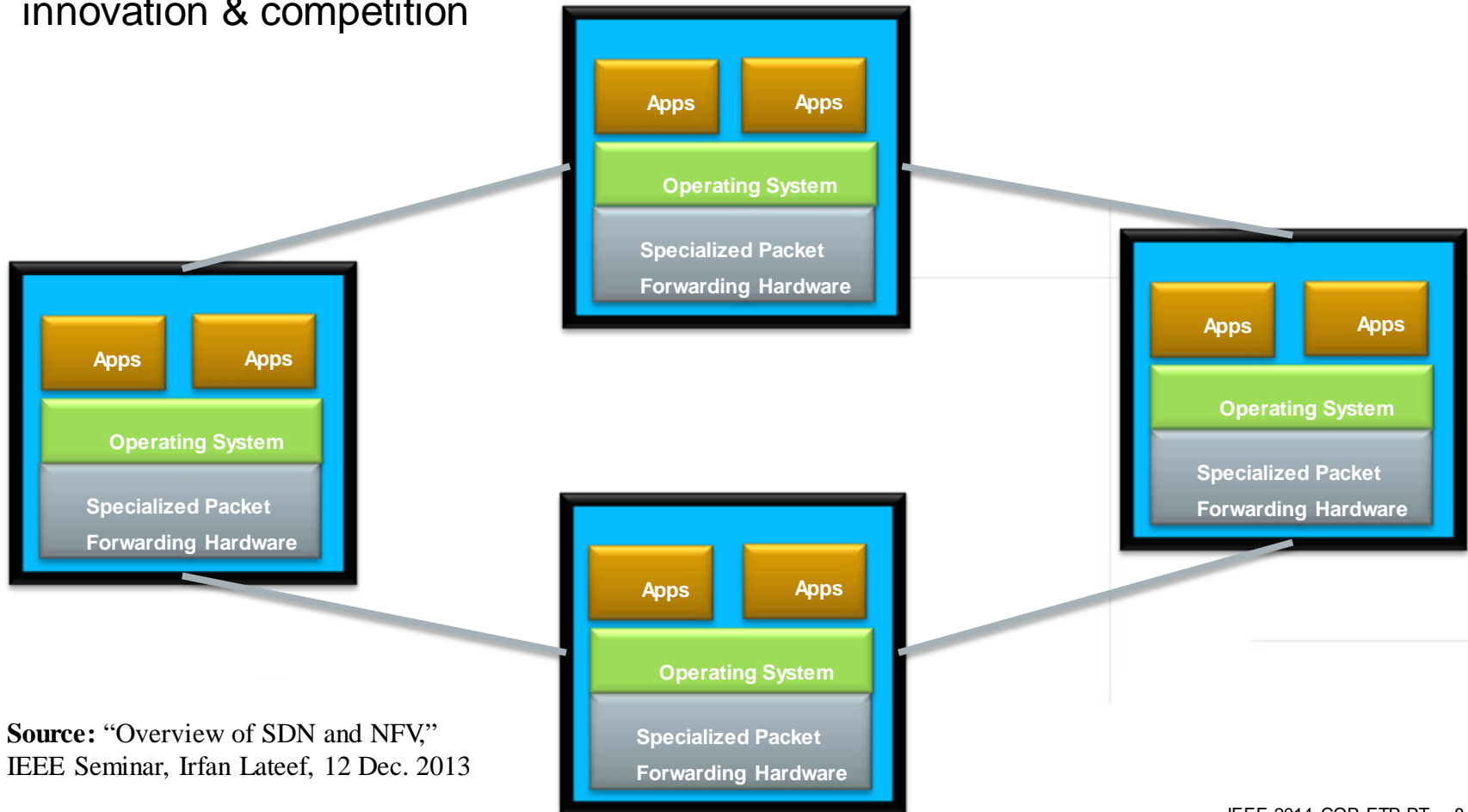
Source: "Overview of SDN and NFV,"
IEEE Seminar, Irfan Lateef, 12 Dec. 2013
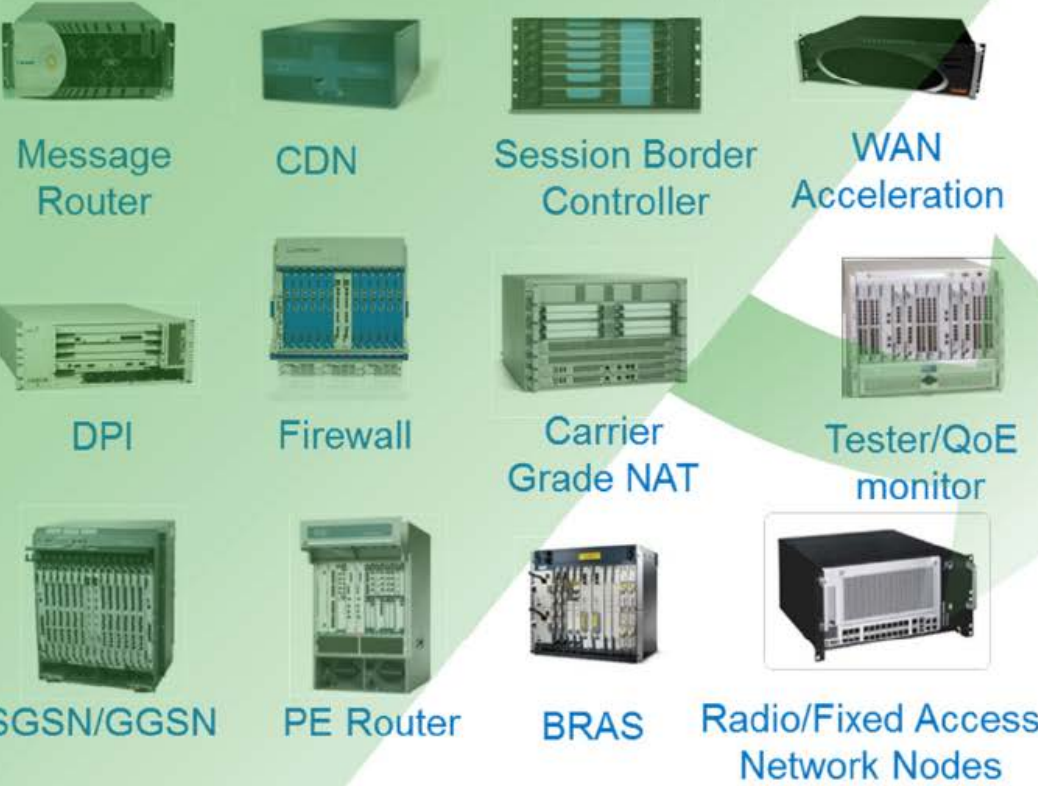
Software Defined Networking (SDN) High-Level View

Isolated Slices

Many Network Operating Systems extensible, possibly open-source

| Apps | Apps | | Apps | Apps | | Apps | Apps | | Apps | Apps |

Well-defined Open API

| Network Operating System 1 | Network Operating System 2 | Network Operating System 3 | Network Operating System 4 |

Open interface to hardware

Virtualization or "Slicing" Layer

Open interface to hardware

Specialized Packet Forwarding Hardware

Specialized Packet Forwarding Hardware

Specialized Packet Forwarding Hardware

Specialized Packet Forwarding Hardware

Specialized Packet Forwarding Hardware

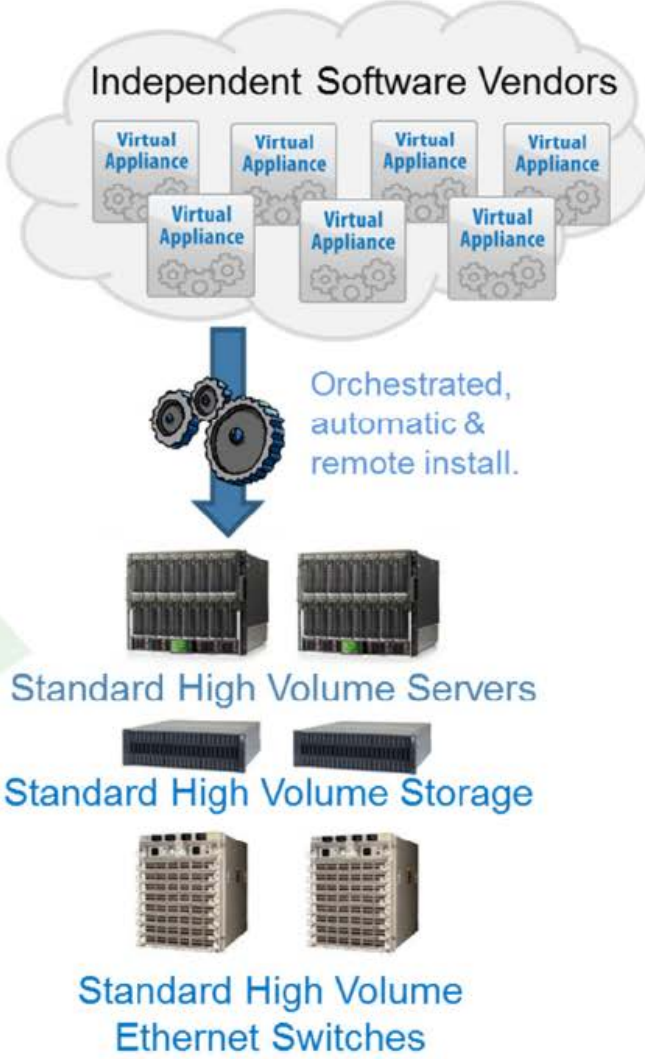**The "Old Reliability Roadmap" needs to be adjusted!**

API: Application Programming Interface

Network Functions Virtualization (NFV)
ETSI NFV Industry Specification Group's Vision

Classical Network Appliance Approach

Message Router · CDN · Session Border Controller · WAN Acceleration

DPI · Firewall · Carrier Grade NAT · Tester/QoE monitor

SGSN/GGSN · PE Router · BRAS · Radio/Fixed Access Network Nodes

- Fragmented non-commodity hardware.
- Physical install per appliance per site.
- Hardware development large barrier to entry for new vendors, constraining innovation & competition.

Independent Software Vendors

Virtual Appliance · Virtual Appliance · Virtual Appliance · Virtual Appliance
Virtual Appliance · Virtual Appliance · Virtual Appliance

Orchestrated, automatic & remote install.

Standard High Volume Servers

Standard High Volume Storage

Standard High Volume Ethernet Switches

Network Functions Virtualisation Approach

Reliability/Availability Framework for Emerging Technologies (ET) - based Networks & Services

- **Address:**

  - The growing concerns about the reliability/availability of ET-based networks
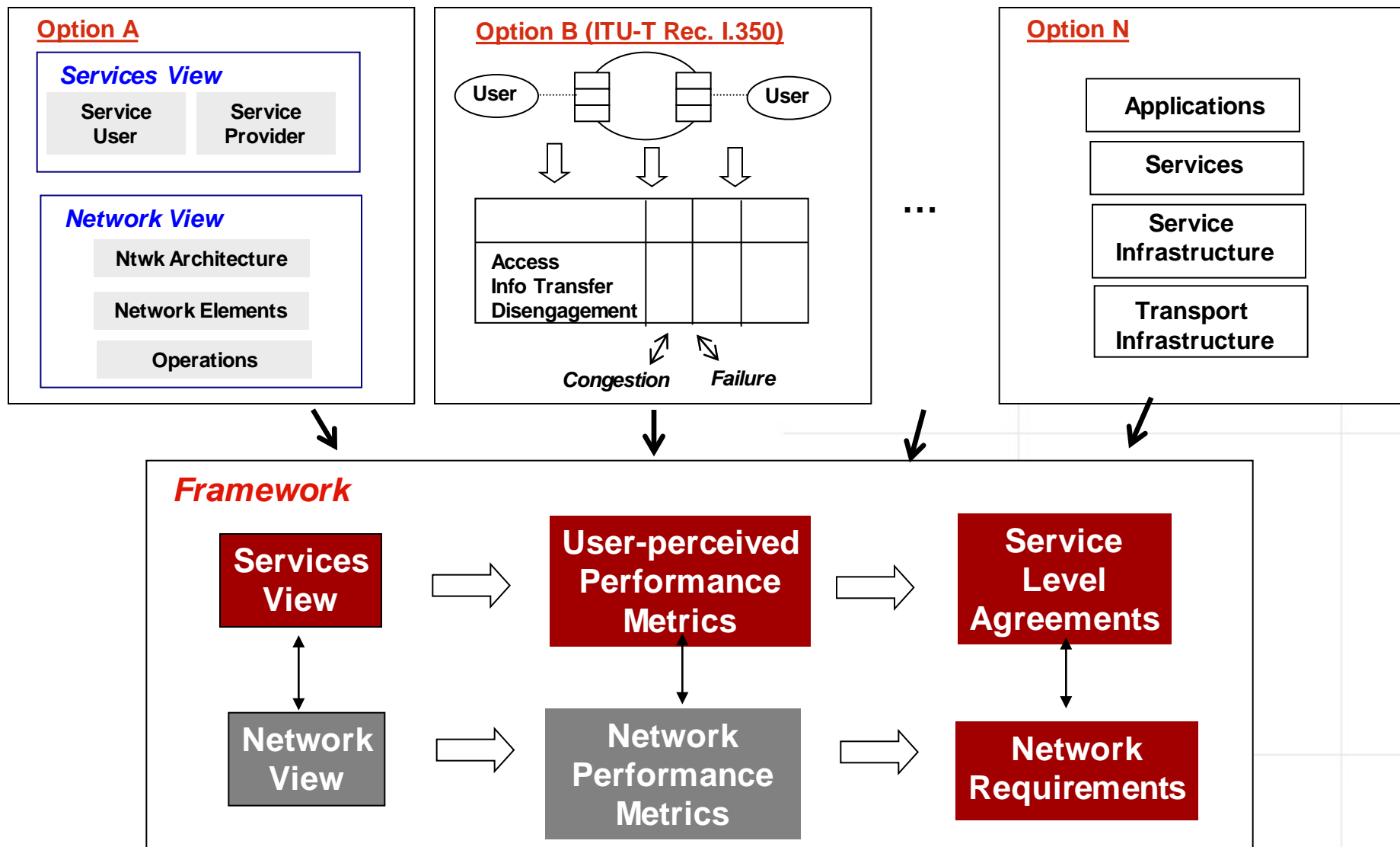 - Service quality/performance under failure conditions

- **Define a set of metrics and guides to promote consistent:**

  - SLAs that are rich in reliability/availability attributes
  - Reliability/availability requirements for ET-based network architectures where:
    - "Everything-as-a-Service" is the trend
    - Modularization/decoupling of hardware and software (SDN & NFV principles respectively)
    - Unified control across both legacy & new network architectures/protocols/systems (SDN principle)
    - Multi-level virtualization (e.g., virtualize H/W by creating Virtual Machines, Access, Transport, Signaling, Services)
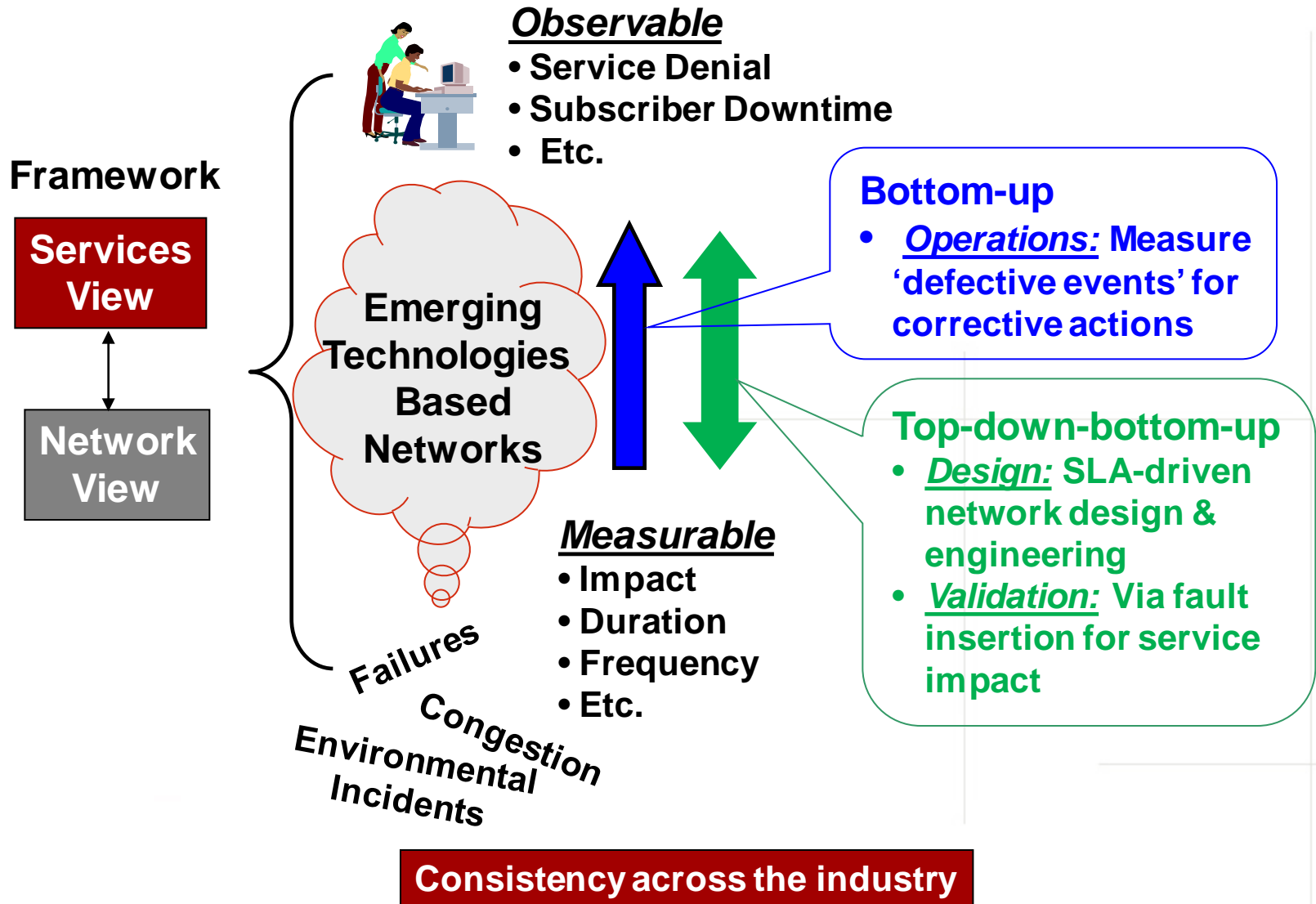
- **Discuss:**

  - Impact of failures and operational activities (network dimensioning, traffic engineering, & capacity management) on service availability
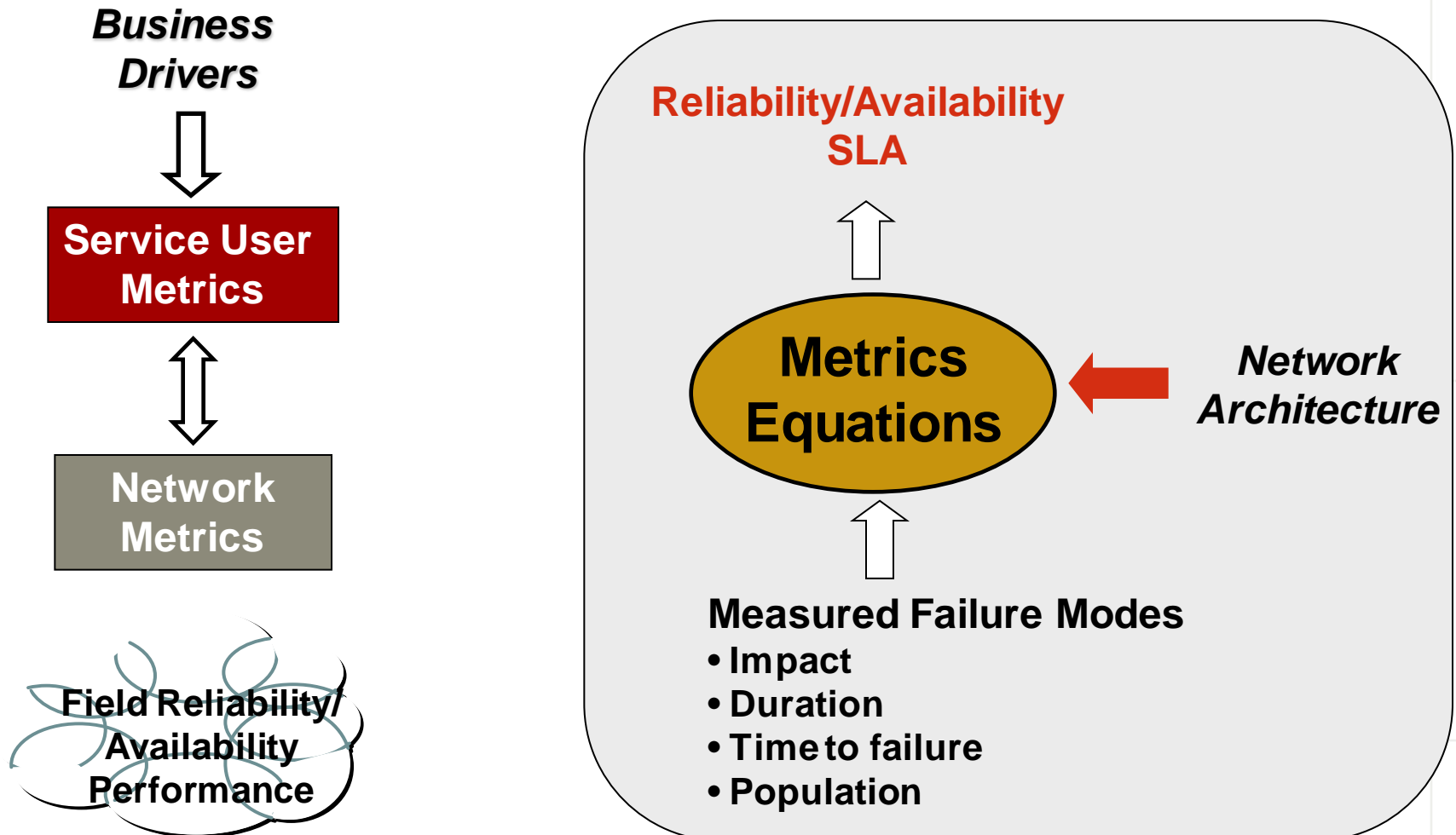 - QoS benchmarks to define failure thresholds
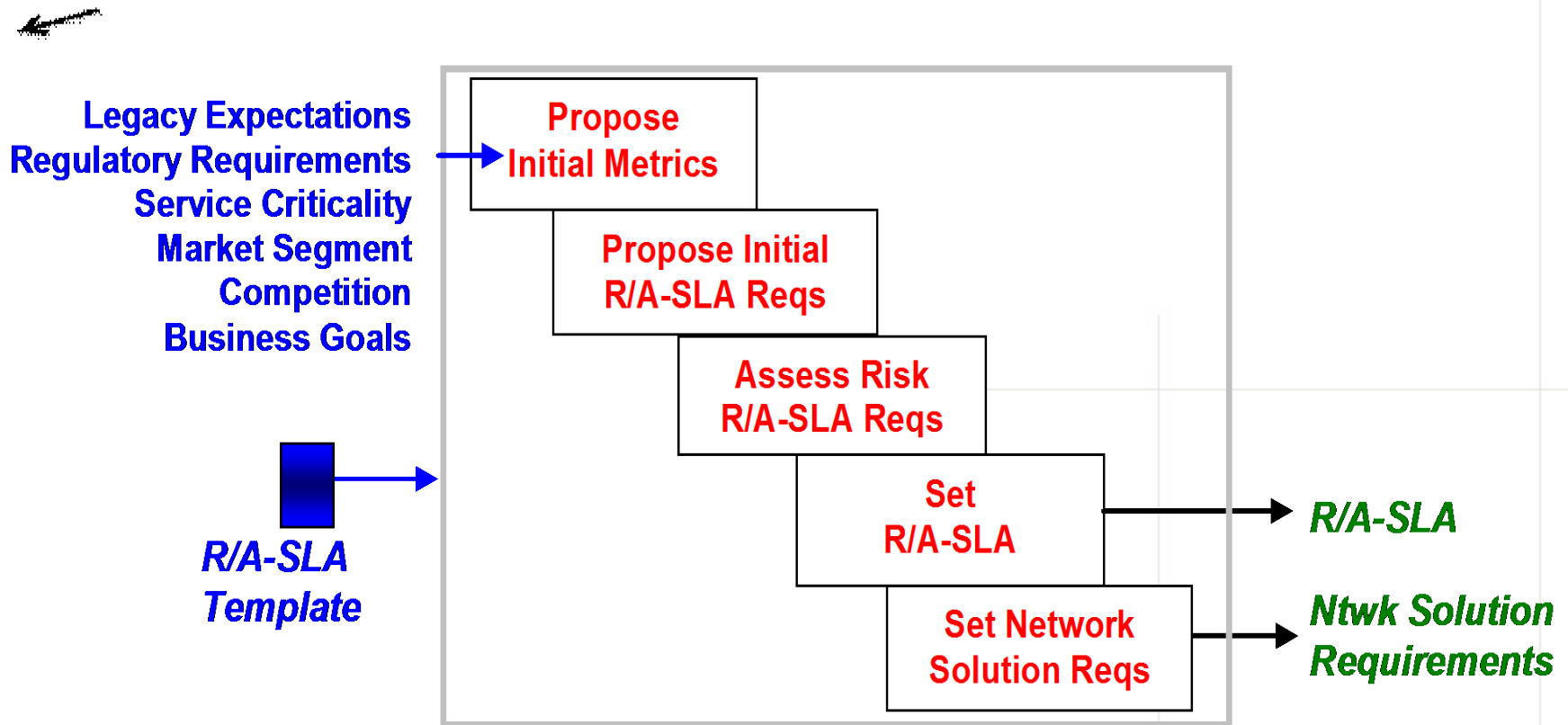
Reliability Framework: Overview

Reliability Framework: Application

Framework

Services View

Network View

Emerging Technologies Based Networks

Failures
Congestion
Environmental Incidents

<u>Observable</u>
- Service Denial
- Subscriber Downtime
- Etc.

<u>Measurable</u>
- Impact
- Duration
- Frequency
- Etc.

Bottom-up
- *<u>Operations:</u>* **Measure 'defective events' for corrective actions**

Top-down-bottom-up
- *<u>Design:</u>* **SLA-driven network design & engineering**
- *<u>Validation:</u>* **Via fault insertion for service impact**

Consistency across the industry

Reliability Framework: Measurement

Business Drivers

↓

Service User Metrics

↕

Network Metrics

Field Reliability/ Availability Performance

Reliability/Availability SLA

↑

Metrics Equations ⬅ **Network Architecture**

↑

Measured Failure Modes
- Impact
- Duration
- Time to failure
- Population

Reliability/Availability SLA
Process Steps

Legacy Expectations
Regulatory Requirements
Service Criticality
Market Segment
Competition
Business Goals

R/A-SLA
Template

Propose Initial Metrics

Propose Initial R/A-SLA Reqs

Assess Risk R/A-SLA Reqs

Set R/A-SLA

Set Network Solution Reqs

R/A-SLA

Ntwk Solution Requirements

R/A-SLA: Reliability/Availability - Service Level Agreement

Availability vs. Uptime in a Virtualized Networking Environment:
Sometimes Could Mean Two Different Things*

- **Uptime**
  - When a cloud provider or data center hosting company says they offer 99.9999% (or more) uptime, what they really mean is the time in which a cloud server is "powered on" and available to system administrators. "Uptime", in this case pertains only to power.
  - In some cases, multi-tenant data center providers may use the term uptime and availability interchangeably to indicate guarantee of its data center infrastructure and interconnection services.

- **Availability:**
  - It typically implies a broader connotation that includes both availability of the physical environment (i.e., server power and network within the data center) along with the external network connecting users to the physical infrastructure.
  - What end-users of an application or system care about is if the services are available or not, along with the response time or performance from an end-to-end perspective.

Example SLA for Interconnection: "The service availability goal is 100% uptime"

*Source: http://www.telx.com/blog/cloud-resilience-and-the-quest-for-higher-availability/

Industry Challenges for Emerging Technologies based Networks & Services

- Lack of industry consistency for reliability analysis or benchmarks of Emerging Technologies-based networks

- Need for network providers to know if what they are building with Emerging Technologies will deliver the service availability/performance required by end-users

- Service providers specify service availability within own network domains; end-user services delivered across multiple domains are virtually impossible to guarantee

- Best-in-class reliability/availability SLAs while minimizing the cost of operations and maintenance

- Coordination of efforts in different Standards Development Organizations – SDOs (e.g., ATIS, ITU-T, IEEE, ETSI, IETF/IRTF, 3GPP, OMG, ONF, OMA-DM) and government-sponsored organizations/councils (e.g., NIST, CSRIC)

Maintain momentum on Emerging Technologies (SDN, NFV, Cloud Computing, etc.) by avoiding a <u>protracted</u> Reliability Standards effort <u>fragmented</u> in different SDOs

To Fulfill the Promise of Service Convergence in Emerging Technology (ET) based Networks

> **The industry needs a set of reliability metrics and terminology that are common across the ET-based network for which individual service availability requirements can be specified**

Emerging Technology Reliability Roundtable
Few Thoughts for Discussion

- NFV *
  - One of the essential elements of application modernization is "performance and through-put at scale with resiliency built in"

- Cloud Computing: Everything-as-a-Service *
  - Available when and where you need it
  - The strict SLAs for availability are not there (cost sensitive)

- Redundancy will be build in the application level <u>not</u> in the system *

- Resiliency becomes an application-level concern *

- New fault modes for the SDN/NFV virtualization layer (e.g. total platform failure)

- New SDN/NFV self-healing capabilities need to be evaluated

- The "nines-availability game"
  - Examples:

PSTN Network	= 99.94% (not even 4-nines!)
SONET/SDH Ring	= 99.9992% (5-nines)
SDN/NFV-based networks	= ???? (some talk about 6-nines!)

* Source: Lew Tucker, CTO, Cisco Systems // IEEE GLOBECOM'13 Keynote Address
http://www.youtube.com/watch?v=h0w7Ol6gK3Q&feature=youtu.be

Back-up Viewgraphs

IEEE Software Defined Ecosystem Standards
Highlights of the April 25, 2014 Mtg in Newark, NJ USA

- Objective
  - Identify primary standards development opportunities in SDN/ NFV & related areas

- Approach
  - Demonstrate and document the steps necessary to establish an early industry presence in key areas of opportunity
  - Provide a "gap" analysis to determine standardization opportunities in SDN/NFV and and related areas
  - Explore launching new standards activities in these areas under ComSoc sponsorship,

- Outcome - The participants:
  - Performed a gap analysis for each topic (i.e., security, reliability, performance) to determine standardization opportunities in SDN, NFV, and related areas
  - Discussed possible future steps to make further progress on each such group
  - Agreed to start the process to form a formal Study Group with the objective of launching new standards activities in these areas under IEEE ComSoc sponsorship
  - Agreed to recruit contributors

Source: Meeting Report of IEEE Software Defined Ecosystem Standards Working Meeting (M. Ulema, May 2, 2014)

ATIS Standards & Technical Reports (TRs) on Network Reliability/Survivability developed at PRQC

Published:

- ATIS Technical Report on "Enhanced Network Survivability Performance", T1.TR.68-2001, February 2001
- ATIS Technical Report on "A Reliability/Availability Framework for IP-based Networks and Services", T1.TR.70-2001, Sept. 2001
- ATIS Technical Report on "Access Availability of Routers in IP-based Networks" T1.TR.78-2003, January 2003
- ATIS Technical Report on "Reliability Aspects of Next Generation Networks" (ATIS-0100002.2004)
- ATIS Technical Report on "Priority for NS/EP Services in NGN/IP Environment – Role of TSP" (ATIS-0100011.2007)
- ATIS Standard on "End-to End Service Availability: General Definition" (ATIS-0100016.2007)
- ATIS Standard on "Quantifying the Impact on IP Service Availability from Network Element Outages" (ATIS-0100020.2008)
- ATIS Standard on "Priority Classification Levels for Next Generation Networks" (ATIS-0100022.2008)
- ATIS Technical Report on "A Methodology for Estimating the Availability of Access IP Routers in Terms of Customer Facing Line Card Availability" (ATIS-0100025.2009)
- ATIS Technical Report on "A Methodology for Design of End-to-End Network Reliability for Proactive Reliability Planning" (ATIS-0100026.2010)
- ATIS Technical Report on "Availability – A Guide to Consistent Definitions" (ATIS-0100027.2010)
- ATIS Technical Report on "Network Resiliency Planning for Enterprise Customers" (ATIS-0100028.2010)
- ATIS Technical Report on "IP Network Disaster Recovery Framework" (ATIS-0300100.2011)
- ATIS Standard on "Defects Per Million (DPM) Metric for Transactions Services Such as VoIP" (ATIS-0100008.2007, Revision 2012)
- ATIS Technical Report on "Analysis of FCC-Reportable Service Outage Data" (ATIS-0100021.2012)
- ATIS Standard on "Mean Time Between Outages – A Generalized Metric for Assessing Production Failure Rates in Telecommunications Network Elements" (ATIS-0100030.2012)
- ATIS Technical Report on "A Method to Display Metrics Related to the Robustness of the Undersea Cable Infrastructure" (ATIS-0100031.2012)
- ATIS Technical Report on "Multi-Layer Coordination in All-IP Networks" (ATIS-0100033.2012)
- ATIS Standard on "Impact Weighted MTBF – A Metric for Assessing Reliability of Hierarchical Systems" (ATIS-0100037.2013)

ATIS PRQC Active Issues on Reliability & Performance (May 2014)

Current Active Issues / Documents Expected:

Issue #	Status	Title	Output
A0064	Active	IPTV Performance Management and Reporting (Formerly IIF Issue 113)	
A0063	Active	Video Content Definition for Optimal Service Quality in Adaptive Streaming Services (Formerly IIF Issue 122)	
A0062	Active	QoS/QoE Considerations for Telepresence Phase II	
A0061	Active	QoS & Reliability Aspects for PSTN Transition	
A0054	Active	ATIS PRQC Interaction with QuEST Forum TL9000 – Development of Availability, Reliability, Performance, and QoS Metrics for NGN Packet Networks	ATIS-0100033

ATIS: Alliance for Telecommunications Industry Solutions
PRQC: Performance Reliability & Quality Committee