THE SERVICE RELIABILITY ECOSYSTEM

©Michael Tortorella, Ph. D.
Managing Director
Assured Networks, LLC

THEME

SDN/NFV NETWORK RELIABILITY STANDARDS CAN'T BE SENSIBLY CONSTRUCTED UNLESS YOU FIRST KNOW WHAT SERVICE RELIABILITY TARGETS YOU ARE TRYING TO MEET

OVERVIEW

- Service examples
- Customers want reliable services
- There is a language for talking about service reliability
- There is a theory and a set of engineering principles supporting reliable services
- Service reliability requirements come first!

OVERVIEW

- Service reliability requirements are abstracted from any requirements for reliability of service delivery infrastructure (SDI) and its elements
- The reliability characteristics of the SDI determine the how reliable the service it supports will be
- The order in which you do things matters!
- Ecosystem diagram

TELECOM SERVICE EXAMPLES

- Voice telephony service
  - POTS network
  - Connectionless networks
  - Mobile
- Internet access service
  - TCP/ IP WAN backbone
  - Local access varies
    - + Dial-up
    - + DSL
    - + TV Cable
    - + Optical

TELECOM SERVICE EXAMPLES

- Various entertainment services
  - Most mediated by the Internet
- Complex combinations of services
  - Video teleconferencing
  - Point-of-sale credit approval
  - Mobile banking
- Peer-to-peer services

CUSTOMERS WANT RELIABLE SERVICES

- *PC Magazine* reliability ratings of ISPs
  - Internet access service "outages"
  - Upload and download speeds
- Customer reliability complaints about mobile services
  - Dropped calls
  - Echo
  - Slow data
- Verizon FiOS advertising "the fastest and most reliable Internet"

SERVICE RELIABILITY LANGUAGE

- Transactions
- Service failure classifications according to transaction phases
  - Accessibility
  - Continuity/ Fulfillment
  - Release
- Requirements for these are based on systems engineering understanding of customer needs and desires for satisfactory transactions in each service

SERVICE RELIABILITY
ENGINEERING PRINCIPLES

- Service failure modes can be catalogued
- Service failure mechanisms and failure causes are events or omissions in the SDI
- Congestion is always a factor in SDIs
  - Economically unreasonable to provision an SDI for every possible service demand
  - When SDI elements fail, a level of service demand that might have been supportable if everything were working properly will lead to increased congestion

SERVICE RELIABILITY
ENGINEERING PRINCIPLES

- So if you want to understand how reliable your service is,
  - Make a reliability model to relate the frequency and duration of service failures and outages to the frequency and duration of events or omissions in the SDI and/ or
  - Collect and analyze accessibility, continuity/ fulfillment, and release data
    - + DPM approach is followed by many service providers

SERVICE RELIABILITY
ENGINEERING PRINCIPLES

- And if you want to know what reliability requirements you should put on your SDI and its elements, “work the model backwards”

VOICE TELEPHONY
EXAMPLE

- Voice telephony (VT) is the ability to speak with another party beyond shouting distance
- VT was first delivered on an analog network
  - Panel, step-by-step, crossbar switching
  - Twisted pair, coax, microwave transport
- In the 1960s-1970s, VT began to be provided on a digital network
  - Seamless transition to
    - + Electronic switching
    - + SONET/ SDH, OC-3-12-48-292, and many other digital transport systems

VOICE TELEPHONY EXAMPLE

- Nobody noticed! Customers don't know or care what technology you are using to provide their service
- This important principle means that service reliability requirements are invariant with respect to the nature of the SDI you use to deliver the service

VOICE TELEPHONY
EXAMPLE

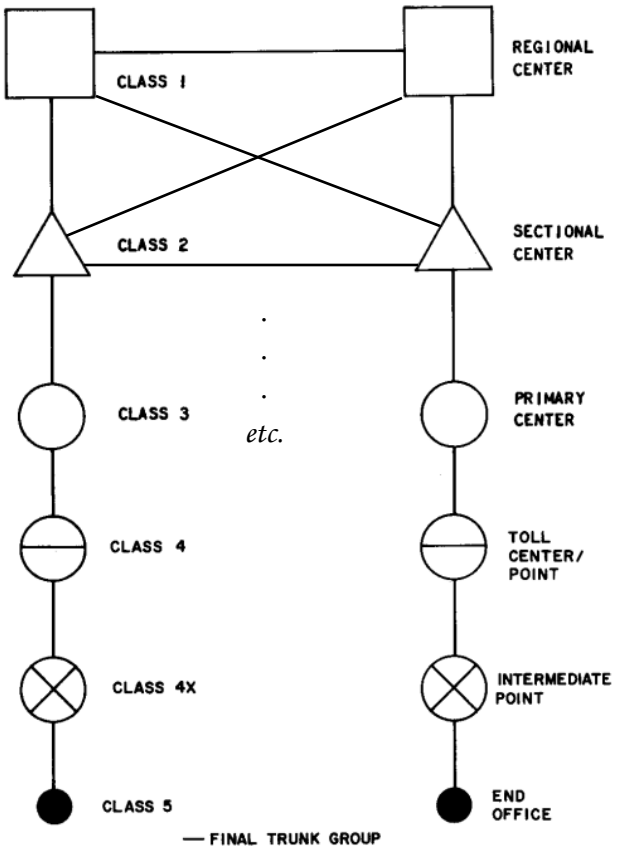
ASSURED NETWORKS

- "Carrier grade" service accessibility has always been claimed to be ≥ 0.99999 ("5 nines")
  - Does not account for delays
  - No local – toll distinction
- "Carrier grade" service continuity objective was "no more than 250 DPM" (for exponentially-distributed holding times with a mean of 6 minutes)
- Service release failures were so rare that no one cared
- Some important questions still linger
  - Was the 2 hours downtime in 40 years switching system requirement really necessary?

VOICE TELEPHONY
EXAMPLE

- Reliability model for the POTS network based on the 5-level hierarchy in the toll network
  - Using cut set – path set methods combined with renewal-reward capacity models for network elements
  - Originally, this was for the analog network (slide 16)
    - + But the structure of the digital network was similar
    - + With digital, loss/ noise/ echo were no longer issues so service fulfillment (slide 8) became simpler
  - Later, signaling ran on a separate SS7 network
    - + So signaling network failures need to be incorporated also
- AFAIK, a complete POTS reliability model was never satisfactorily carried to conclusion
  - Used "representative connections" approach instead
  - Generalized to histogram of connection types

VOICE TELEPHONY
LL TOLL HIERARCHY



VOICE TELEPHONY EXAMPLE

- VT can also be provided on a TCP/ IP network
- Then it is called “VoIP” - but it is still a voice telephony service
- Service reliability requirements are the same!
  - Accessibility ≥ 0.99999
  - Continuity ≤ 250 DPM
  - Fulfillment?
  - Release again negligible

VOICE TELEPHONY EXAMPLE

- What kind of TCP/ IP network model do you need to extract these voice telephony service reliability descriptors?
- "Representative connections" makes no sense
- Simulation models hold promise
  - The gov't communication folks use these
- Need to grapple with router and transport systems reliability/ capacity curves

INTERNET ACCESS
EXAMPLE

- The service is the simple ability to connect to the internet
- Service accessibility is the probability that you can bring up your home page when you want
  - Requirement? Any page?
- Service continuity is the probability that your browsing session will be interrupted by loss of internet connectivity
  - Requirement?

INTERNET ACCESS
EXAMPLE

- Service fulfillment is the probability that perceptual aspects (delays, video quality, etc.) of the experience are "satisfactory"
  - Requirements?
- Service release is the probability that the internet connection goes away when you dismiss it
  - Maybe not as simple as it used to be because malware continually introduces new wrinkles
  - Requirements?

INTERNET ACCESS
EXAMPLE

- Catalog accessibility, continuity, and release failure modes
- Catalog associated failure mechanisms and failure causes in the TCP/ IP network
- One of the reasons for inconclusive discussions about internet access service reliability is that not everyone agrees on the language
  - Telephone people
  - IT people
- Standardization can help here

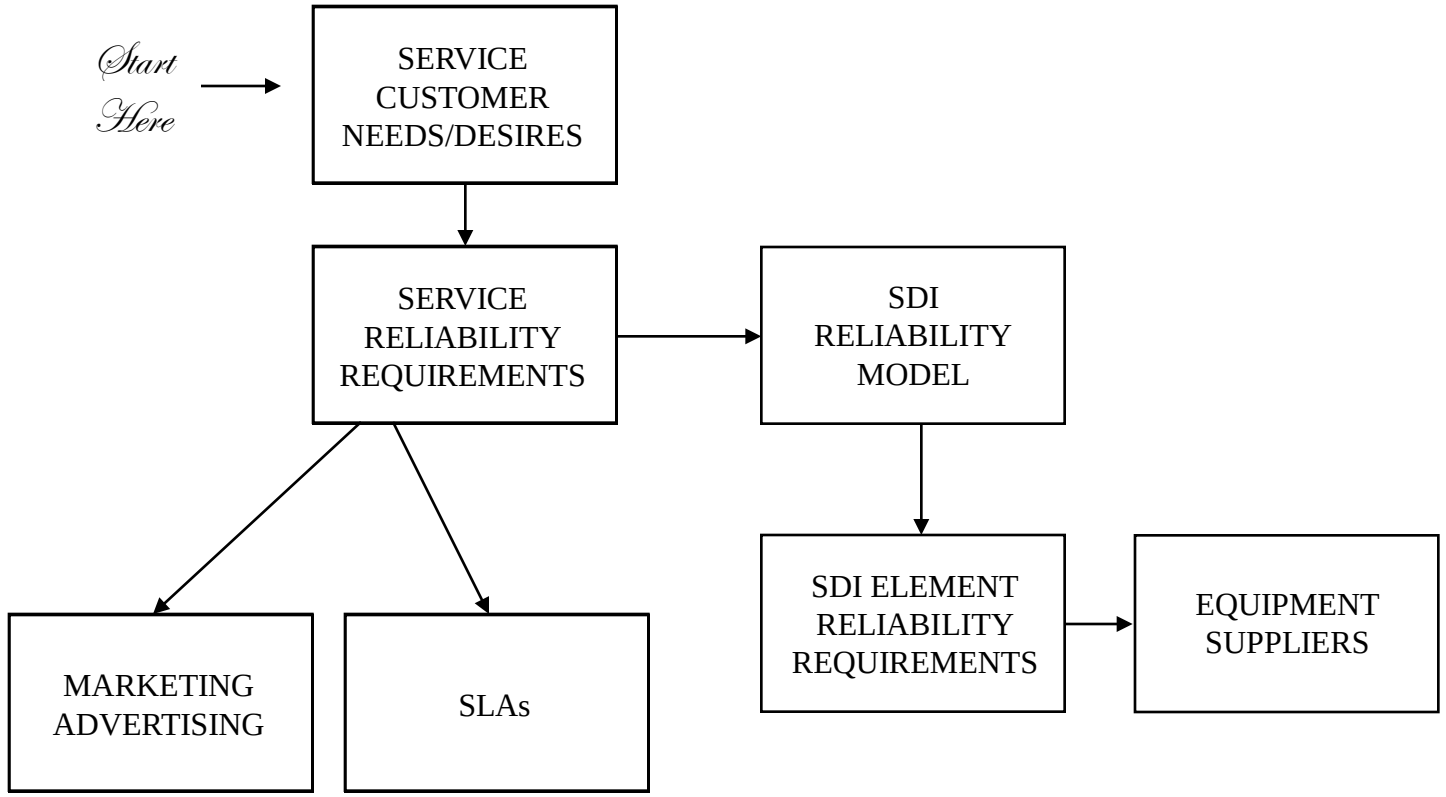
INTERNET ACCESS
EXAMPLE

- Reliability models for TCP/ IP networks are considerably more complicated
- Analytical approaches via limit theorems for connectionless networks with unreliable elements
- Simulation approaches via OpNET, OmNET, etc.
- Whatever model is used, it needs to be focused on accessibility, continuity, and release at the service level

CONSEQUENCES OF INADEQUATE SERVICE RELIABILITY ENGINEERING

- Overprovisioning the SDI
  - Excess CAPEX
- Underprovisioning the SDI
  - More service failures than desirable
    - + Excess congestion
- Failures in network elements make the network look underprovisioned for the period of time the outages persist

SERVICE RELIABILITY ECOSYSTEM DIAGRAM



SOME BENEFITS OF STANDARDIZATION

- Promote the idea of focusing on the service first
  - Not every service provider need offer the same service reliability
  - A service provider can offer different grades of service reliability
  - Customers can make comparisons, analyze SLAs, etc.
- Promote a common language across the various stakeholder communities
- Abstract the service reliability requirements from the SDI element reliability requirements
  - Rational approach to SDI reliability requirements

SOME BENEFITS OF STANDARDIZATION

- Use the service reliability ecosystem to establish a process-based approach to SDI design and provisioning
- A clear path forward for the hard technical work of devising reliability requirements for SDN/ NFV networks and their elements
- The next generation of telecom engineers won't have to reinvent this wheel
  - Some "new" "better" technology will come along to succeed SDN/ NFV